rasProject_01 / weSweetHome

R. 96 2025-10-14

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Chapter 1

rasProject1 - process control with Raspberry Pi

The ideas behind using a Raspberry Pi for process control are published in **raspberry4distributed↩ Control.pdf** (dir) at **a-weinert.de**.

1.1 Process control features

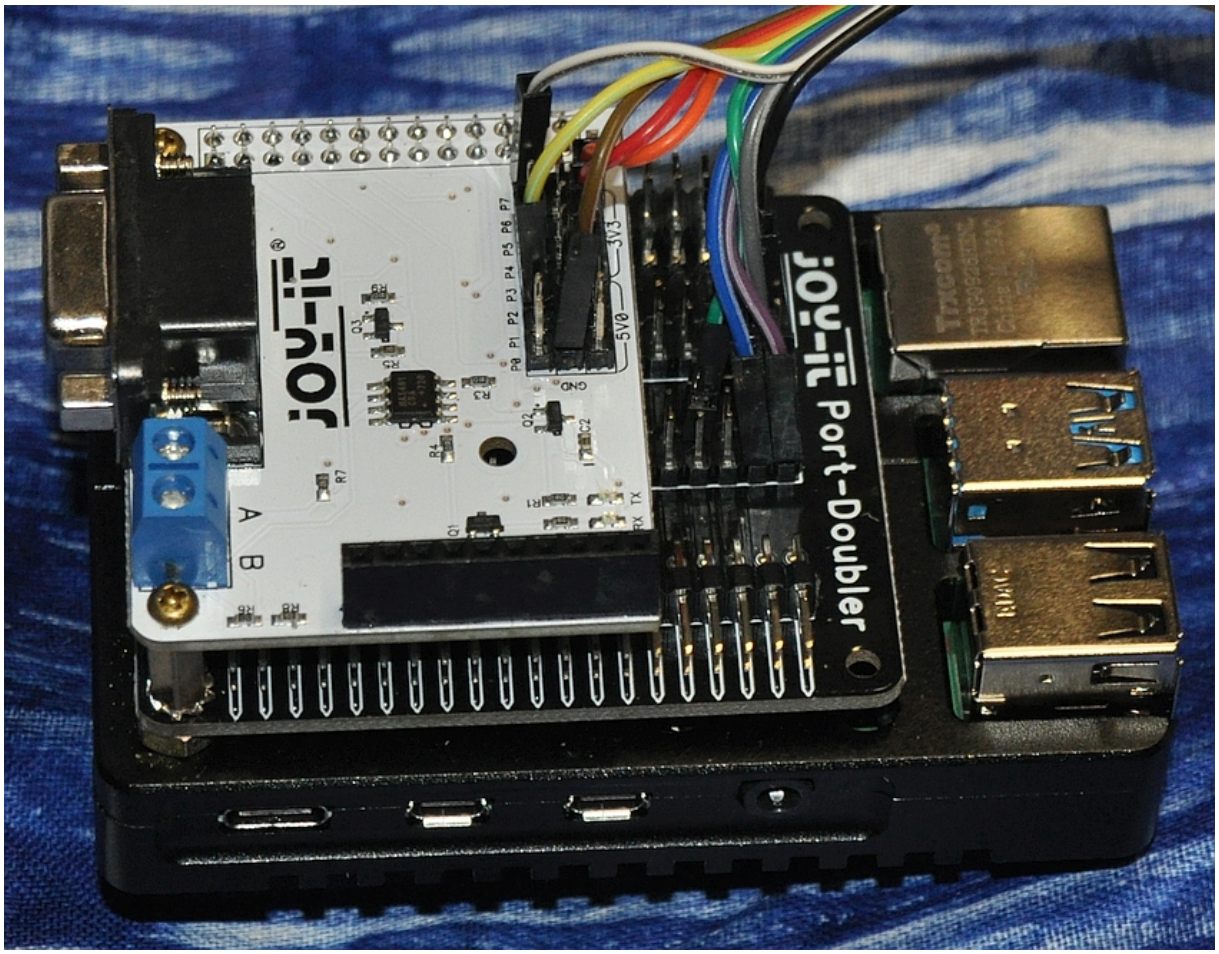

Figure 1.1 RasPi4 with RS485 and GPIO

By certain configuration and utilising constraints we get 24/7 base for control software with

- cycles (1ms, 10ms, 20ms, 100ms, 1s)
- support for Modbus, MQTT, 1-wire and more
- HMI via Web-interface
- watchdog

Compared with industrial PLCs and weAut01 there is

- no supervising of power supply, and, hence
- no (cycle for) programmable reaction on power outages

Devices supported by the library include

- modbus power meters
- PV inverter
- bar code / QR code reader
- DCF77 receivers and else

The preferred Raspberry test and target platform for control applications is a Pi3 or Pi4 with a non graphical OS. But other (Pi 0) and older platforms (Pi1) may be sufficient sometimes. To handle differences (GPIO pinning e.g.) in a uniform way, the include files in this directory describe those platforms. On the other (dark) side you won't find Pi5 due to its breaking all GPIO handling compatibilities of Pi0..4.

1.2 A note on Copyright and License

For software and documentation developed for this project:

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1.3 Raspberries' architecture differences

The different Raspberry types, like Pi1, 3, 4, Zero (0) etc. but no Pi5 can be handled transparently to the control programs. This is done by a make variable TARGET identifying a concrete target machine and, hence, the architecture, via the PLATFORM variable. The latter can also be set directly as PLATFORM = raspberry_03 e.g.. raspberry_04 is the default by the way.

By the variable TARGET we do also switch between a 32bit and a 64 bit cross platform tool chain. Obviously, the installed OS is a "fixed" property of the concrete Pi. The mechanism used is calculated make includes and calculated C includes. See config.h and config_raspberry_04.h for the mechanism and the 40 pin IO. (For 26 pin see config_raspberry_01.h.)

Chapter 2

Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

Chapter 3

File Index

3.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 4

Data Structure Documentation

4.1 cmdLookUp_t Struct Reference

Structure for a defined remote command.

`#include <sweetHome.h>`

Data Fields

- char **command** [22]

  command max. 20 characters
- uint32_t **mask**

  command value (usually 1 bit set)

4.1.1 Detailed Description

Structure for a defined remote command.

This structure combines a command's short / mnemonic name used as query string, like "startPump", and the command's (cmdBits_t) bit value resp. mask usually defined as makro, like START_HWPUMP_COMMAND.
An array cmdLookUp_t cmdLookUp[] (e.g.) is used to define and look-up a command given in a query string. The array's end must be an entry {"", 0}, i.e. empty mnemonic and no command bit.

The documentation for this struct was generated from the following file:

- include/sweetHome.h

4.2 cycTask_t Struct Reference

Cyclic or event driven task / threads structure.

`#include <weUtil.h>`

Data Fields

- union {
  cycTaskEventData_t cycTaskEventData
  < *allow different event data for cyclic and other event types*
  };

  Event data for cyclic and other event types.
- pthread_cond_t **cond**

  the event occurred condition
- uint32_t **count**

  the event counter (modified by manager, only)
- timespec **stamp**

  absolute / monotonic event stamp (dto.)

4.2.1 Detailed Description

Cyclic or event driven task / threads structure.

This structure supports the organisation of tasks respectively threads to work all on a same event type. One common case is the event being a next time interval, like the next 100ms entered, and, as thread e.g., the process control tasks to work on the 100ms cycle.

Such approach involves two types of threads:
One controller/manager determining the event, recording it by increasing the event counter and signalling all worker threads.
Zero to some worker threads doing work on every or every other etc. event, usually by holding and updating an event counter value at which to do the work.

The main purpose are absolute time driven cyclic tasks as usual in industrial PLCs.
For the standard cycles provided here, 1ms, 10ms .. 100ms, 1s the handler thread is provided as singleton doing other time and date related jobs for all; see theCyclistStart(), theCyclistWaitEnd() and endCyclist().

See cyc1ms, cyc10ms, cyc20ms, cyc100ms, cyc1sec
See also have1msCyc, have10msCyc ... have1secCyc

4.2.2 Field Documentation

4.2.2.1 cycTaskEventData

```
cycTaskEventData_t cycTaskEventData
```

< allow different event data for cyclic and other event types

cyclic event data

4.2.2.2

```
union { ...  } @10
```

Event data for cyclic and other event types.

This union allows for different event data types for different types of events like cyclic ticks, or any other event types. Anyway the information must be copied by the event controller / manager under mutex lock to the event handler's (i.e. this) task structure.

The documentation for this struct was generated from the following file:

- include/weUtil.h

4.3 cycTaskEventData_t Struct Reference

Event data for cyclic tasks.

```
#include <weUtil.h>
```

Data Fields

- uint8_t **cnt10inSec**

  0..9; counts 100ms events in the second
- uint64_t cnt1ms

  A ms counter for cycles and tasks.
- uint8_t **cnt210sec**

  0..209 s counter (to provide n s periods)
- timespec **cycStart**

  monotonic start time of the cycle
- int **cycStartMillis**

  millisecond (0..999) missing in struct tm
- struct tm cycStartRTm

  The broken down calculated local start time.
- int **hourOffs**

  actual time zone offset in hours (incl. DST +: east)
- uint8_t **msTo100Cnt**

  0..99; at 0 we will have a 100ms event
- uint32_t realSec

  The real time epoch seconds.
- char **rTmTxt** [34]

  local time as text

4.3.1 Detailed Description

Event data for cyclic tasks.

This structure holds data — mainly time and date by diverse clocks and cycle counters — to be used by cyclic tasks. It will be provided as as cycTask_t.cycTaskEventData.

4.3.2 Field Documentation

4.3.2.1 realSec

```
uint32_t realSec
```

The real time epoch seconds.

The value may jump with coarse NTP corrections. And it will be not precise and or jump with leap seconds, which can't be handled in UTC.

4.3.2.2 cycStartRTm

```
struct tm cycStartRTm
```

The broken down calculated local start time.

This is the cycle start / event local time.
It is kept updated by the cyclist (when having been started; see theCyclistStart).

4.3.2.3 cnt1ms

```
uint64_t cnt1ms
```

A ms counter for cycles and tasks.

This ms counter may be used to time stamp IO values and other events in a unique and sortable manner.
It is 1 in all first cycles (signalled as event) when the cyclist is started without delay. Otherwise the first value is this delay. The value 0 will will correspond to allCycStart.

Usually the lower 32 bits (cast (uint32_t)) should be sufficient. The lower 32 bit will wrap after 49.7 days.
For an absolute stamp in seconds resolution see cycTaskEventData_t.realSec and

The documentation for this struct was generated from the following file:

- include/weUtil.h

4.4 dayStrtVal_t Struct Reference

Day start values.

```
#include <sweetHome.h>
```

Data Fields

- float meterValDay [2][2]

  Start day meter values.
- uint32_t stmpSDay

  Absolute time stamp for the day's start values.
- uint8_t valQual

  Quality of the values.

4.4.1 Detailed Description

Day start values.

This structure combines mainly meter reading values for import and export work (cf. makros Wimp, Wexp, PL1 etc.) to be put in / got from a binary daily retain file.

Attention: Variables of this type dayStrtVal_t are kept in shared memory by several programs. Changing order or size for sake of one program almost certainly will spoil the others.

4.4.2 Field Documentation

4.4.2.1 stmpSDay

```
uint32_t stmpSDay
```

Absolute time stamp for the day's start values.

This stamp marks the import and export work values of a successful meters reading very early in the current day. If a early day reading was neither taken nor read from retained values the application would put the first successful reading after program start here.

0 marks no values taken so far.

4.4.2.2 meterValDay

```
float meterValDay[2][2]
```

Start day meter values.

This array contains for every meter the import and export work as quadReg_t.f[0] and [1] respectively taken at dayStrtVal_t.stmpSDay.

4.4.2.3 valQual

```
uint8_t valQual
```

Quality of the values.

0: invalid
1: taken any time of day at program start
2: taken at predefined (fixed) time at change of day

Note: Even when having high quality values (for consecutive days), consider days may have 23 or 25 h in zone time, also.

The documentation for this struct was generated from the following file:

- include/sweetHome.h

4.5 dcf77recPerData_t Struct Reference

Data for one received DCF77 AM period.

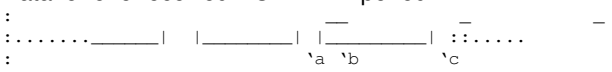
```
#include <weDCF77.h>
```

Data Fields

- uint32_t cbTic
  The system tick at second's start (notation).
- uint32_t per
  The period's duration.
- char sysClk [14]
  The system time as text hh:mm:ss.mmm at second's start.
- uint32_t tic
  The GpioD time tick.
- uint32_t tim
  The modulation's duration.

4.5.1 Detailed Description

Data for one received DCF77 AM period.



This structure holds the minimal values of one received DCF77 modulation period, i.d. amplitude 15% from a to b and full modulation from b to c = next a.
Nothing is said about a correct timing signal or a receiver module error or EMI.

4.5.2 Field Documentation

4.5.2.1 tic

```
uint32_t tic
```

The GpioD time tick.

This is the tick (see get_current_tick()) at point a, i.e. begin of 15% AM. get_current_tick() is a unsigned 32 bit μs counter wrapping around about every 72 min.
For a correct modulation signal this marks a second's begin.
As described at dcf77recPerData_t::per, with lower grade AM receiver modules it may also mark the beginning of a non filtered spike.

The current `uint32_t` tick is got by `get_current_tick(int pi)`. It can be used in user to calculate how far in past the the last received DCF77 second's start is.
`delay = get_current_tick(::thePi) - recStruc.tic`
will work even when the unsigned 32 bit tick wraps around about every 72 min.

4.5.2.2 sysClk

```
char sysClk[14]
```

The system time as text hh:mm:ss.mmm at second's start.

In fact it is the time when the call back function for start of 15% AM is called.

4.5.2.3 cbTic

```
uint32_t cbTic
```

The system tick at second's start (notation).

In fact it is the time when the call back function for start of 15% AM is called. By the event to callback delay cbTic should be later than tic.

4.5.2.4 tim

```
uint32_t tim
```

The modulation's duration.

This is the time from point a to b in μs. With a correct signal this difference is the length of the transmitted serial bit. Ideally it would be either 100000μs for logical 0 respectively FALSE or 200000μs for logical 1 respectively TRUE.

4.5.2.5 per

`uint32_t per`

The period's duration.

This is the time from point a to c in μs. This difference is the full period. Ideally it would be either 1000000μs for seconds 0 to 57 and 2000000μs for the seconds 58 and 59 combined. In the case of a leap second the numbers would be 0 to 58 and 59 and 60.

Hence this variable's value is the real source of all information, like start of minute and the serial telegram.

For real world DCF77 AM receivers one will see a wide range instead of these ideal numbers. Additionally, lower grade receivers (the Pollin module being the most prominent of them) will insert false ON periods. Sometimes those "spikes" affect a third of all seconds. Additionally some seconds will be infected by more than one spike.

Obviously, without some filtering one would never get sensible information from lower grade modules or conditions. For the very first one or two receptions (after registering the receive call back, usually dcf77receiveRec) this value and dcf77recPerData_t::tim will be wrong.

The documentation for this struct was generated from the following file:

- include/weDCF77.h

4.6 dualReg_t Union Reference

A 32 bit union.

`#include <basicTyCo.h>`

4.6.1 Detailed Description

A 32 bit union.

This structure serves formatting and endianess plumbing purposes.

Besides that some Modbus devices use two (dual) so called registers of the standard Modbus 16bit size for one float. Some Modbus manufactures call such dual register a "parameter".

As Modbus has no data types except for the 16 bit register (with whatever semantic) libmodbus will handle the endianess for that two byte registers but can do nothing for bigger data types. Many modbus servers will use 32 bit and longer types. EASTRON smart meters handle all measurements as 32 bit floats and call that type "parameter". Hence 1 parameter is 2 registers in default big endian register ordering.

The union dualReg_t allows all endian repairs for such "parameter" type.

The documentation for this union was generated from the following file:

- include/basicTyCo.h

4.7 durDiscrPointData_t Struct Reference

Values for discrimination of duration.

`#include <weDCF77.h>`

Data Fields

- char c
  Charakter.
- unsigned i
  Index.
- char n [6]
  Name.
- uint32_t v
  Value.

4.7.1 Detailed Description

Values for discrimination of duration.

This structure holds the data of one discrimination point.
The primary value type are duration as uint32_t in μs.

4.7.2 Field Documentation

4.7.2.1 i

`unsigned i`

Index.

The lowest value in a chain (array or enum) shall get the index 0.
This value[0] shall be the upper value of the discrimination range [lowest possible / measurable values ... v[0]-1].
For an unsigned value type (used here) the lowest possible value is 0 while the lowest measurable value might be higher.
v[j] <= v[j+1] must hold.

4.7.2.2 v

`uint32_t v`

Value.

This is the upper bound value of the range.
The highest value in a chain (array or enum) is implied as the maximum possible / measurable value and must, hence, never be used in a comparison and shall be set to MXUI32 (=UINT32_MAX).
v[j] <= v[j+1] must hold.

4.7.2.3 n

```
char n[6]
```

Name.

This is a short (5 character max.) name of the discrimination range, like, e.g., "spike", "error", "1 sec", "0" etc.

4.7.2.4 c

```
char c
```

Charakter.

This is a recognisable character for the discrimination range, best unique for the complete chain. It may be used for (narrow) logs instead of durDiscrPointData_t::n.

The documentation for this struct was generated from the following file:

- include/weDCF77.h

4.8 memAlloc_t Struct Reference

Structure for allocated, re-allocatable memory.

4.8.1 Detailed Description

Structure for allocated, re-allocatable memory.

The documentation for this struct was generated from the following file:

- getLocalWeatherData.c

4.9 meterVal_t Struct Reference

One smart meter's readings.

```
#include <sweetHome.h>
```

Data Fields

- int **err**

  0: OK -99: not set
- int **hourOffs**

  actual offset in hours of local time zone (+ is east)
- uint16_t **ms**

  ms supplement to stmpS
- uint16_t **msDurRead**

  duration on Modbus read (successful or timed out)
- float **pSum**

  power sum (all, all three or the relevant phases) [W]
- char **rTmTxt** [34]

  local time as text; length is 32
- uint32_t stmpS

  Absolute time stamp for the current value.
- float vals [18]

  Compact and re-sorted meter readings.

4.9.1 Detailed Description

One smart meter's readings.

The (first) four timing values are the start of reading; to have the end add .msDurRead.

4.9.2 Field Documentation

4.9.2.1 stmpS

```
uint32_t stmpS
```

Absolute time stamp for the current value.

This value and its supplements meterVal_t.ms, meterVal_t.hourOffs and meterVal_t.rTmTxt are updated at every Modbus read.

4.9.2.2 vals

```
float vals[18]
```

Compact and re-sorted meter readings.

These values are to be updated on every error-free meter reading (by Modbus, RS485 e.g.). The indexes are: /code 0..2 : U (L1, L2, L3) 3..5 : I (L1, L2, L3) 6..8 : P (L1, L2, L3) 9 : f 10, 11 : Wimp Wexp 12..14 : phi (L1, L2, L3) 15..17 : reserve (not used in R.115) /endcode

The documentation for this struct was generated from the following file:

- include/sweetHome.h

4.10 modBvals_t Struct Reference

Modbus readings and other process values.

`#include <growattHome.h>`

Data Fields

- sdm124regs_t **hld0Regs**
  a stack of 124 holding registers
- int **hourOffs**
  actual offset in hours of local time zone (+ is east)
- sdm124regs_t **imp0Regs**
  a stack of 124 input registers
- uint16_t **ms**
  ms supplement to stmpS
- int **retHimp59**
  modbus 15 holding registers from 59 return
- int **retHimp9**
  modbus 20 holding registers from 9 return
- int **retRimp0**
  modbus 34 input register from 0 read return
- char **rTmTxt** [34]
  local time as text; length is 32
- uint32_t **stmpS**
  epoch time; s since 1.1.1970 (until 7.2.2106)

4.10.1 Detailed Description

Modbus readings and other process values.

This structure unites all inverter readings and settings plus some common evaluation and process control values.

The four timing data will mark the the evaluation and forwarding time of the complete structure/information. For the meter read times see the equivalent data in the structure .meterVal, which will be 300 .. 600ms older for the meter's latest read (+1s for every other meter read earlier).

The documentation for this struct was generated from the following file:

- include/growattHome.h

4.11 modRS_t Struct Reference

Structure for Modbus RS485 (RTU).

`#include <weModbusRedu.h>`

Data Fields

- int **baud**
  default 9600
- uint16_t **conErrCnt**
  error count for connection trials
- modbus_t * **ctx**
  Pointer to (libmodbus) Modbus structure.
- char device [21]
  Modbus RTU / RS485 device address as string.
- int **hourOffs**
  actual offset in hours of local time zone (+ is east)
- uint16_t **ms**
  ms supplement to stmpS
- char **parity**
  default N
- modRS485state_t **rsState**
  interface state
- char **rTmTxt** [34]
  local time as text; length is 32
- uint32_t **stmpS**
  epoch time of last connect [error]; s since 1.1.1970
- int **stopBits**
  default 1

4.11.1 Detailed Description

Structure for Modbus RS485 (RTU).

4.11.2 Field Documentation

4.11.2.1 device

```
char device
```

Modbus RTU / RS485 device address as string.

example: /dev/serial0 (Raspberry's UART GPIO15/16 TxD/RxD) or /dev/ttyS0

The documentation for this struct was generated from the following files:

- include/weModbus.h
- include/weModbusRedu.h

4.12 modSharMem_t Struct Reference

Structure for shared memory.

`#include <growattHome.h>`

Data Fields

- uint16_t **copInCnt**
  values copy in count; incremented by server
- modBvals_t **modBvals**
  the values; copied in form the server

4.12.1 Detailed Description

Structure for shared memory.

The documentation for this struct was generated from the following file:

- include/growattHome.h

4.13 modTCP_t Struct Reference

Structure for Modbus TCP.

`#include <weModbus.h>`

Data Fields

- char addr [21]
  Modbus IP (4) address as string.
- modbus_t * **ctx**
  Pointer to (libmodbus) Modbus structure.
- modBusLinkState_t **mlStat**
  connection/slave state
- uint16_t port
  Modbus IP port.

4.13.1 Detailed Description

Structure for Modbus TCP.

4.13.2 Field Documentation

4.13.2.1 addr

```
char addr[21]
```

Modbus IP (4) address as string.

for server: 0.0.0.0 (accept from all)

4.13.2.2 port

```
uint16_t port
```

Modbus IP port.

default value: 1502; Hint: 502 will need sudo for the server.

The documentation for this struct was generated from the following file:

- include/weModbus.h

4.14 oneWireDevice_t Struct Reference

A structure for 1-wire devices.

```
#include <we1wire.h>
```

Data Fields

- char **contBuf** [80]
  read content buffer
- char **name** [16]
  short sensor name (8 characters max., 6..8 recommended)
- int **value**
  value in mgrdC (1/1000 °C)
- char **valueFile** [56]
  value file path
- char valueGrdC [8]
  The value as floating point string.

4.14.1 Detailed Description

A structure for 1-wire devices.

4.14.2 Field Documentation

4.14.2.1 valueGrdC

```
char valueGrdC[8]
```

The value as floating point string.

This string is equivalent to ((float)value) / 1000.0 formatted right aligned with %6.2f. The bad value will be "-99.9 ". The function getTemp() will provide this strings without floating point arithmetic nor format string parsing. value in grdC (as %6.2f string)

The documentation for this struct was generated from the following file:

- include/we1wire.h

4.15 phPckSwSet_t Struct Reference

Simple Structure for phase packet switch setting.

```
#include <sweetHome.h>
```

Data Fields

- uint8_t **offPhases**
  number of off phases
- uint8_t **onPhases**
  number of on phases (20ms periods at 50Hz)

4.15.1 Detailed Description

Simple Structure for phase packet switch setting.

The documentation for this struct was generated from the following file:

- include/sweetHome.h

4.16 sdm124regs_t Union Reference

A type for 124 registers respectively 62 values of 32 bit.

```
#include <basicTyCo.h>
```

4.16.1 Detailed Description

A type for 124 registers respectively 62 values of 32 bit.

Modbus RS484 has a very restricted maximum telegram length of 256, allowing for 252 data bytes, respectively 248 value bytes or 124 registers in say FC4 (read input registers). See sdm80regs_t

The documentation for this union was generated from the following file:

- include/basicTyCo.h

4.17 sdm80regs_t Union Reference

A type for 80 registers respectively 40 values of 32 bit.

```
#include <basicTyCo.h>
```

4.17.1 Detailed Description

A type for 80 registers respectively 40 values of 32 bit.

Modbus RS484 (aka Modbus/RTU; RTU = Remote Terminal Unit) has a very restricted maximum telegram length of 256, allowing for 252 data bytes, respectively 248 value bytes or 124 registers in say FC4 (read input registers); see sdm124regs_t. EASTRON smart meters restrict this further to 80 registers respectively a maximum of 40 float values, called parameters.

The documentation for this union was generated from the following file:

- include/basicTyCo.h

4.18 semCtlPar_t Union Reference

Parameter type for semctl().

```
#include <weShareMem.h>
```

4.18.1 Detailed Description

Parameter type for semctl().

The documentation for this union was generated from the following file:

- include/weShareMem.h

4.19 smdX30modbus_t Struct Reference

A structure for SMDx30 smart meters.

`#include <basicTyCo.h>`

Data Fields

- uint16_t **errorCount**
  for the application to handle recurring errors
- int **lastRetCode**
  for the application to keep last return/error value
- modBusLinkState_t **linkState**
  state of the (slave's) communication link
- char **name** [10]
  short meter name (8 characters max., 6..8 recommended)
- int slave
  phase i title (max. 30; line1 e.g. or battery/heater)
- char **tiPh** [3][32]
  short phase i name (max. 5, 2 or 3 recommended; L1 e.g.)
- char **title** [32]
  meter explanation name (30 characters max.)

4.19.1 Detailed Description

A structure for SMDx30 smart meters.

RS458 communication and state related data plus one set of 40 input data (two 16 bit MOdbus registers as one float, also called "parameter" by meter's manufacturer).

4.19.2 Field Documentation

4.19.2.1 slave

`int slave`

phase i title (max. 30; line1 e.g. or battery/heater)

Modbus slave number 1..247; 0: all undefined

The documentation for this struct was generated from the following file:

- include/basicTyCo.h

4.20 state_t Struct Reference

The structure for state machines.

`#include <weStateM.h>`

Data Fields

- union {
  enterState_t const doEnter
  This state machine's function to enter it.
  enterStateF_t const **doEnterF**
  Float control substitute or addendum to state_t.doEnter.
  enterStateS_t const **doEnterS**
  Character control substitute or addendum to state_t.doEnter.
  };

  Just one enter function (type).
- union {
  };

  This state machine's function to leave it.
- union {
  };

  This state machine's trigger respectively check function.
- float **controlF**

  the analogue / float control value (some state types)
- uint32_t **controlV**

  the integer control value (most state types)
- char controlVS [8]

  The control value for the state machine in question.
- genStateText_t doGenStateText

  This state machine's function for status text generation.
- uint32_t endTime

  The end time of a state or sub-state.
- char **infoTxt** [36]

  state infotext (provided by application software)
- uint8_t instanceB [4]

  Four byte values to the state machines disposal.
- float instanceF [3]

  Three float values to the state machines disposal.
- char const name [22]

  State machine name.
- uint8_t const offChainEnd

  Length of OFF chain.
- uint8_t const onChainEnd

  Length of ON chain.
- onStateChange_t const onStateChange

  This state machine's callback function for state changes.
- uint32_t **realSecOff**

s time stamp of last exit transition

- uint32_t **realSecOn**

  s time stamp of last enter transition
- uint8_t status

  Status number.
- uint8_t subStatus

  Addendum to status for more complicated state machines.
- float threshBadLo

  The bad Lo limit.
- float **threshCritLo**

  The critical Lo limit.
- float threshOFF

  The lower or OFF threshold.
- float threshON

  The higher or ON threshold.
- uint8_t const typ

  State machine type.

4.20.1 Detailed Description

The structure for state machines.

The semantics and usage of most fields depends on the type state_t::typ of the state machine and often on concrete implementations (instance).
Fields normally unused by the design of the basic type state_t::typ may, with caution, be used by the code making or using concrete state machines.

4.20.2 Field Documentation

4.20.2.1 name

```
char const name[22]
```

State machine name.

The names must be unique within one application and best also within a site as it usually will appear in logs as the only identifier of a state machine.

The maximum length is 20. It is recommended to have all state names the same length in an application or better site if feasible. This gives better readability of state machine logs (see logStateText()).
Our current common value is 12.

4.20.2.2 typ

```
uint8_t const typ
```

State machine type.

As of Revision 193 the following types are defined and recognised by genStateText() respectively logStateText(): /code 0xAD: Timer, seconds resolution, UTC stamp 0xDB: switch de-Bounce 0xFF: Float value hysteresis 0x5B: 5 band check ...badLO | critLo | OK | critHi | badHi... 0xFC: sequential Control (SFC) /endcode

4.20.2.3 onChainEnd

```
uint8_t const onChainEnd
```

Length of ON chain.

With SFCs (typ 0xFC) this (or a greater) subStatus value in ON chain will lead to the stable (1:0) ON state. This value is set finally at SFC construction and can't be changed hence on. I.e, this member can be set just once in the respective constructor macro. This corresponds to a "blank final" object variable in Java.
The same holds for onChainEnd, name and typ.

A value of, e.g., 4 would produce an on chain (0:1)->(0:2)->(0:3)=>(1:0) when not changed in a onStateChange function.

With switch de-Bounce (typ 0xDB) it is the up-counter level to recognise ON.

Other state machines defined so far don't define a use for this member variable. See also offChainEnd

4.20.2.4 offChainEnd

```
uint8_t const offChainEnd
```

Length of OFF chain.

With SFCs (typ 0xFC) this (or greater) subStatus value in OFF chain will lead to the stable (0:0) OFF state. This value must be set at SFC construction and should not be changed hence on.
A value of, e.g., 8 would produce an off chain (1:6)->(1:7)=>(0:0) when not changed in a onStateChange function.
Trick: Lower parts of the off-chain may be used as a check / stay on state machine, e.g. (1:1)->(1:2)-(1:3)->(1↩
:4)=>(1:1). By setting the substatus to 5 or allowing it to increment to 5 in the example would enter the "real" off chain.

With switch de-bounce (typ 0xDB) it is the down-counter start value to recognise OFF at 0.

Other state machines defined so far don't define a use for this member variable.

4.20.2.5 doEnter

```
enterState_t const doEnter
```

This state machine's function to enter it.

The fitting function to enter this state, respectively to start its transition from OFF to ON might be recorded in and then called via this function pointer.

4.20.2.6

```
union { ... } @4
```

Just one enter function (type).

Any state machine object (instance) will have a distinct final enter function, the type of which is specific for the state machine type. Hence a union over the (currently three) possible function types is well justified.
The same holds for the doLeave and tickCheck types.

Note: Unions of state variables designated for use only in separate types were banned as of Rev. 86. The savings of memory space by those unions were not worth the danger of hard to find errors, when underlying the assumptions were violated.

4.20.2.7

```
union { ... } @6
```

This state machine's function to leave it.

The fitting function to leave this state, respectively to start its transition from ON to OFF might be recorded in and then called via this function pointer.

4.20.2.8

```
union { ... } @8
```

This state machine's trigger respectively check function.

The fitting function to check if a change of state_t.status or state_t.subStatus is due might be recorded in and then called via this function pointer.

4.20.2.9 onStateChange

```
onStateChange_t const onStateChange
```

This state machine's callback function for state changes.

The fitting function to be called on a real change of state_t.status and depending on type also on changes of state_t.subStatus must be recorded in this function pointer. In contrast to the other function pointers in this state_t structure, this pointer should not be NULL.

4.20.2.10 doGenStateText

```
genStateText_t doGenStateText
```

This state machine's function for status text generation.

The default setting will be genStateText().

4.20.2.11 status

```
uint8_t status
```

Status number.

State numbers together with sub state numbers (if applicable) must be unique, and best dense (0..n-1) within a concrete state machine (being in exactly one of n states). Status number 0,0 is reserved for the machine's default / reset / OK state.

State machines with just two (big / first level) states can best be modelled having just one "singleton" state being either On or Off.

timer (AD):
1: (still) running; 0: ended

simple:
0: OFF; else: ON

SFC (FC):
0,0: OFF
0,x: chain to ON
4,x: chain to ON interrupted
1,0: ON
1,x: chain to OFF
5,x: chain to OFF interrupted;

Five band check (5B):
2: bad Hi
1: critical Hi
0: OK (and, hence, here usually ON while 2 and 6 would mean OFF)
5: critical Lo
6: bad Lo
//// 8: unknown / reset
//// subStatus is used as previous state.

4.20.2.12 subStatus

```
uint8_t subStatus
```

Addendum to status for more complicated state machines.

The semantic of subStatus is machine type dependent.
For SFC (FC) it is 0: stable; !=0: internal transitions.

4.20.2.13 endTime

```
uint32_t endTime
```

The end time of a state or sub-state.

For timers it's the end time of the ON state.

4.20.2.14 controlVS

```
char controlVS[8]
```

The control value for the state machine in question.

This is the recorded control value of the last trigger. Any state machine instance must finally chose one of these three types according to the type of the tick (trigger) function.
The three types are

- char[] for a cause abbreviation of length 6 (like BatVlo)
- unit32t an unsigned integer control value
- float a signed real number (voltage, temperature etc.)

4.20.2.15 threshOFF

```
float threshOFF
```

The lower or OFF threshold.

For five band check (5B) this is the bad Hi limit.

For a float hysteresis (FF) the following inequation
`::threshON >= ::threshOFF`

must hold.

4.20.2.16 threshON

```
float threshON
```

The higher or ON threshold.

For five band check (5B) this is the critical Hi limit.

4.20.2.17 threshBadLo

```
float threshBadLo
```

The bad Lo limit.

For five band check (5B) the following inequation
`::threshOFF > ::threshOn > ::threshCritLo > ::threshBadLo`
should be
`::threshBadHi > ::threshbadLo > ::threshON > ::threshOFF`

must hold.

4.20.2.18 instanceF

```
float instanceF[3]
```

Three float values to the state machines disposal.

4.20.2.19 instanceB

```
uint8_t instanceB[4]
```

Four byte values to the state machines disposal.

Currently (10.2025) only [2] and [3] used.

The documentation for this struct was generated from the following file:

- include/weStateM.h

4.21 valFilVal_t Struct Reference

Smart meters' and other process values.

```
#include <sweetHome.h>
```

Data Fields

- float batVolt
  Battery voltage by esp8266 module and MQTT.
- uint8_t by [12]
  Relays, outputs and states.
- float chStLimit
  Actual charging station current limit.
- float **fLine**
  last valid power line frequency
- float **groVoltP**
  Growatt panel (DC) voltage.
- float **growLoss**
  Growatt inverter loss negative: all values invalid.
- float **groWorkD**
  Growatt work of the current day.
- float **groWorkS**
  Growatt total inverter work.
- float **growPow**
  Growatt line power.
- float **growTemp**
  Growatt inverter temperature.

- int **hourOffs**

  actual offset in hours of local time zone (+ is east)
- uint16_t **ms**

  ms supplement to stmpS
- float **pAll**

  all power sum (all meters were read OK)
- float **pBatUnl**

  battery unload power (+ unload, since 7.2020: - load)
- float **pGiveAway**

  PstdW - Pwaste (all meters were read OK)
- float phPckLimit

  Actual phase packet switch power limit (/W) water boiler.
- float **phPckpower**

  actual phase packet switch power (/W)
- float **pSolar**

  solar power (w/o Growatt) only, w/o bat unload
- float **pWaste**

  battery load and other waste; negative to be waste
- char **rTmTxt** [34]

  local time as text; length is 32
- uint32_t **stmpS**

  epoch time; s since 1.1.1970 (until 7.2.2106)
- uint32_t **stmpS1stStartSol**

  epoch time stamp for 1st solar power ON
- uint32_t **stmpSCurStartSol**

  time stamp for current/last solar power ON
- uint32_t **stmpSLstStopSol**

  time stamp for current/last solar power OFF
- int **tempPipe**

  Temperature dto.; (hot water pipe, forward feed)
- int **tempTankBott**

  Temperature in 1/1000 grdC; (tank bottom)
- int **tempTankTop**

  Water temperature in 1/1000 grdC; (tank top)
- float **wSumExp**

  sum of export work (all meters were read OK)
- float **wSumIn**

  sum of import work (all meters were read OK)

4.21.1 Detailed Description

Smart meters' and other process values.

This structure unites all (two, ANZmodSLAVES) smart meter readings as a meterVal_t array plus some common evaluation and process control values.

The four timing data will mark the the evaluation and forwarding time of the complete structure/information. For the meter read times see the equivalent data in the structure .meterVal, which will be 300 .. 600ms older for the meter's latest read (+1s for every other meter read earlier).

4.21.2 Field Documentation

4.21.2.1 by

```
uint8_t by[12]
```

Relays, outputs and states.

```
Byte 0 :  relays (8..1 in bit 7..0)                  Bits 7..0:  P..W_S.uX
Byte 1 :  power module voltage PWM: 0 = lowest; 255 = highest
Byte 2 :  outputs (open drain)                       Bits 7..0:  P234_xHIB
Byte 3 :  error 0:  OK; 1,2,3:  meter 0,1,both;
Byte 4 :  stateBits                                  Bits 7..0:  UBLK_wWGS
Byte 5 :  phase packet switch PhPckSw                power:  0..200 (%)
Byte 6 :  state2Bits  (PPS manual, limits, h2        Bits 7..0:  M-PL_--fh
     :  P: power at Limit L, L: limit L at it's max, fh:  heater2 at full /
:  half power; ph:  number of phases used by E-Car:  1..3 (default:3)
Byte 7 :  chStBits  man,  ball, carCon, .Pow |   _     nPh (1..6)
Byte 8 :  c2StBits                          |  iLim  _ phLimH phLimLo
```

4.21.2.2 batVolt

```
float batVolt
```

Battery voltage by esp8266 module and MQTT.

The value by ESP and MQTT will be corrected by ESP_U_CORR. battery voltage by esp8266 module and MQTT

4.21.2.3 phPckLimit

```
float phPckLimit
```

Actual phase packet switch power limit (/W) water boiler.

Surplus solar energy will be put in a battery storage, in charging an electric car and in the hot water tank, automatically. This ensures in-house-consumption (Eigenverbrauch).

Of all these the water boiler has the highest capacity and mid range power. Most important for Eigenverbrauch is its virtually unlimited availability and fast and fine grained power control. phPckpower is the current value and phPckLimit the actual limit (/W) for heating water.

Start value: PCK_POWER_LIM_DEF

4.21.2.4 chStLimit

```
float chStLimit
```

Actual charging station current limit.

The value is the limit in A per phase set for E-Cars loading their drive batteries. The number of phases depend on the car's loading electronics (hence on data not seldom hard to find). One car may use 1 to 3 phases.

With two cars connected one may have 2..6 phases used. Both cars would get the same current limit, i.e. control pilot (CP) pulse width (PWM). The value (which can't be less than 6A) is an upper limit the cars must obey but the may draw any lower value down to zero. Hence, few cars are no means for fine grained surplus power consumption.

The power limit set so is chStLimit $*$ 230V $*$ nOfPhases (by), where the last factor may be not known. actual charging station current limit (/A every phase)

The documentation for this struct was generated from the following file:

- include/sweetHome.h

4.22 valsSharMem_t Struct Reference

Structure for shared memory.

`#include <sweetHome.h>`

Data Fields

- uint32_t **clientCommand**

  single command from (web) client to server
- uint16_t **copInCnt**

  values copy in count; incremented by server
- valFilVal_t **valFilVal**

  the values; copied in form the server

4.22.1 Detailed Description

Structure for shared memory.

The documentation for this struct was generated from the following file:

- include/sweetHome.h

Chapter 5

File Documentation

5.1 dcf77onPi.c File Reference

This program is for using DCF77 AM receivers on a Pi.

```
#include "weGPIOd.h"
#include "weUtil.h"
#include <getopt.h>
#include "weLockWatch.h"
#include <errno.h>
#include "weDCF77.h"
```

Functions

- int main (int argc, char **argv)

  The program.

Variables

- uint32_t **lesDCFout**

  Bit mask of all outputs set by dcfOut.
- int **outScn** [ ]

  GPIO assignments, default pi4scann.
- int **outTrf** [ ]

  GPIO assignments, default piTrafficShield.
- char const **outTxt** [ ][8]

  Names for outputs: LEDs and control.

5.1.1 Detailed Description

This program is for using DCF77 AM receivers on a Pi.

```
Copyright (c)    2021 2023    Albrecht Weinert
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/         /      /\
/         /___   /  \       |
\        /____\ /____\ |  _|__
\  /\  / \    /       \|    |
\/  \/   \__/         \__/|_


Revision history
Rev.  58 19.06.2024
Rev.  236 01.02.2021 :  new  (testOnPi fork)
.
```

Purpose

This program handles the modulation signal of an AM (amplitude modulation) DCF77 receiver. DCF77 is the German long wave transmitter to broadcast the official/legal time.
Up to Revision 239++ April 2021 it is merely for testing AM receivers by logging every signal and timing.

By program options any GPIO can be chosen for the AM signal, as well as the signal polarity, filter modes and much more. The reception can be observed by up to 6 output signals respectively LEDs. The DCF77 signal is decoded and can be logged.

Options are:

```
--useWD --noWD      use the watchdog / do not use it (default)
--useLock --noLock  use the IO singleton lock / do not use it (default)
--GPIO    -G   GPIO number for the AM signal input
--pin     -p   IO connector pin number for the AM signal input
--invert --noInvert invert standard polarity / do not (default)
--pullnone --pullup --pulldown  pull resistor no / up (default) / down
--pullkeep           keep input's pull resistor setting as is
--glitch  -g         set glitch filter time in &mu;s
```

Use "dcf77onPi --help" to see the actual list.

GPIO usage

The program may use every GPIO by command line parameter.

Timing

Data for every modulation period are put asynchronously in a FIFO.

The program has a cyclic process control (in SPS manner, by weUtil.h weUtil.c etc). We use

```
a) a 10 ms cycle to sample the FiFo and do all other work, like
   decoding, logging etc.
b) so far no other cycle
```

Library usage

The program uses some standard libraries plus own libraries in weRasp/..c and include/..h, namely weGPIOd, sysUtil etc..

Prerequisites

As the program may use GPIO via pigpiod and the watchdog it requires them both available, e.g. by a (sudo crontab) cronjob

```
@reboot  /usr/local/bin/pigpiod  -s 10
@reboot  sleep 5 && chmod a+=rw /dev/watchdog
@reboot  chmod a+=rw /dev/hidraw0


Compile, build, load
```

cross-compile by:

```
make TARGET=pi4scann PROGRAM=dcf77onPi clean all
```

program by:

```
make PROGRAM=dcf77onPi TARGET=pi4you FTPuser=pi:piPi progapp
```

5.1.2 Function Documentation

5.1.2.1 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

Run by: dcf77onPi [options

For options see: dcf77onPi –help memcpy(dfc77ringBrecPer[readInd].sysClk, "hh:mm:ss.mil\0", 13); // init as hh↩
:mm:ss

5.2 getLocalWeatherData.c File Reference

A console program to fetch local weather data.

```
#include "sysBasic.h"
#include "we1wire.h"
#include <sys/file.h>
#include <signal.h>
#include <errno.h>
#include <getopt.h>
#include "weUtil.h"
#include "sweetHome.h"
#include "sweetHomeLocal.h"
#include <curl/curl.h>
#include <dirent.h>
```

Data Structures

- struct memAlloc_t

  Structure for allocated, re-allocatable memory.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.2.1 Detailed Description

A console program to fetch local weather data.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  72 12.11.2024
Rev.  144 12.06.2018 :  new; just for testing algorithms and data acquisition
Rev.  147 16.06.2018 :  time handling in library functions improved
Rev.  155 27.06.2018 :  time handling debugged
Rev.  164 11.07.2018 :  sunset/sunrise location params; 1-wire search
Rev.  168 21.07.2018 :  1-wire temperature sensor handling enhanced
```

Program functions

This program gets one or two JSON pages from open weather map and parses them for sunset sunrise (this day, this location) and cloudiness (dto. forecast from now.

The current and next day sunrise and sunset are calculated approximately by a cosine algorithm using integer lookup tables (no float arithmetic).

Additionally it determines the 1-wire sensors present and reveals their real location in the file system.

Library usage

The program uses the curl library to fetch data from internet.

Local build and compile on a Raspberry: g++ getLocalWeaterData.c -o getLocalWeatherData -lcurl

Cross-compile by:

```
    arm-linux-gnueabihf-gcc -DF_CPU=1200000000 -DPLATFORM=raspberry_03
       -DMCU=BCM2837  -DTARGET=raspi61  -I./include
            -c -o getLocalWeatherData.o getLocalWeatherData.c
and so on ...
    arm-linux-gnueabihf-gcc -I. -DPLATFORM=raspberry_03 -DMCU=BCM2837
       -DTARGET=raspi61  -I./include   getLocalWeatherData.o
          weRasp/weUtil.o   --output getLocalWeatherData.elf
              -Wl,-Map=getLocalWeatherData.map,--cref
                  -lcurl
```

or by:

```
make PROGRAM=getLocalWeatherData TARGET=meterpi clean all
```

program by:

```
make PROGRAM=getLocalWeatherData TARGET=meterPi FTPuser=sweet:0123 progapp
```

respectively by the displayed winscp.com /script=progTransWin /parameter sweet:0123 meterPi bin getLocal↩ WeatherData

5.2.2 Variable Documentation

5.2.2.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.2.2.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.2.2.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.3 gnBlinkSimple.c File Reference

A very first program for Raspberry's GPIO pins 75 (19.02.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

```
#include <stdio.h>
#include <pigpio.h>
#include <pigpiod_if2.h>
#include <unistd.h>
```

Variables

- int thePi

  The standard Pi for gpio(d) IO of the program.

5.3.1 Detailed Description

A very first program for Raspberry's GPIO pins 75 (19.02.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

This is a most simple version of a GPIO pin output program using pigpio(d).

Compile on Pi by: g++ gnBlinkSimple.c -o gnBlinkSimple -lpigpiod_if2

Compile on Windows by: arm-linux-gnueabihf-gcc -I./include -c -o gnBlinkSimple.o gnBlinkSimple.c arm-linux-gnueabihf-gcc -I. gnBlinkSimple.o –output gnBlinkSimple.elf -lpigpiod_if2 -lpthread cp gnBlinkSimple.elf gnBlink↩Simple winscp.com /script=progTransWin /parameter sweet:0123 targetPi bin gnBlinkSimple

5.3.2 Variable Documentation

5.3.2.1 thePi

```
int thePi
```

The standard Pi for gpio(d) IO of the program.

This global variable is provided to hold the main pi used by a program doing process IO via piGpIO[d]. In most local use cases
```
thePi = pigpio_start(NULL, NULL);
```

it will be 0 = this local Pi. After usage don't forget to terminate the connection to the pigpio daemon by
```
pigpio_stop(thePi);
```

5.4 gpioChipInfo.c File Reference

A program to list Raspberry's GPIO chip infos 74 (7.02.2025) Copyright (c) 2024 Harry Fairhead Raspberry Pi IoT in C, Third Edition, I/O Press 2024 Copyright (c) 2025 Albrecht Weinert porting, modifications, make weinert-automation.de a-weinert.de.

```
#include <stdio.h>
#include <unistd.h>
#include "arch/config.h"
#include <errno.h>
#include <fcntl.h>
#include <sys/ioctl.h>
#include <linux/gpio.h>
```

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.4.1 Detailed Description

A program to list Raspberry's GPIO chip infos 74 (7.02.2025) Copyright (c) 2024 Harry Fairhead Raspberry Pi IoT in C, Third Edition, I/O Press 2024 Copyright (c) 2025 Albrecht Weinert porting, modifications, make weinert-automation.de a-weinert.de.

This program runs on any Pi with a PiOS not to old.

Compile on Pi by: g++ gpioChipInfo.c -o gpioChipInfo

Compile on Windows by: /code make PROGRAM=gpioChipInfo TARGET=pi4play clean all make PROGRAM=gpio↩ ChipInfo TARGET=pi4play FTPuser=sweet:0123 progapp /endcode

5.4.2 Variable Documentation

5.4.2.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.4.2.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.4.2.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.5 gpioList.c File Reference

A program to list Raspberry's GPIO register states w/o changing them 87 (6.07.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

```
#include <stdio.h>
#include <getopt.h>
#include <pigpio.h>
#include <pigpiod_if2.h>
#include "weGPIOd.h"
#include "sysBasic.h"
#include "weUtil.h"
#include <unistd.h>
#include "arch/config.h"
#include <math.h>
```

Variables

- char const prgNamPure []
  The pure program name.
- char const prgSVNdat []
  The complete SVN date string.
- char const prgSVNrev []
  The complete SVN revision string.

5.5.1 Detailed Description

A program to list Raspberry's GPIO register states w/o changing them 87 (6.07.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

This program runs on a Pi with gpio(d). It does no output nor nor changes any GPIO register state. It just lists states caused by other IO programs. Consequently, it will not try to get the conventional gpiod lock.

Compile on Pi by: g++ gpioList.c -o gpioList -lpigpiod_if2

Compile on Windows by: /code make PROGRAM=gpioList TARGET=pi4play clean all make PROGRAM=gpioList TARGET=pi4play FTPuser=sweet:0123 progapp /endcode

5.5.2 Variable Documentation

5.5.2.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.5.2.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.5.2.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.6 gpioListExp.c File Reference

A simple program to list Raspberry's GPIO register states 76 (26.02.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

```
#include <stdio.h>
#include <getopt.h>
#include <pigpio.h>
#include <pigpiod_if2.h>
#include "weGPIOd.h"
#include <unistd.h>
#include "arch/config.h"
```

Variables

- char const prgNamPure [ ]
  The pure program name.
- char const prgSVNdat [ ]
  The complete SVN date string.
- char const prgSVNrev [ ]
  The complete SVN revision string.

5.6.1 Detailed Description

A simple program to list Raspberry's GPIO register states 76 (26.02.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

This is simple GPIO program doing neither input nor out nor changing GPIO register state. It just lists states cuased by other IO programs running. Do do so it will not try to get the conventional gpiod lock.

Compile on Pi by: g++ gpioListExp.c -o gpioListExp -lpigpiod_if2

Compile on Windows by: /code make PROGRAM=gpioListExp TARGET=pi4play clean all make PROGRAM=gpio↩ ListExp TARGET=pi4play FTPuser=sweet:0123 progapp /endcode

5.6.2 Variable Documentation

5.6.2.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.6.2.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.6.2.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.7 growattLink.c File Reference

Communication with a Growatt inverter.

```
#include "arch/config.h"
#include <stdint.h>
#include "mqttHome.h"
#include "growattHome.h"
#include "weUtil.h"
#include "weStateM.h"
#include "weLockWatch.h"
#include "weShareMem.h"
#include <errno.h>
#include <sys/sem.h>
#include <getopt.h>
#include <weModbus.h>
#include "weGPIOd.h"
```

Functions

- int main (int argc, char **argv)

  The program.
- void **mqttClean** ()

  End as MQTT client.
- int mqttInit ()

  Initialise as MQTT client.
- void * processIOthread (void *args)

  The task of controlling process IO.
- void * rs232ModThread (void *args)

Variables

- char clientId [38]

  MQTT client ID.
- modBvals_t **modBvals**

  modbus respectively process values
- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.
- char subTopStPlg01 [14]

  State sub topic of S20 plug Number 01 to 09.

5.7.1 Detailed Description

Communication with a Growatt inverter.

The program's main task is to communicate with (currently) one Growatt PV (photovoltaics) inverter via its RS232 Modbus interface. Data got on a regular basis from the input and holding registers are made available to other programs on the same Pi, like e.g. the GCI program growattRead.c, by shared memory. Locking and signalling for the shared memory is done by a semaphore set. This is the same approach as in hometersControl.c.

The most important panel/inverter values are signalled to programs on other Pis (hemetersControl) by MQTT. The MQTT message has the form: Up: 119.6V P: 65.0W L: 7.2W T: 26.5gdC Wd/t: 1.2 / 2316.2kWh featuring Panel DC voltage, line Power (to grid), inverter loss and temperature, day's and total work.

The program runs on a Raspberry with GUI-less (no graphics) Raspbian lite. GUI/HMI is featured as Web-Interface (Apache, C CGI) in the (W)LAN.

This program was originally implemented quick and dirty = non-structured programming. This sin is to be repaired, soon!

```
Copyright  (c)  2019 2025  Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  85 15.06.2025
Rev.  213 13.08.2019 :  new; derived from hometersControl.c
Rev.  216 31.08.2019 :  first operable with Modbus outages (hopefully)
Rev.  219 06.11.2019 :  Growatt MQTT all important values in one message
Rev.  270 07.11.2024 :  use old includes before meterpi crash ("BC")
Rev.    76 22.02.2025 :  from pi to sweet
Rev.    81 15.04.2025 :  serial gone, now /dev/ttyS0
Rev.    82 18.04.2025 :  mosquitto_loop 3 times in a second en lieu de 1*
Rev.    83 04.05.2025 :  no new log file when short
Rev.  83b 18.05.2025 :  read recovery log corrected.                vvvv
       2025-05-18 06:05:34.129 ##  read recovered  after -2055142704 bad
Rev.    85 15.06.2025 :  inhibit endless semaphore lock error logs
```

Communication

This program uses serial communication with a RS232 converter to handle the Growatt inverter's Modbus link.

MQTT protocol via Ethernet or WLAN is used to publish essential inverter values and data. The MQTT broker or host defaults to 192.168.178.87, the port is 1883.

HTTP is used for GUI (via Apache and program growatt.read). HTTPS is not used as all LAN communication is in guarded private home or laboratory networks.

Common memory is used to communicate with other programs. At present this is a a small CGI program handling the AJAX link to the Apache based Web interface.

A backlink via HTTP parameter and shared memory and/or MQTT to control the inverter (via holding registers) is not implemented but may be in the future.

GPIO usage

This communication program currently uses no GPIO pins but includes all libraries etc. to do so.
As Test it uses three pins as output assuming LEDs connected to defined in include/target_growPi.h as Hi=On

```
Pi 1  / Pi 3       Pin
GPIO17/ 17 :  red    11
GPIO21/ 27 :  green  13
GPIO26     :  yellow 47
```

Modbus usage

This program acts as client for one Growatt inverter 1500P "GEAD1018" with firmware G.2.0 and Modbus protocol version 3.01. It is a single line phase, single PV array and zero battery type.

Communication setting will be 'RTU / RS232 9600, none'.

Timing

The program has a cyclic process control (in SPS manner). We have

```
a) a 100 ms cycle for process control, process I/O, SFCs etc.
b) an 1s cycle for Modbus communication, timer handling and some SFCs
```

Server functions

Shared memory and a set of three semaphores is provided to share current values with other (C) programs as well as (in future) for receiving command and status information. This interface is also used to provide web interfaces in a flexible way.

Client functions

The program acts as (see above) as Modbus client. And it acts as MQTT publisher currently using a mosquitto broker on another Raspberry in the same private (W)LAN.

Library usage

The program uses the standard libraries pthread, pigpiod_if2, modbus, shm, sem and mosquitto. The own libraries in weRasp/..c and include/..h, namely weModbus, weGPIOd, sysUtil, weShareMem, weCGIajax etc. are compiled and linked in.

cross-compile by:

```
make PROGRAM=growattLink TARGET=growPi clean all
```

program respectively transfer to target machine by:

```
make PROGRAM=growattLink TARGET=growPi progapp
```

Due to idiosyncrasies of newer windows versions the make file can't execute the command (as was done for may years and variants)

```
winscp.com /script=progTransWin /parameter us:pw growPi bin growattLink
```

Instead it will be output and must be copied and executed by hand.

The building of this application is governed by the make include files makeProg_growattLink_settings.mk and makeTarg_growPi_ettings.mk. The latter will lead to including include/arch/target_growPi.h.

This programme was originally / is quick and dirty. Outstanding task: make it structured.

5.7.2 Function Documentation

5.7.2.1 mqttInit()

```
int mqttInit ( )
```

Initialise as MQTT client.

On success only: subscribe, loop and publish.

Returns

0: success the common mosq is set and usable; else: errno

5.7.2.2 processIOthread()

```
void * processIOthread (
            void * args )
```

The task of controlling process IO.

Except for the Modbus communication, this thread controls all processIO: at present this is just three LEDs. Which means: it does nothing quite useful as this is just a "read Modbus" programme.

It is a 100 ms cycle thread.
The cyclic 100 ms task then distinguishes 10 steps within a second. This ten (0..9) steps serve for the synchronisation with the other thread and act as state machine framework.

5.7.2.3 rs232ModThread()

```
void * rs232ModThread (
            void * args )
```

if (modBvals.retRimp0 == retRead) goto case9; // old error

out char formIfix[60] = // form P 2 l7 Wd 16 l4 T 27 l5 Up 40 l 6 0123456789x123456789v123456789t123456789q123456789c1 2 3 4 "P: 1299.4W, Wd: 12.4kWh, T: 29.7gdC, Up: 114.3V\0\0\0"; formFixed16(formIfix + 2, 7, // form P 2 l7 mod↩ Bvals.imp0Regs.regs[12], 1); // lo line power / .1W formFixed16(formIfix + 16, 4, modBvals.imp0Regs.regs[27], 1); // lo work day / .1 kWh formFixed16(formIfix + 27, 5, modBvals.imp0Regs.regs[32], 1); // Temp / .grdC form↩ Fixed16(formIfix + 40, 6, modBvals.imp0Regs.regs[3], 1); // Upanel / .1V = out

5.7.2.4 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

run by: growattLink [options
For options see longOptions and :: optHlpTxt.

Parameters

argc	number of parameters + 1
argv	optional options

xxxxx for(;commonRun;) { // use main thread for async. tasks like MQTT pthread_yield(); break; // no asyn tasks yet if (!commonRun) break; pthread_yield(); if (!commonRun) break; if (!commonRun) break; pthread_yield(); if (!commonRun) break; } // commonRun async tasks xxxxx

5.7.3 Variable Documentation

5.7.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.7.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.7.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.7.3.4 subTopStPlg01

```
char subTopStPlg01[14]
```

State sub topic of S20 plug Number 01 to 09.

It's preset as plug01/POWER for 01, but the digit at index [5] will be set before each use accordingly.

5.7.3.5 clientId

```
char clientId[38]
```

MQTT client ID.

default value: sweetHomeControl; length: 15; max. length: 36
May be changed before mqttInit().

5.8 growattRead.c File Reference

A CGI program for a Growatt PV inverter.

```
#include "sysBasic.h"
#include "arch/config.h"
#include "growattHome.h"
#include "weCGIajax.h"
#include "weShareMem.h"
#include <fcntl.h>
#include <weModbus.h>
```

Functions

- int main (int argc, char **argv)

  The program.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.8.1 Detailed Description

A CGI program for a Growatt PV inverter.

```
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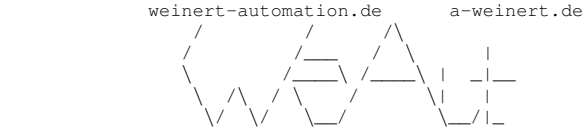
weinert-automation.de a-weinert.de
```



Revision history

```
Rev.  83 15.05.2025
Rev.  209 16.07.2019 :  new; derived from meteRead.c
Rev.  210 28.07.2019 :  JSON syntax  (https://jsonformatter.org/json-parser)
Rev.  211 01.08.2019 :  P U I f like meteRead instead of U I P f
Rev.  212 03.08.2019 :  read holding registers on request
Rev.  215 27.08.2019 :  from direct Modbus read to shared memory
Rev.  270 07.11.2024 :  use old includes before meterpi crash ("BC")
```

Client functions

This program gets values from growattLink via shared memory synchronised with a set of semaphores:
sem # 0: exclusive lock of shared memory (for the shortest time possible !)
sem # 1: signal from from hometersControl to other program
sem # 2: signal from from hometersControl to this program (growattRead) This program gets values from a Growatt PV inverter via a serial Modbus link.

In future, under the same semaphore (#0) lock, it may set command codes via the shared memory according to the query string. A query will usually be part of the request when buttons were pressed in the web page.

GCI (common gateway interface) server functions

This program's output (i.e. AJAX answer) are physical readings, status values and times as JSON object, leaving selection of values and their display to the HTML page respectively its Javascript code.

In the JSON object's text delivered all numerical values (int, float) are put as strings in appropriate form and precision. The rationale is to avoid auto parsing of data, all or most of which will probably be formatted (back to text) to be put in the web page. And, alas, formatting is not Javascript's strong point, while parsing a string to a number would not be a problem, if a number is needed.

This beta version is fixed to: 9600 baud slave 1 and 1 inverter with 1 panel, 0 batteries and 1 AC-power line. All read values are put in one "reads:"[] array. This will have to be more structured (c.f. meteRead.c) in future.

GCI back-link – command by query

Not implemented yet.

Library usage

The program uses the library (lib...): pthread modbus

cross-compile by:

```
make PROGRAM=growattRead TARGET=growPi clean all
```

program by:

```
make PROGRAM=growattRead TARGET=growPi FTPuser=pi:piSecret progapp
```

5.8.2 Function Documentation

5.8.2.1 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

Run by (Apache) web server as (cgi) script with optional (query string) parameters.

5.8.3 Variable Documentation

5.8.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.8.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.8.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.9 growattReadSimple.c File Reference

A Modbus test program for a Growatt PV inverter.

```
#include "sysBasic.h"
#include "arch/config.h"
#include "growattHome.h"
#include "weCGIajax.h"
#include <fcntl.h>
#include <weModbus.h>
```

Functions

- int main (int argc, char **argv)

  The program.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.9.1 Detailed Description

A Modbus test program for a Growatt PV inverter.

```
Copyright  (c)   2019  Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___    /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  83 15.05.2025
Rev.  209 16.07.2019 :  new; derived from meteRead.c
Rev.  210 28.07.2019 :  JSON syntax  (https://jsonformatter.org/json-parser)
Rev.  211 01.08.2019 :  P U I f like meteRead instead of U I P f
Rev.  212 03.08.2019 :  read holding registers on request
Rev.  216 31.08.2019 :  changes in modbus lib
Rev.  270 07.11.2024 :  use old includes before meterpi crash ("BC")
```

This program gets values from a Growatt PV inverter via a serial Modbus link.

GCI server functions

This program's output (i.e. AJAX answer) are physical readings, status values and times as JSON object, leaving selection of values and their display to the HTML page respectively its Javascript code.

In the JSON object's text delivered all numerical values (int, float) are put as strings in appropriate form and precision. The rationale is to avoid auto parsing of data, all or most of which will probably be formatted (back to text) to be put in the web page. And, alas, formatting is not Javascript's strong point, while parsing a string to a number would not be a problem, if a number is needed.

This beta version is fixed to: 9600 baud slave 1 and 1 inverter with 1 panel, 0 batteries and 1 AC-power line. All read values are put in one "reads:"[] array. This will have to be more structured (c.f. meteRead.c) in future.

GCI back-link – command by query

Not implemented yet.

Library usage

The program uses the library (lib...): pthread modbus

cross-compile by:
```
make PROGRAM=growattReadSimple TARGET=growPi clean all
```

program by:
```
make PROGRAM=growattReadSimple TARGET=growPi FTPuser=pi:piSecret progapp
```

5.9.2 Function Documentation

5.9.2.1 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

Run by (Apache) web server as (cgi) script with optional (query string) parameters.

5.9.3 Variable Documentation

5.9.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.9.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.9.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.10 helloCrossWorld.c File Reference

Almost the traditional greeting program.

```
#include <stdio.h>
#include <math.h>
```

5.10.1 Detailed Description

Almost the traditional greeting program.

The program's purpose is to test the complete tool chain from the Windows workstation with Eclipse, cross compilers, C, Java, make, ... Filezilla, WiSCP, putty and much more from the source to the executable binary in /home/[user]/bin on a target Pi.

The test binary shall not depend on any special libraries, other programs or hardware components on any target Pi in our "zoo", .e.g. meterPi.

```
Copyright  (c)  2024  Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  1 3.12.2024
Rev  269 23.10.2024 :  new    for testing start at zero after a  crash
```

Build the program

cross-compile by:

```
make PROGRAM=helloCrossWorld TARGET=meterPi clean all
```

program by:

```
make PROGRAM=helloCrossWorld TARGET=meterPi FTPuser=sweet:home  progapp
```

or due to some bugs in make use winscp and IP directly by:

```
winscp.com /script=progTransWin /parameter sweet:home meterpi bin helloCrossWorld
```

5.11 homeDoorPhone.c File Reference

Process control program for door bells IP phones etc.

```
#include "arch/config.h"
#include "homeDoor.h"
#include "weUtil.h"
#include "weStateM.h"
#include <getopt.h>
#include "weLockWatch.h"
```

Functions

- void bellsButChg (uint8_t status)
  Reaction to bell button presses.
- void doorOpTimChg (state_t *const me)
  Door opener was activated timer state change.
- void doorUnlckChg (state_t *const me)
  Door opener activation state change.
- int main (int argc, char **argv)
  The program.
- void mlBellButChg (state_t *const me)
  Middle and lower bell state change.
- void mlBellTimChg (state_t *const me)
  Middle and lower bell was rung timer state change.
- void * processIOthread (void *args)
  The task of controlling process IO.
- void resOpCoupChg (state_t *const me)
  Reserve optocoupler state change.
- void upBellButChg (state_t *const me)
  Upper bell state change.
- void upBellTimChg (state_t *const me)
  Upper bell was rung timer state change.

Variables

- char const *const astDoor
  Ring the door bell phones (fritzbox broadcast nummer).
- state_t doorOpTimer
  Door opener was activated timer.
- state_t mlBellTimer
  Middle and lower bell was rung timer.
- char const *const **prepDoor**
  Prepare ringing by file copy.
- char const prgNamPure [ ]
  The pure program name.
- char const prgSVNdat [ ]
  The complete SVN date string.
- char const prgSVNrev [ ]
  The complete SVN revision string.
- state_t upBellTimer
  Upper bell was rung timer.

5.11.1 Detailed Description

Process control program for door bells IP phones etc.

The program's tasks is to monitor door bells and a door opener and to control at least one IP phone ∗) via an Asterisk server on the same Pi. It will log door bell events and signal door bell ringing by calling other phones (via Asterisk and a Fritz.box).

Note ∗): This requires that the Pi with Asterisk is made an IP phone in the home phone system (i.e. Fritz.box).
For making a phone call by something equivalent to
```
cp /home/pi/asteriskFiles/callDphon.txt  /var/spool/asterisk/outgoing
```

write acces to /asterisk/outgoing/ is required for this program, e.g. by
```
sudo chmod -R a+rwx /var/spool/asterisk/outgoing
```

The program runs on a Raspberry Pi 4 with head-less (no graphics) Raspbian lite hosting an Asterisk telephone server and also an Apache web server. The Pi 4 seems more than sufficient.
```
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weinert-automation.de          a-weinert.de
    /          /      /\
   /          /___   /  \       |
   \         /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history
```
Rev.  83 15.05.2025
Rev.  223 18.06.2020 :  new
Rev.  224 26.06.2020 :  door bell rung timers and LEDs
Rev.  228 20.07.2020 :  50 Hz have wave optocoupler input filter enhanced
Rev.  230 31.07.2020 :  program data handling partly to weRasp\sysBasic
Rev.  239 08.03.2021 :  log system() file handling errors
Rev.  264 22.09.2024 :  gn LEDs dimmed
Rev.  265 03.10.2024 :  three states gn right LED door opener
```

Communication

HTTP (via Apache) is used for offering the log files and other information. In future a web GUI may be implemented like those for the other process control applications, cf. hometersControl.

HTTPS is not used as all LAN communication is in guarded private home or laboratory networks. Hence, the Pi can't get a Let's Encrypt certificate in the usual way. And self signed ones aren't worth the toils in a very small user community.

A VoIP phone is used to signal events to other telephones. This phone is emulated by the Asterisk server on the same Pi and registered in the site's or home's telephone system, like fritz.box.

Calling phone(s) mechanism

When this programme detects event (door bell) to be reported by a phone call it moves a command file from ∼/asteriskFiles/ to /var/spool/asterisk/outgoing/. Asterisk monitors that directory and executes command files found and deletes them (no matter success or failure).
The file is moved and not copied to /var/spool/asterisk/outgoing/ to avoid the execution of partly copied files. Hence the file to be moved will be prepared by local copy (within ∼/asteriskFiles/). Content, e.g.:
```
Channel:  SIP/629
```

Server functions

This program handles and fills error and log files to record events. Those can be accessed and viewed via http. Door bell rings are forwarded to a set of phones via Asterisk (and fritz.box).

Library usage

The program uses some standard libraries plus own libraries in weRasp/..c and include/..h, namely weGPIOd, sysUtil etc..

cross-compile by:
```
make PROGRAM=homeDoorPhone TARGET=pi4Ast clean all
```

program by:
```
make PROGRAM=homeDoorPhone TARGET=pi4Ast FTPuser=pi:piPa progapp
```

or due to some bugs in make use winscp and IP directly by:
```
winscp.com /script=progTransWin /parameter pi:piPa l.e.p.i bin homeDoorPhone
```

5.11.2 Function Documentation

5.11.2.1 bellsButChg()

```
void bellsButChg (
            uint8_t status )
```

Reaction to bell button presses.

This function organises the reaction to the OR of all (two as of 7'2020) bell button presses. This is a) a beeper and b) make the telephone(s) in question ring.

Parameters

status	the calling bell's changed button state

5.11.2.2 upBellTimChg()

```
void upBellTimChg (
            state_t *const me )
```

Upper bell was rung timer state change.

It turns the left red LED ON when rung respectively OFF after 4 hours or when the door opener was activated.

Parameters

me	pointer to the pump timer

5.11.2.3 upBellButChg()

```
void upBellButChg (
            state_t *const me )
```

Upper bell state change.

This function controls the respective LED, controls the ORed bells state and triggers the "upper bell was rung" reminder timer.

5.11.2.4 mlBellTimChg()

```
void mlBellTimChg (
             state_t *const me )
```

Middle and lower bell was rung timer state change.

It turns the left yellow red LED ON when rung respectively OFF after 4 hours or when the door opener was activated.

Parameters

me	pointer to the lower bell timer

5.11.2.5 mlBellButChg()

```
void mlBellButChg (
            state_t *const me )
```

Middle and lower bell state change.

This function controls the respective right yellow LED, controls the bells state and triggers the "middle and lower bell was rung" reminder timer.

5.11.2.6 doorOpTimChg()

```
void doorOpTimChg (
            state_t *const me )
```

Door opener was activated timer state change.

It turns the right green LED ON dimmed to signal the door opener was inactive for more than 4 hours. On bright means inactive for less than 4 hours.when rung respectively

Parameters

me	pointer to the lower bell timer

5.11.2.7 doorUnlckChg()

```
void doorUnlckChg (
            state_t *const me )
```

Door opener activation state change.

This function controls the respective LED and ends the "bell was rung unnoticed" timers.

5.11.2.8 resOpCoupChg()

```
void resOpCoupChg (
            state_t *const me )
```

Reserve optocoupler state change.

This optocoupler input is not used (as of July 2020) or powered. This function just logs the (de-bounced) On state (which should not occur).

5.11.2.9 processIOthread()

```
void * processIOthread (
            void * args )
```

The task of controlling process IO.

This thread controls almost all processIO: 1 relay output, 6 LEDs, four digital inputs to be filtered (half wave AC via optocouplers), one beeper.

It is the 1 ms cycle and takes every forth step to sample an input. This gives five times per 50 Hz period. 2 of three will be active (LO) when the optocoupler sees an AC signal.

5.11.2.10 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

run by: homeDoorPhone [options

For options see longOptions and :: optHlpTxt.

5.11.3 Variable Documentation

5.11.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.11.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.11.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.11.3.4 astDoor

```
char const* const astDoor
```

Ring the door bell phones (fritzbox broadcast nummer).

fritz.box configuration (27.06.2020): Trklingel **887 Sammel-Nr Asterisk call file:
`Channel: SIP/629`

Start ringing by file move.

5.11.3.5 upBellTimer

```
state_t upBellTimer
```

Upper bell was rung timer.

This timer is running as reminder that the bell was rung.

5.11.3.6 mlBellTimer

```
state_t mlBellTimer
```

Middle and lower bell was rung timer.

This timer is running as reminder that the bell was rung.

5.11.3.7 doorOpTimer

```
state_t doorOpTimer
```

Door opener was activated timer.

This timer is running as reminder that door was opened.

5.12 hometersConsol.c File Reference

A console program to co-operate with hometersControl.

```
#include "sweetHome.h"
#include "weUtil.h"
#include "weShareMem.h"
#include <errno.h>
#include <getopt.h>
```

Functions

- int main (int argc, char **argv)

  The program.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.12.1 Detailed Description

A console program to co-operate with hometersControl.

This program gets values from hometersControl.c via shared memory and displays them on console. This is mainly for local test. The operational HMI is by (Apache 2.4) web interface via CGI and AJAX by meteRead.c.

```
Copyright  (c)  2017   Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  72 12.11.2024
Rev.  73+ 29.11.2017 :  new; derived from hometersControl.c
Rev.    75 30.11.2017 :  first operable
Rev.  188 15.10.2018 :  deprecated, use the web interface
Rev.  214 15.08.2019 :  corrections in Doxygen comments, loopCnt
Rev.  229 23.07.2020 :  valFil (CSV) removed
Rev.  270 31.10.2024 :  changes after meterPi's Jessie  crash
```

Client functions

This program gets values from hometersControl via shared memory synchronised by a set of semaphores: sem # 0: exclusive (short!) lock of shared memory sem # 1: signal from from hometersControl to (this) hometersConsol sem # 2: signal from from hometersControl to other (CGI etc.) programs

Library usage

The program uses the libraries (lib...): pthread, pigpiod_if2 and modbus The (weRasp/..c, include/..h) weModbus, weGPIOd and sysUtil libraries are linked in. They may be converted to and used as (.so) library, also.

cross-compile by:

```
make PROGRAM=hometersConsol TARGET=meterPi clean all
```

program respectively transfer to target machine by:

```
make PROGRAM=hometersConsol TARGET=meterPi FTPuser=sweet:0123 progapp
```

or due to some bugs in make use winscp and IP directly by:

```
  winscp.com /script=progTransWin /parameter sweet:0123 192.168.178.87 bin hometersConsol
The building of this application is governed by the make include
makeProg_hometersConsol_settings.mk:  \code
   \include makeProg_hometersConsol_settings.mk
```

5.12.2 Function Documentation

5.12.2.1 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

run by: hometersConsol [options
for help: hometersConsol -h

5.12.3 Variable Documentation

5.12.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.12.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.12.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.13 hometersControl.c File Reference

Process control for a modestly smart home.

```
#include "arch/config.h"
#include "sweetHome2.h"
#include "weUtil.h"
#include "weStateM.h"
#include "weLockWatch.h"
#include "weEcarLd.h"
#include "weShareMem.h"
#include "weAR_N4105.h"
#include <errno.h>
#include <sys/sem.h>
#include <getopt.h>
#include <weModbus.h>
#include "sweetHomeLocal.h"
```

Functions

- void batCntBalStatChg (state_t *const me)

  Battery as controlled ballast SFC state changes.
- void batCntLodStatChg (state_t *const me)

  Battery controlled load or keep; SFC state changes.
- void batUnloadStatChg (state_t *const me)

  Battery unload SFC state changes.
- void **genHWPstateText** (char *stateText, state_t const *const me, char const *stamp)

  Hot water comfort pump control timer state text function.
- void hotWatPmpCntlTimChg (state_t *const me)

  Hot water comfort pump control timer state change function.
- void hotWatPmpSchTimChg (state_t *const me)

  Hot water comfort pump schedule timer state change function.
- void hotWpmpButChg (state_t *const me)

  Hot water comfort pump button state change.
- void initDawnDusk (void)

  Adjust dawn and dusk timers.
- void initSunRiSet (int init)

  Initialise dawn, sunrise, sunset and dusk timers.

- void load250WstateChg (state_t ∗const me)

  Controlled fixed surplus consumption; SFC state changes.
- int main (int argc, char ∗∗argv)

  The program.
- void ∗ processIOthread (void ∗args)

  The task of controlling process IO.
- int readRetFil (void)

  Read (day start) retain file.
- void switchARN4105 (uint8_t const cutOff)

  AR-N 4105 implementation function.
- int writeRetFil (void)

  Write (day start) retain file.

Variables

- state_t **batCntBalSeq**

  Battery controlled load as ballast.
- state_t **batCntLodSeq**

  Battery loading and keeping.
- state_t **batUnloadSeq**

  Battery controlled unload via inverter.
- __time_t const hotTimSched [ ]

  Schedule times for hot water comfort pump starts.
- state_t hotWatPmpCntlTimer

  Hot water comfort pump control timer.
- state_t hotWatPmpSchTimer

  Hot water comfort pump schedule timer.
- state_t **load250Wcont**

  Controlled load SFC.
- volatile int nologBatCap

  Control logging inhibit charging battery due to capacity limit.
- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.13.1 Detailed Description

Process control for a modestly smart home.

The program's tasks are mainly related to electrical power involving two or three smart meters (three phase 230/400V) and power modules for battery and solar panel / inverter handling. 2017 the development started on a realistic laboratory experiment and soon (mid 2018) spun off to a real life home control set-up with extra comfort and buffer battery functions.
The MQTT topic root "labExp/sweetHome/" as well as the "hometers" in the application were kept so far out of reverence for the very beginnings.

The program runs on a Raspberry with a GUI-less (no graphics) Raspbian lite having an Apache Webserver and a MQTT broker on the same machine. GUI/HMI is featured as Web-Interface (Apache, C CGI) on the (W)LAN.

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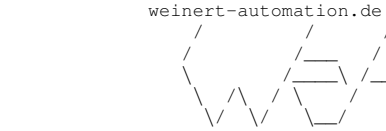

Revision history

```
Rev.  95 9.10.2025
Rev.    60 01.11.2017 :  new setup with reliable Modbus communication to smart
                        meters with neither smart protocol nor documentation
Rev.    73 29.11.2017 :  shared memory, semaphores and hometersControl.h
Rev.    85 21.12.2017 :  more relays, more commands, GCI via shared memory
Rev.  164 11.07.2018 :  sunset/sunrise location; /ref Hippogreiff relay
Rev.  167 20.07.2018 :  Phase packet switch (PPS) automated
Rev.  190 12.02.2019 :  preparation for VDE-AR-N 4105 inverter cut off
Rev.  199 02.04.2019 :  battery discharge allow / disallow start parameter
Rev.  205 18.05.2019 :  lad acid battery voltage stress handling enhanced
Rev.  216 31.08.2019 :  changes in Modbus library
Rev.  217 07.09.2019 :  Growatt inverter with Modbus-Rs232 to MQTT bridge
                       added; see growattLink.c
Rev.  220 15.11.2019 :  Growatt keep day's work intact.  inverter day == light
Rev.  240 11.08.2021 :  battery keep inhibit timer handling changed
Rev.  251 26.07.2023 :  two heater elements, web interface enhanced
Rev.  268 15.10.2024 :  float lookup Uload(pwm) range 0..141, Ubat correction
Rev.  270 03.11.2024 :  ERROR piOS fault ttyS0 instead of serial0 for Modbus
Rev.    76 25.02.2025 :  pthread_yield sched_yield // exchange by macro for test
Rev.    79 21.03.2025 :  Pi and contactor on M2=L3 (ex BatLoad+Heater)
Rev.    81 26.03.2025 :  try sem1lock error try recovery; seems OK now
keep command still fails « no idea what was meant here
Rev.    83 30.05.2025 :  BATVOLT_MX_STRT_LOAD new start loading limit
Rev.    84 01.06.2025 :  miniJoule replaced by Growatt 2 input:  one for panel &
one for battery step up.  a) no input switching (CONb)
b) battery unloading possible any time,
c) less hot water pump on surplus power
Rev.    86 16.06.2025 :  BATVOLT_REDUC_BLST removed, other limits changed
water temp limits reduced, heat power reduct.  /4
Rev.    88 10.07.2025 :  unload400, check all three phases
Rev.    89 17.07.2025 :  Modbus error log limits higher (solB : read ..  error)
Rev.    90 30.07.2025 :  battery keep SFC values changed
Rev.    92 15.08.2025 :  load unload values and SFCs (Rev.  92..94, 02.09.)
Rev.    95 05.10.2025 :  strLapend() chaos repair begun
```

Communication

This program uses a serial half duplex communication with a TTL to RS485 converter to handle two smart meters (max. 7 m away) via Modbus. The RS485 module forwards all GPIO pins it covers. Growatt inverters have Modbus via RS232, hence not sharable and needing an extra o provide a MQTT interface; see growattLink.c.

MQTT protocol [W]LAN is used to attach more remote periphery, like a battery surveillance connected directly to and supplied by the battery clamps. Other MQTT periphery devices are of the shelf remote power relays. An extra Pi with Modbus over V.24 is supervising a Growatt inverter.
Examples for messages to parse: 'Up: 119.6V P: 65.0W L: 7.2W T: 26.5gdC Wd/t: 0.0 / 2316.2kWh' for topic 'lab↩
Exp/sweetHome/grow01/meas' 'batU 0 : 12.19 V, adc:641' for topic 'labExp/sweetHome/bat/volt' '{"POWER":"ON"}' for topic 'labExp/sweetHome/plug01/RESULT' 'ON' for topic 'labExp/sweetHome/plug01/POWER' '{"POWER":"↩
OFF"}' for topic 'labExp/sweetHome/plug01/RESULT' 'OFF' for topic 'labExp/sweetHome/plug01/POWER'

HTTP is used for GUI (via Apache). HTTPS is not used as all devices are in a guarded private home or laboratory network. Hence the Pi can't get a Let's Encrypt certificate and self signed ones aren't worth the while.

A 1-wire bus is used to add some analogue sensors to the ADC abstinent Raspberry Pi. At present there are three hot water tank/pipe temperature sensors to limit the 0..6kW ballast heater usage.

Common memory is used to communicate with other programs. At present this is a CGI program (meteRead.c) handling the AJAX link to the Apache based Web interface (meteRead.html).

GPIO usage

GPIO pins are used to control relays, LEDs and one button switch in the Pi's immediate neighbourhood. Three open drain outputs in a small extra module control slightly remote (10m) periphery via shielded cable and acts as guard to the virtually non-protected Raspberry IO pins.

The GPIO configuration definitions are found in file sweetHome2.h.

Modbus usage

This program acts as client for two B+G E-Tech three phase EASTRON smart meters, currebtly (2017..25) one SDM630-Modbus and one SDM530-Modbus. (One phase meters like SDM230-Modbus were used in early experimental lab set-ups, only). Even in the Lab, no B+G E-Tech EASTRON Modbus communicated reliably above 9.6 baud (the default). Due to this low speed and, additionally, low response times, only two meter readings per second are possible over one RS485 line.

Communication will be 'RTU / RS485 9600, none' as common denominator. See Eastron, SMD230Modbus, Smart Meter Modbus Protocol Implementation V1.2 Eastron, SDM630Modbus, Smart Meter Modbus Protocol 630 (V1.5 ?) Eastron, SDM530Modbus, Smart Meter Modbus Protocol 530 (V1.1 or V1.5)
Due to the similar register layout, the meter types can be replaced with virtually no change in program. The SMD230, of course, can only be used if one phase (L1) is sufficient. Due to its technical inferiority it is not recommended except if space limitations on the DIN rails are hard.

The usage of said two three phase meters is: A - slave 3: a SDM530Modbus three phase meter for the whole house. L1 L2 L3 are the three phases, each max. 80 A to supply the building under experiment. Import means power flows from public supply. Export is considered prohibited and will be inhibited by controlling suitable consumers, as water tank heater, and the buffer battery. In 2023 a car chargers power control/limit (by PWM) was added. As there is no suitable electric cars for an reasonable this feature is not used, yet. B - slave 0: a SDM630Modbus meter is used for two solar panel groups (A1/mJB, B3/big) and one for waste (ballast) and battery (C3/xLD). Import means power flow from panels respectively battery; export means battery charging and extra (waste/ballast) consumers including idle inverter losses.

One severe complication with serial communication is the frequent change of the serial interface's name with Raspbian version changes.

Timing

The program has a cyclic process control (in SPS manner, like Simatic, e.g.). As of Revision 150 we have
a) a 20 ms cycle for phase packet switching
b) a 100 ms cycle for process control, process I/O, SFCs etc.
c) an 1s cycle for Modbus ∗) communication, timer handling and some SFCs
The 100 ms cycle b) does not use the the library's (weUtil.c / .h) own generic 100 ms cycle but a by 5 sub-division of the 20 ms cycle a).
The generic cycles (a and c) are, by library implementation, own threads.
) The Eastron meter communication is dead slow by both answering delays and default baud rate. All experiment deviating from default settings failed.

Server functions

This program handles error, log, hibernation etc. files to provide values for humans and other programs.

Additionally shared memory and a set of three semaphores is provided to share real time values with other (C) programs as well as for receiving command and status information. This interface is also used to provide web interfaces in a flexible way.

And the program acts as MQTT subscriber and publisher using a mosquitto broker, currently on the same Raspberry Pi. The primary MQTT purpose was to have "own" MQTT periphery. Those are remote power relays and a battery voltage monitoring ESP8266 in the private LAN – the latter choice was made due to Pi's lack of analogue input.

Library usage

The program uses the standard libraries pthread, pigpiod_if2, modbus, shm, sem and mosquitto. The own libraries in weRasp/..c and include/..h, namely weModbus, weGPIOd, sysUtil, weShareMem, weCGIajax etc. are compiled and linked in.
They could also be converted to and used as .so library. But, in the application environment given, this approach brings no advantage.

Build the program

cross-compile by:
```
make PROGRAM=hometersControl TARGET=meterPi clean all
```

program by:
```
make PROGRAM=hometersControl TARGET=meterPi progapp
```

or due to some bugs in make use winscp and IP directly by:
```
winscp.com /script=progTransWin /parameter sweet:0123  meterPi bin hometersControl
```

The latter's correct variant is generated as output of make ... progapp

5.13.2 Function Documentation

5.13.2.1 initDawnDusk()

```
void initDawnDusk (
             void  )
```

Adjust dawn and dusk timers.

This method initialises the settings of the dawn and dusk timers at program (re-) start.

5.13.2.2 readRetFil()

```
int readRetFil (
             void  )
```

Read (day start) retain file.

Returns

0 : file found and read; else: not

5.13.2.3 writeRetFil()

```
int writeRetFil (
             void  )
```

Write (day start) retain file.

Returns

0 : file opened/created and written; else not

5.13.2.4 initSunRiSet()

```
void initSunRiSet (
            int init )
```

Initialise dawn, sunrise, sunset and dusk timers.

The function is currently used only at program start start.

If the parameter init is true valFilVal .dayStrtVal values will be calculated for the current day. Otherwise the are assumed to be valid, i.e. read usually from that days start (hibernation) file. initDawnDusk() will be called in any case.

Parameters

init	true: calculate dayStrtVal else use file

5.13.2.5 hotWatPmpCntlTimChg()

```
void hotWatPmpCntlTimChg (
            state_t *const me )
```

Hot water comfort pump control timer state change function.

It turns the pump on respectively off. At turning off the next on schedule is determined and set as next end time for the "hot water comfort pump schedule timer".

Parameters

me	pointer to the pump timer

5.13.2.6 hotWpmpButChg()

```
void hotWpmpButChg (
            state_t *const me )
```

Hot water comfort pump button state change.

This function (re-) triggers the hot water comfort pump timer.

5.13.2.7 hotWatPmpSchTimChg()

```
void hotWatPmpSchTimChg (
            state_t *const me )
```

Hot water comfort pump schedule timer state change function.

It starts pump control timer.

Parameters

me	pointer to the pump timer

5.13.2.8 batUnloadStatChg()

```
void batUnloadStatChg (
            state_t *const me )
```

Battery unload SFC state changes.

This sequential state machine (SFC) organises the battery unload via a step up converter module and one input of a low voltage (60V) two input solar inverter for a small panel set.
It handles all switching steps and (inhibit) conditions. Used in:
state_t batUnloadSeq = newSeqCont("batUnloadSeq", batUnloadStatChg,

Parameters

me	pointer to the battery unload SFC, never NULL (not checked!)

5.13.2.9 batCntBalStatChg()

```
void batCntBalStatChg (
            state_t *const me )
```

Battery as controlled ballast SFC state changes.

This sequential state machine organises the battery load as ballast for surplus energy.

Parameters

me	pointer to the battery ballast load SFC, never NULL (not checked)

5.13.2.10 batCntLodStatChg()

```
void batCntLodStatChg (
            state_t *const me )
```

Battery controlled load or keep; SFC state changes.

This sequential state machine organises the battery loading and keeping it in good load state. Not to be confused with batCntBalStatChg, i.e. using battery as storage/ballast.

Parameters

me	pointer to the battery unload SFC, never NULL

5.13.2.11 load250WstateChg()

```
void load250WstateChg (
            state_t *const me )
```

Controlled fixed surplus consumption; SFC state changes.

This sequential state machine organises the the handling of a load of about 250 W with restricted switching rules. One example is a compressor air drier.
The rules implemented here are:
When switched ON, run at least 30 minutes before allow turning OFF.
Do not turn ON twice within 2 hours.
Do not run longer than 4 hours.

The controlled load is at Plg1 (MQTT). The additional relay 5's (8 relays module directly at Pi) contact is currently not used. Its LED still serves as a signal of Plg1's state.

Parameters

me	pointer to the controlled load (0) SFC, never NULL

5.13.2.12 switchARN4105()

```
void switchARN4105 (
            uint8_t const cutOff )
```

AR-N 4105 implementation function.

This is the VDE-AR-N 4105 cut off function to be provided site specific by user / application software. It does the cut off respectively switch back on the generators and optionally log the event.

Parameters

cutOff	not 0: do the cut off, 0: switch generators back on

5.13.2.13 processIOthread()

```
void * processIOthread (
            void * args )
```

The task of controlling process IO.

With the exception of the Modbus / RS485 coupled smart meters, this thread controls almost all processIO: 8 relay outputs, some LEDs, one button input, one PWM signal and some open drain M-switches.

It is a 20 ms cycle thread to control line power by phase packet switching while all the rest is effectively done in a 100 ms cycle, i.e. every 5th 20ms cycle.

The cyclic 100 ms task then distinguishes 10 steps within a second and sometimes differentiates odd and even seconds by the actual Modbus slave number in the respective 1s RS4885 thread.
This ten (0..9) respectively twenty steps serve the synchronisation with the other thread and act as state machine framework.
1, 6: command processing; 7: wouldGive250WHyst

5.13.2.14 main()

```
int main (
              int argc,
              char ** argv )
```

The program.

run by: hometersControl [options

For options see longOptions and :: optHlpTxt.

5.13.3 Variable Documentation

5.13.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.13.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.13.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.13.3.4 nologBatCap

```
volatile int nologBatCap
```

Control logging inhibit charging battery due to capacity limit.

1: log next time when it occurs and (always) decrement 0: or high value log no more this day. n: inhibit the next 2∗n seconds while continually trying

5.13.3.5 hotTimSched

```
__time_t const hotTimSched[]
```

Schedule times for hot water comfort pump starts.

This is a sorted array starting with the earliest start time in seconds relative to localMidnight. At least the first (earliest) entry has to be put at the end 24h (86400s) later, to find a next day entry.

Note: The first entry itself is nevertheless not dispensible as the program may be started between midnight and that time.
Note 2: At days with DST change the first time in that day will be by one hour wrong. Hence, beware using this approach for other purposes without consideration.
Note 3: __time_t (= long int = 64 bit) could be replaced by int (32bit) as it is not used for absolute epoch times. The entries are added to such values, like localMidnight.
Hint 4: This sorted array of a day's clock readings might be replaced by an array of structures to implement day of week as filter condition for a schedule time.

5.13.3.6 hotWatPmpSchTimer

```
state_t hotWatPmpSchTimer
```

Hot water comfort pump schedule timer.

This timer is running to the next time to start the comfort pump on schedule. On running out it will trigger the pump control timer to start the pump or prolong its run time accordingly. Afterwards this timer will be restarted to the next schedule point in future.

5.13.3.7 hotWatPmpCntlTimer

```
state_t hotWatPmpCntlTimer
```

Hot water comfort pump control timer.

This timer is running / active as long as the comfort pump is running. It might be triggered or prolonged by push button (hotWpmpButChg), web interface command or the pump schedule timer.

5.14 hometersDayVal.c File Reference

A program to handle some day specific settings and values.

```
#include "arch/config.h"
#include "sweetHome.h"
#include "weUtil.h"
#include <errno.h>
#include <getopt.h>
```

Functions

- int main (int argc, char **argv)

  The program.
- int readRetFil (void)

  Read (day start) retain file.
- int writeRetFil (void)

  Write (day start) retain file.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.14.1 Detailed Description

A program to handle some day specific settings and values.

At the present (simple start) stage this program just displays the current day's start / hibernation value file content.

More feature controlled by start parameters will be added in future.

```
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    /         /      /\
   /         /___    /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \     /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  79 23.03.2025
Rev.  151 20.06.2018 :  new; just see current day values file (to start with)
Rev.  199 07.03.2019 :  -t parameter, help text enhanced
Rev.  270 30.10.2024 :  changes due to meterpi hardware crash & new piOS
Rev.    79 13.03.2025 :  trying/starting to enhance, make lists &c.
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DF_CPU=1200000000 -DPLATFORM=raspberry_03
   -DMCU=BCM2837  -DTARGET=raspi61  -I./include
         -c -o hometersControl.o hometersDayVal.c
arm-linux-gnueabihf-gcc -DF_CPU=1200000000 -DPLATFORM=raspberry_03
    -DMCU=BCM2837 -DTARGET=raspi61  -I./include
         -c -o weRasp/weUtil.o weRasp/weUtil.c
```

and so on ....

```
arm-linux-gnueabihf-gcc -I. -DPLATFORM=raspberry_03 -DMCU=BCM2837
   -DTARGET=raspi61  -I./include   hometersControl.o
      weRasp/weUtil.o weRasp/weModbus.o weRasp/weGPIOd.o
        weRasp/weShareMem.o --output hometersControl.elf
          -Wl,-Map=hometersControl.map,--cref
              -lrt -pthread -lmodbus -lpigpiod_if2
```

or by:

```
make PROGRAM=hometersDayVal TARGET=meterPi clean all
```

program by:

```
make PROGRAM=hometersDayVal TARGET=meterPi FTPuser=sweet:123 progapp
```

or due to some bugs in make use winscp and IP directly by:

```
winscp.com /script=progTransWin /parameter sweet:123 meterPi bin hometersDayVal
```

5.14.2 Function Documentation

5.14.2.1 readRetFil()

```
int readRetFil (
             void  )
```

Read (day start) retain file.

Returns

0 : file found and read; else not

5.14.2.2 writeRetFil()

```
int writeRetFil (
            void  )
```

Write (day start) retain file.

Returns

0 : file opened/created and written; else not

5.14.2.3 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

run by: hometersControl [options options so far (14.11.17): any parameter = use stdout and stderr

5.14.3 Variable Documentation

5.14.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.14.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.14.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.15 include/arch/config.h File Reference

Organising platform specific includes for the make process.

```
#include "arch/config_raspberry_03.h"
```

5.15.1 Detailed Description

Organising platform specific includes for the make process.

```
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    /         /      /\
   /         /___    /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \     /       \|   |
     \/  \/   \__/          \__/|_
```

Revision history

```
Rev.  93 30.08.2025
Rev.  150 18.06.2018 :  minor, comments only
Rev.  209 22.07.2019 :  work around a Doxygen bug (default Pi4)
Rev.  255 03.08.2023 :  minor clarification
Rev.    74 07.02.2025 :  optionally include target specific .h file
Rev.    93 27.08.2025 :  typo
```

The different Raspberry types, like Pi1, 3, 4, Zero (0) and 5 can be handled transparently to the control programs. This is done by a make variable TARGET identifying a concrete target machine, i.e. the targets make include makeTarg_<TARGET>_settings.mk. This file will among other values set the PLATFORM variable. The latter can also be set directly as PLATFORM = raspberry_03 e.g.. raspberry_04 is the default by the way.

The mechanism used is calculated make includes and calculated C includes (organised by this file config.h).

5.16 include/arch/config_raspberry_00.h File Reference

Configuration settings for Raspberry Pi zero.

Macros

- #define **PIN27**

  SDA0.
- #define **PIN28**

  SCL0.
- #define stdUARTpath

  /def stdUARTpath Pi's standard UART.

5.16.1 Detailed Description

Configuration settings for Raspberry Pi zero.

This file contains some platform (type) specific definitions. These settings influence the compilation and build process. Most of those settings can not be changed later at runtime.

With respect to (process) I/O pins there is no difference to Pi3 and Pi4.

```
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    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  82 3.05.2025
Rev.  234 13.11.2020 :  fork of config_raspberry_04.h
Rev.  246 01.05.2023 :  typos corr
Rev.    82 15.04.2025 :  SVN changed, no serial0
```

5.16.2 Macro Definition Documentation

5.16.2.1 stdUARTpath

```
#define stdUARTpath
```

/def stdUARTpath Pi's standard UART.

It is the one on the Pins 8 (GPIO14) for Tx and 10 (GPIO15) for Rx. Here it is set to the long year standard value /dev/serial0. As this seemed changed in some Raspbians, this macro definition can be overruled in a target specific include file.

5.17 include/arch/config_raspberry_01.h File Reference

Configuration settings for Raspberry Pi1 (Models A)

Macros

- #define GPIO2pin

  GPIO [0..39] to pin number (1..40) lookup list.
- #define **PIN03**

  SDA0 (GPIO 02 on other Pis)
- #define **PIN05**

  SCL0 (GPIO 03 on other Pis)
- #define **PIN13**

  GPIO 21 (GPIO 27 on other Pis)
- #define PIN2gpio

  Pin number [0..26] to GPIO number lookup list.
- #define stdUARTpath

  /def stdUARTpath Pi's standard UART.

5.17.1 Detailed Description

Configuration settings for Raspberry Pi1 (Models A)

This file contains some platform (type) specific definitions. These settings influence the compilation and build process. Most of those settings can not be changed later at runtime.

Since end 2017 we mostly use Pi3 ++.

```
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```

Revision history

```
Rev.  82 3.05.2025
Rev.  190 12.02.2019 :  minor, comments only
Rev.  209 10.07.2019 :  stdUARTpath
Rev.  231 13.08.2020 :  two digit PIN0x  and  GPIO2pin added
Rev.    82 15.04.2025 :  SVN changed, no serial0
```

5.17.2 Macro Definition Documentation

5.17.2.1 GPIO2pin

```
#define GPIO2pin
```

GPIO [0..39] to pin number (1..40) lookup list.

0 means has no pin on the 40 pin connector; see also gpio2pin

5.17.2.2 PIN2gpio

```
#define PIN2gpio
```

Pin number [0..26] to GPIO number lookup list.

0..56: GPIO number; 95: 5V pin; 93: 3.3V; 90: Ground 0V;
99 means not existent. N.b.: [1..26] are: valid pin numbers, only.

See also

pin2gpio

5.17.2.3 stdUARTpath

```
#define stdUARTpath
```

/def stdUARTpath Pi's standard UART.

It is the one on the Pins 8 (GPIO14) for Tx and 10 (GPIO15) for Rx. Here it is set to the long year standard value /dev/serial0. As this seemed changed in some Raspbians, this macro definition can be overruled in a target specific include file.

5.18 include/arch/config_raspberry_03.h File Reference

Configuration settings for Raspberry Pi3.

Macros

- #define **PIN27**

  SDA0.
- #define **PIN28**

  SCL0.
- #define stdUARTpath

  /def stdUARTpath Pi's standard UART.

5.18.1 Detailed Description

Configuration settings for Raspberry Pi3.

This file contains some platform (type) specific definitions. These settings influence the compilation and build process. Most of those settings can not be changed later at runtime.

With respect to (process) I/O pins there is no difference to Pi3b. Hence, for Pi3∗ define PLATFORM as raspberry↩ _03. Additionally, there is no difference between Pi4∗, Pi0∗ and Pi3∗; hence the defines in config_raspberry_04.h, config_raspberry_00.h and config_raspberry_03.h are the same. See just config_raspberry_04.h.

```
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```

Revision history

```
Rev.  82 3.05.2025
Rev.  190 12.02.2019 :  minor, comments only
Rev.  209 10.07.2019 :  stdUARTpath
Rev.  231 13.08.2020 :  two digit PIN0x  and  GPIO2pin added
Rev.    82 15.04.2025 :  SVN changed, no serial0
```

5.18.2 Macro Definition Documentation

5.18.2.1 stdUARTpath

```
#define stdUARTpath
```

/def stdUARTpath Pi's standard UART.

It is the one on the Pins 8 (GPIO14) for Tx and 10 (GPIO15) for Rx. Here it is set to the long year standard value /dev/serial0. As this seemed changed in some Raspbians, this macro definition can be overruled in a target specific include file.

5.19 include/arch/config_raspberry_04.h File Reference

Configuration settings for Raspberry Pi4.

Macros

- #define GPIO2pin

  GPIO [0..39] to pin number (1..40) lookup list.
- #define **PIN03**

  GPIO 02 SDA1 (GPIO 0 on Pi1)
- #define **PIN05**

  GPIO 03 SCL (GPIO 1 on Pi1)
- #define **PIN07**

  GPIO 04 GPCLK0.
- #define **PIN08**

  GPIO 14 TXDI.
- #define **PIN10**

  GPIO 15 RXDI.
- #define **PIN11**

  GPIO 17.
- #define **PIN12**

  GPIO 18.
- #define **PIN13**

  GPIO 27 (GPIO 21 on Pi1)
- #define **PIN15**

  GPIO 22.
- #define **PIN16**

  GPIO 23.
- #define **PIN18**

  GPIO 14.
- #define **PIN19**

  GPIO 10 SPI.MOSI | S.
- #define **PIN21**

  GPIO 09 MSPI.ISO | P.
- #define **PIN22**

  GPIO 25.
- #define **PIN23**

  GPIO 11 SPI.SCLK | I.
- #define **PIN24**

GPIO 08 SPI.CE0 / .

- #define **PIN26**

  GPIO 07 SPI.CE1 / .
- #define **PIN27**

  SDA0.
- #define **PIN28**

  SCL0.
- #define **PIN29**

  GPIO 05.
- #define PIN2gpio

  Pin number [0..43] to GPIO number lookup list.
- #define **PIN31**

  GPIO 06.
- #define **PIN32**

  GPIO 12.
- #define **PIN33**

  GPIO 13.
- #define **PIN35**

  GPIO 19.
- #define **PIN36**

  GPIO 16.
- #define **PIN37**

  GPIO 26.
- #define **PIN38**

  GPIO 20.
- #define **PIN40**

  GPIO 21.
- #define stdUARTpath

  /def stdUARTpath Pi's standard UART.

5.19.1 Detailed Description

Configuration settings for Raspberry Pi4.

This file contains some platform (type) specific definitions. These settings influence the compilation and build process. Most of those settings can not be changed later at runtime.

With respect to I/O pins there is no difference between Pi4∗, Pi0∗ and Pi3∗; hence the defines in config_raspberry_04.h, config_raspberry_00.h and config_raspberry_03.h are the same.

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     \/  \/   \__/          \__/|_
```

Revision history

```
Rev.  82 3.05.2025
Rev.  223 18.06.2020 :  fork of config_raspberry_03.h
Rev.  231 13.08.2020 :  two digit PIN0x  and  GPIO2pin added
Rev.  237 01.03.2021 :  included in Doxygen documentation
Rev.    82 15.04.2025 :  SVN changed, no serial0
```

5.19.2 Macro Definition Documentation

5.19.2.1 GPIO2pin

```
#define GPIO2pin
```

GPIO [0..39] to pin number (1..40) lookup list.

0 means has no pin on the 40 pin connector; see also gpio2pin

5.19.2.2 PIN2gpio

```
#define PIN2gpio
```

Pin number [0..43] to GPIO number lookup list.

0..56: GPIO number; 95: 5V pin; 93: 3.3V; 90: Ground 0V;
99 means not existent. N.b.: [1..40] are: valid pin numbers, only.

See also

pin2gpio

5.19.2.3 stdUARTpath

```
#define stdUARTpath
```

/def stdUARTpath Pi's standard UART.

It is the one on the Pins 8 (GPIO14) for Tx and 10 (GPIO15) for Rx. Here it is set to the long year standard value /dev/serial0. As this seemed changed in some Raspbians, this macro definition can be overruled in a target specific include file.

5.20 include/arch/config_raspberry_05.h File Reference

Configuration settings for Raspberry Pi5.

Macros

- #define GPIO2pin

  GPIO [0..39] to pin number (1..40) lookup list.
- #define **NO_PIGPIO_LIB**

  No proven IO libraries on Pi5, no pigpio(d)
- #define **PIN03**

  GPIO 02 SDA1 (GPIO 0 on Pi1)
- #define **PIN05**

  GPIO 03 SCL (GPIO 1 on Pi1)
- #define **PIN07**

  GPIO 04 GPCLK0.
- #define **PIN08**

  GPIO 14 TXDI.
- #define **PIN10**

  GPIO 15 RXDI.
- #define **PIN11**

  GPIO 17.
- #define **PIN12**

  GPIO 18.
- #define **PIN13**

  GPIO 27 (GPIO 21 on Pi1)
- #define **PIN15**

  GPIO 22.
- #define **PIN16**

  GPIO 23.
- #define **PIN18**

  GPIO 14.
- #define **PIN19**

  GPIO 10 SPI.MOSI | S.
- #define **PIN21**

  GPIO 09 MSPI.ISO | P.
- #define **PIN22**

  GPIO 25.
- #define **PIN23**

  GPIO 11 SPI.SCLK | I.
- #define **PIN24**

  GPIO 08 SPI.CE0 / .
- #define **PIN26**

  GPIO 07 SPI.CE1 / .
- #define **PIN27**

  SDA0.
- #define **PIN28**

  SCL0.
- #define **PIN29**

  GPIO 05.
- #define PIN2gpio

  Pin number [0..43] to GPIO number lookup list.
- #define **PIN31**

  GPIO 06.
- #define **PIN32**

GPIO 12.

- #define **PIN33**

  GPIO 13.
- #define **PIN35**

  GPIO 19.
- #define **PIN36**

  GPIO 16.
- #define **PIN37**

  GPIO 26.
- #define **PIN38**

  GPIO 20.
- #define **PIN40**

  GPIO 21.
- #define stdUARTpath

  /def stdUARTpath Pi's standard UART.

5.20.1 Detailed Description

Configuration settings for Raspberry Pi5.

This file contains some platform (type) specific definitions. These settings influence the compilation and build process. Most of those settings can not be changed later at runtime.

With respect to I/O pins to GPIO mapping there is no difference between Pi0∗, Pi3∗, Pi4∗ and Pi5; hence for those defines there is no difference to config_raspberry_04.h etc. The main problem with Pi5 is no established and proven IO library will work, including pigpio(d). See Albrecht Weinert, Raspberry for distributed control technical paper, January 2025 https://weinert-automation.de/pub/raspberry4distributed↩Control.pdf and Fairhead, Harry, Raspberry Pi IoT in C, Third Edition, I/O Press 2024.

```
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     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  75 19.02.2025
Rev.  74  25.01.2025 :  fork of config_raspberry_04.h, Pi5 limitations
```

5.20.2 Macro Definition Documentation

5.20.2.1 GPIO2pin

```
#define GPIO2pin
```

GPIO [0..39] to pin number (1..40) lookup list.

0 means has no pin on the 40 pin connector; see also gpio2pin

5.20.2.2 PIN2gpio

```
#define PIN2gpio
```

Pin number [0..43] to GPIO number lookup list.

0..56: GPIO number; 95: 5V pin; 93: 3.3V; 90: Ground 0V;
99 means not existent. N.b.: [1..40] are: valid pin numbers, only.

See also

pin2gpio

5.20.2.3 stdUARTpath

```
#define stdUARTpath
```

/def stdUARTpath Pi's standard UART.

It is the one on the Pins 8 (GPIO14) for Tx and 10 (GPIO15) for Rx. Here it is set to the long year standard value /dev/serial0. As this seemed changed in some Raspbians, this macro definition can be overruled in a target specific include file.

5.21 include/basicTyCo.h File Reference

Basic types and constants.

```
#include <stdint.h>
```

Data Structures

- union dualReg_t
  A 32 bit union.
- union sdm124regs_t
  A type for 124 registers respectively 62 values of 32 bit.
- union sdm80regs_t
  A type for 80 registers respectively 40 values of 32 bit.
- struct smdX30modbus_t
  A structure for SMDx30 smart meters.

Macros

- #define clearArray(a)

  Clear an array.
- #define **DAYs**

  seconds in days w/o DST switch or leap seconds
- #define ERAend

  A point in time far away.
- #define FALSE

  false off aus arrêt stop halt.
- #define **FOURYEARS**

  days in four years (3 ∗ YEAR + LEAPYEAR)
- #define **HOURs**

  seconds in hours
- #define **LEAPYEAR**

  days in leap year
- #define memBarrier()

  Memory barrier.
- #define MILLIARD

  MILLIARD 1/nano = Giga = 10∗∗9.
- #define MILLION

  Million = 1/micro = Mega = 10∗∗6.
- #define **MINUTEs**

  seconds in minutes
- #define OFF

  false Off Aus arrêt stop halt.
- #define ON

  true On An marche go.
- #define PLATFlittlE

  The target platform is little endian.
- #define TRUE

  true on an marche go.
- #define YEAR

  Days in normal year.

Typedefs

- typedef enum modBusLinkState_t modBusLinkState_t

  A set of possible states of a Modbus link.

Enumerations

- enum modBusLinkState_t {
  ML_OFF , ML_ON , ML_IDLE , ML_INITED ,
  ML_REQSEND , ML_RESPREC , ML_LISTEN , ML_REQREC ,
  ML_RESPOND , ML_ERR_ANY , ML_ERR_INIT , ML_ERR_REQ ,
  ML_ERR_RESP }

  A set of possible states of a Modbus link.

5.21.1 Detailed Description

Basic types and constants.

This file contains some basic type definitions and values, i.e. macro constants. It does not contain function definitions and, hence, has no implementing .c file.

```
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```

Revision history

```
Rev.  93 30.08.2025
Rev.  152 21.06.2018 :  new, excerpted from sysBasic.h V.151
Rev.  182 12.08.2018 :  types reduced
Rev.  190 12.02.2019 :  minor, comments only
Rev.  209 13.07.2019 :  include stdint.h only (string.h no more)
Rev.  215 26.08.2019 :  type sdm124regs_t added
Rev.    93 27.08.2025 :  description (comment) improvements
```

5.21.2 Macro Definition Documentation

5.21.2.1 PLATFlittlE

```
#define PLATFlittlE
```

The target platform is little endian.

values: 0 : no (known at compile time); 1 : yes (dto.); littleEndian() : compute at runtime as no commonly used target information macros are available

5.21.2.2 ON

```
#define ON
```

true On An marche go.

value: 1

5.21.2.3 OFF

```
#define OFF
```

false Off Aus arrêt stop halt.

value: 0

5.21.2.4 TRUE

```
#define TRUE
```

true on an marche go.

value: 1

5.21.2.5 FALSE

```
#define FALSE
```

false off aus arrêt stop halt.

value: 0

5.21.2.6 MILLIARD

```
#define MILLIARD
```

MILLIARD 1/nano = Giga = 10∗∗9.

The constant Milliard. (Amercians, wrongly, call that Billion.)

value: 1000000000

5.21.2.7 MILLION

```
#define MILLION
```

Million = 1/micro = Mega = 10∗∗6.

value: 1000000

5.21.2.8 YEAR

```
#define YEAR
```

Days in normal year.

value: 365

5.21.2.9 ERAend

```
#define ERAend
```

A point in time far away.

This is 2.2.2106 in Unix seconds and very near the end of the unsigned 32 bit era. In the sense of small embedded control applications we consider this (for tasks timers etc.) as beyond end of life and, hence, infinity.
value: 4294512000U

5.21.2.10 clearArray

```
#define clearArray(
              a )
```

Clear an array.

This is to set a real fixed size array to zero (0). Using this instead of looping or own optimising gets better code on almost all gcc compilers. Note: "Real" array means an array declared and defined with a fixed length; and no malloced pointer.

Parameters

a	the array to be set all 0 (not NULL, fixed length array)

5.21.2.11 memBarrier

```
#define memBarrier( )
```

Memory barrier.

This macro is an ARM memory fence instruction insuring cache updates.

Memory mapped IO, as used in Raspberries' ARM s BCM2835, BCM2835 and BCM2836 is quite problematic. As the semantics of memory is (non regarding caches and multiprocessing) extremely simple both compilers and processors may optimise memory access by all kinds of re-ordering and dropping.

A variable is an abstractions of memory cell respectively a pointer or reference is an abstraction of a memory cell address. If such variable points neither to nor is a memory cell but an IO register (say a USART buffer FIFO e.g.) this optimising by re-ordering or dropping would be disastrous. This has to be inhibited at compile time as well as at run time. Indeed, at runtime too as those newer s are clever enough to re-order and drop memory accesses by them self.

Compile time memory access optimisation is inhibited by the volatile keyword for every variable and reference meaning an IO register. Just one omission is good for effects hard to diagnose.

Run time optimisation and especially re-ordering is inhibited by putting memory fence instructions (this one) at the right places. The BCM2835 data sheet says: "Accesses to the same peripheral will always arrive and return in-order. It is only when switching from one peripheral to another that data can arrive out-of-order. The simplest way to make sure that data is processed in-order is to place a memory barrier instruction at critical positions in the code. You should place: ∗ A memory write barrier before the first write to a peripheral. ∗ A memory read barrier after the last read of a peripheral. It is not required to put a memory barrier instruction after each read or write access. Only at those places in the code where it is possible that a peripheral read or write may be followed by a read or write of a different peripheral. This is normally at the entry and exit points of the peripheral service code. As interrupts can appear anywhere in the code so you should safeguard those. If an interrupt routine reads from a peripheral the routine should start with a memory read barrier. If an interrupt routine writes to a peripheral the routine should end with a memory write barrier."

That's quite clear and applies to BCM2836 and BCM2837, too (we have no data sheet for those, only for BCM2835). And to repeat: Too many volatiles and memory fences makes programs longer and slower. But one too less is good for disaster.

Language hint: In Java this would be volatile, transient and synchronised. Implementation hint: This macro is __↩ sync_synchronize() Interrupt hint: We and most of us do not make a sequence of IO accesses atomic by interrupt disable. We rely on interrupt routines doing it right as described in the data sheet.

5.21.3 Typedef Documentation

5.21.3.1 modBusLinkState_t

```
typedef enum modBusLinkState_t modBusLinkState_t
```

A set of possible states of a Modbus link.

Modbus link here means a connection to a concrete Modbus slave/server seen by the master/client.

Note: The numbering may change in future but the ordering off < operational < operated < error will not.

The set of states is limited by the interface type (RS485, Ethernet, ..) and may be further limited by the device or application. The subset ML_OFF ML_ON ML_INITED ML_ERR_REQ ML_ERR_RESP will be enough for some RS485 slaves.

5.21.4 Enumeration Type Documentation

5.21.4.1 modBusLinkState_t

```
enum modBusLinkState_t
```

A set of possible states of a Modbus link.

Modbus link here means a connection to a concrete Modbus slave/server seen by the master/client.

Note: The numbering may change in future but the ordering off < operational < operated < error will not.

The set of states is limited by the interface type (RS485, Ethernet, ..) and may be further limited by the device or application. The subset ML_OFF ML_ON ML_INITED ML_ERR_REQ ML_ERR_RESP will be enough for some RS485 slaves.

Enumerator

ML_OFF	do not use that Modbus device
ML_ON	may be used but connection not ready
ML_IDLE	may be usable, basic state
ML_INITED	initialised and settings (if any)
ML_REQSEND	request sent, response pending
ML_RESPREC	response received --> ML_INITED
ML_LISTEN	listening
ML_REQREC	request received
ML_RESPOND	respond sent
ML_ERR_ANY	no concrete error, lower bound of all error states
ML_ERR_INIT	initialisation error (hopeless when re-occurring)
ML_ERR_REQ	request error
ML_ERR_RESP	response error

5.22 include/growattHome.h File Reference

Types and values for the smart home's Growatt inverter handling (laboratory project)

```
#include "arch/config.h"
#include <stdint.h>
#include "weShareMem.h"
```

Data Structures

- struct modBvals_t

  Modbus readings and other process values.
- struct modSharMem_t

  Structure for shared memory.

Macros

- #define **ANZmodSLAVES**

  Number of Modbus attached inverters (usually 1)
- #define **GROWerror**

  JSON key for several inverter errors.
- #define SHARED_MEM_DATA_SIZE

  Size of defined master slave communication data in shared memory.
- #define **SHARED_MEM_FILL_SIZE**

  Size of extra fill array to have a standard shared memory size.

5.22.1 Detailed Description

Types and values for the smart home's Growatt inverter handling (laboratory project)

```
Copyright  (c)  2019   Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  76 26.02.2025
Rev.  213 07.07.2019 :  new derived from sweetHome.h
Rev.  215 26.08.2019 :  shared memory types adapted
Rev.  270 03.11.2024 :  semphore set & shared memory defined in weShareMem.h
```

This include file collects some configuration and naming common to
a) the Growatt inverter communication program
b) server side program(s) (CGI) for the web interfaces

All those programs, running on the system for process control and I/O, are written in C. The client side programming for the web HMI is in Javascript.

The server side programs communicate via shared memory and a set of three (ANZ_SEMAS) semaphores.

5.22.2 Macro Definition Documentation

5.22.2.1 SHARED_MEM_DATA_SIZE

```
#define SHARED_MEM_DATA_SIZE
```

Size of defined master slave communication data in shared memory.

This macro calculates the size in bytes of the shared memory area, see valsSharMem_t. The size of the shared memory SHARED_MEMORY_SIZE should be chosen as a multiple of 256 (512) bytes. The extra bytes are usable as an array uint8_t fill[] of size SHARED_MEM_FILL_SIZE.

5.23 include/homeDoor.h File Reference

Common types and values for the smart home door bell and phone project.

```
#include "arch/config.h"
#include <stdint.h>
#include "weGPIOd.h"
```

Macros

- #define **BEEP**

  beeper, 1-active
- #define **DOoff**

  door opener inactive, 0-inactive
- #define **DOpRel**

  door opener relay, 1-active (5s max.)
- #define **GNdim**

  green LEDs too bright: PWM en liue de permanent ON
- #define **KliMU**

  bell middle and lower floor, 0-active
- #define **KliOb**

  bell upper floor, 0-active
- #define **LEDgeL**

  left yellow LED, 1-active Ko 4h
- #define **LEDgeR**

  right yellow LED, 1-active bell middle & lower
- #define **LEDgnL**

  left green LED, 1-active I'm alive blink
- #define **LEDgnR**

  right green LED, 1-active !door opener
- #define **LEDoc3**

  no LED, 1-active oc3 state
- #define **LEDrtL**

left red LED, 1-active Kmu 4h

- #define **LEDrtR**

  right red LED, 1-active bell upper

- #define **OCres**

  unused optocoupler 3, 0-active

- #define **SamPer**

  50 Hz rectangle (a 20 ms 5 sample period)

- #define **Smp1o4**

  sample 3 of 4 every 4 ms (5∗50 Hz, doorUnl)

5.23.1 Detailed Description

Common types and values for the smart home door bell and phone project.

```
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weinert-automation.de          a-weinert.de
    /          /       /\
   /          /___    /  \       |
   \         /____\ /____\ |  _|__
    \  /\  / \     /       \|    |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  67 5.10.2024
Rev.  223 18.06.2020 :  new
Rev.  228 20.07.2020 :  output LineF
Rev.  264 22.09.2024 :  gn LEDs dimmed
```

This include file collects some configuration and naming common to
a) the process control program
b) server side program(s) (CGI) for the web interfaces

5.24 include/mqttHome.h File Reference

MQTT related definitions for an experimental smart home (lab) project.

```
#include <mosquitto.h>
```

Functions

- void **mqttClean** ()

  End as MQTT client.

- int mqttInit ()

  Initialise as MQTT client.

- void mqttPlg01Set (uint8_t const on)

  Switch the plug Plug01.

- void mqttPlg02Set (uint8_t const on)

  Switch the plug PLG2.

- void mqttPlg03Set (uint8_t const on)

  Switch the plug PLG3.

- void mqttPlg04Set (uint8_t const on)

  Switch the plug PLG4.

Variables

- char clientId [38]

  MQTT client ID.
- char mqttHost [68]

  The MQTT broker URL or name.
- int **mqttPort**

  MQTT port 1883.
- char subTopStPlg01 [14]

  State sub topic of S20 plug Number 01 to 09.

5.24.1 Detailed Description

MQTT related definitions for an experimental smart home (lab) project.

```
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weinert-automation.de      a-weinert.de
    /          /      /\
   /          /___    /  \       |
   \         /____\ /____\ |  _|__
    \  /\  / \     /       \|    |
     \/  \/   \__/          \__/|_
```

Revision history

```
Rev.  218 07.09.2019 :  MQTT excepted from sweetHome2.h
Rev.  219 30.09.2019 :  reconstructed after HDD crash
```

5.24.2 Function Documentation

5.24.2.1 mqttInit()

```
int mqttInit ( )
```

Initialise as MQTT client.

On success only: subscribe, loop and publish.

Returns

0: success the common mosq is set and usable; else: errno

5.24.2.2 mqttPlg01Set()

```
void mqttPlg01Set (
             uint8_t const on )
```

Switch the plug Plug01.

This function publishes the switch command via MQTT to the relay device Plug01, usually a Sonoff S20 with Tasmota.

Parameters

on	switch on when true, else off

5.24.2.3 mqttPlg02Set()

```
void mqttPlg02Set (
            uint8_t const on )
```

Switch the plug PLG2.

See mqttPlg01Set

5.24.2.4 mqttPlg03Set()

```
void mqttPlg03Set (
            uint8_t const on )
```

Switch the plug PLG3.

See mqttPlg01Set

5.24.2.5 mqttPlg04Set()

```
void mqttPlg04Set (
            uint8_t const on )
```

Switch the plug PLG4.

See mqttPlg01Set

5.24.3 Variable Documentation

5.24.3.1 mqttHost

```
char mqttHost[68]  [extern]
```

The MQTT broker URL or name.

May be set by option –mqttHost meterPi or –mqttBroker 192.168.178.87

default: localhost MQTTBroker (currently localhost !)

5.24.3.2 subTopStPlg01

```
char subTopStPlg01[14]  [extern]
```

State sub topic of S20 plug Number 01 to 09.

It's preset as plug01/POWER for 01, but the digit at index [5] will be set before each use accordingly.

5.24.3.3 clientId

```
char clientId[38]  [extern]
```

MQTT client ID.

default value: sweetHomeControl; length: 15; max. length: 36
May be changed before mqttInit().

MQTT client ID.

5.25 include/sweetHome.h File Reference

Common types, values and functions for a smart home project.

```
#include "arch/config.h"
#include <stdint.h>
#include "weShareMem.h"
```

Data Structures

- struct cmdLookUp_t

  Structure for a defined remote command.
- struct dayStrtVal_t

  Day start values.
- struct meterVal_t

  One smart meter's readings.
- struct phPckSwSet_t

  Simple Structure for phase packet switch setting.
- struct valFilVal_t

  Smart meters' and other process values.
- struct valsSharMem_t

  Structure for shared memory.

Macros

- #define **Amsk**

  would give away
- #define ANZmodSLAVES

  Number of smart Modbus meters.
- #define **AUTO_PPSWI_COMMAND**

  auto control (ON=manual)
- #define **BALL_CARLOAD_COMMAND**

  car load as PV surplus ballast
- #define bat2unload(x)

  The battery load/undoad line (30A fuse) is connected to the unload step up converter and, hence, not to the PWM controlled charger.
- #define **BAT_COMMANDS**

  all battery commands mask
- #define **BATLOAD_COMMANDS**

  battery loading commands mask
- #define **BATUNL_COMMANDS**

  battery unloading commands mask
- #define **Bmsk**

  Controlled load battery (as ballast)
- #define **C250W_COMMANDS**

  give 250 W command mask
- #define **CARLOAD_COMMANDS**

  car load command mask
- #define **CHSBmsk**

  CHS mode ballast (1: on at 0.. max power at surplus)
- #define **CHScarC**

  CHS loading station: car connected to EVSE.
- #define **CHScPow**

  CHS loading station: power line connected to car.
- #define **CHSiLhi**

  CHS current limit at hi border.
- #define **CHSiLiM**

  CHS current limit at one border mask.
- #define **CHSiLlo**

  CHS current limit at lo border (usually 6A fixed)
- #define **CHSMmsk**

  CHS mode manual (1: on at max power)
- #define **CHSphas**

  CHS number of phases: 1..6; 0, 7 not used; 3 default.
- #define **CHSphHi**

  CHS number of phases at hi limit (1..6)
- #define **CHSphLo**

  CHS number of phases at lo limit (usually 1 fixed)
- #define **CHSphMs**

  CHS number of phases at limit mask.
- #define cmdBits_t

  Type for command bits.
- #define **DEC_CARLOAD_COMMAND**

  car load decrease max. current

- #define **DECLIM_PPSWI_COMMAND**
  reduce PPSWI limit (by 300W)
- #define **DECR_PPSWI_COMMAND**
  decrement (-1) PPSWI power
- #define getNoPhas()
  Get number of phases.
- #define **GIVE250_COMMANDS**
  commands concerning Plg01 & Rel5
- #define **Gmsk**
  Give away: Alarm / add ballast / etc.
- #define HIPPO_COMMANDS
  Mask for all Hippogreiff commands.
- #define **HWPUMP_COMMANDS**
  comfort pump command mask
- #define **INC_CARLOAD_COMMAND**
  car load increase max. current
- #define **INC_PPSWI_COMMAND**
  increment (+1) PPSWI power
- #define **INCLIM_PPSWI_COMMAND**
  increase PPSWI limit (by 200W)
- #define **Kmsk**
  Keep battery (minimal load voltage)
- #define **Lmsk**
  Load battery (normal program)
- #define **LOWER_BATLOAD_COMMAND**
  lower battery loading power
- #define **LOWER_PPSWI_COMMAND**
  lower PPSWI power
- #define **OFF_C250W_COMMAND**
  off control give 250 W
- #define **OFF_CARLOAD_COMMAND**
  E-car load off.
- #define **OFF_HIPPO_COMMAND**
  off Hippogreiff
- #define **OFF_PLG1_COMMAND**
  off Plug01 give 250 W
- #define **OFF_PLG2_COMMAND**
  off Plug02
- #define **OFF_PLG3_COMMAND**
  off Plug03
- #define **OFF_PLG4_COMMAND**
  off Plug04
- #define **OFF_PPSWI_COMMAND**
  off PPSWI (Power packet switching)
- #define **ON_C250W_COMMAND**
  on control give 250 W
- #define **ON_CARLOAD_COMMAND**
  E-car load on.
- #define **ON_HIPPO_COMMAND**
  on Hippogreiff
- #define **ON_PLG1_COMMAND**

on Plug01 give 250 W

- #define **ON_PLG2_COMMAND**

  on Plug02
- #define **ON_PLG3_COMMAND**

  on Plug03
- #define **ON_PLG4_COMMAND**

  on Plug04
- #define **ONMAN_PPSWI_COMMAND**

  on and manual PPSWI PPSWI
- #define **P2sPmsk**

  PPS element 2 power ∗ 50% (0:0% .. 2:100%)
- #define PCK100PERC_POWER

  Phase packet switching device.
- #define **PCK1PERC_POWER**

  phase packet switch 1% power / W
- #define **PCK50PRC_POWER**

  phase packet switch 50% power / W
- #define **PHDEC_CARLD_COMMAND**

  assume E-cars using 1 phase less
- #define **PHINC_CARLD_COMMAND**

  assume E-cars using 1 phase more
- #define **PLG1_COMMANDS**

  Plug01 command mask.
- #define **PLG2_COMMANDS**

  Plug02 command mask.
- #define **PLG3_COMMANDS**

  Plug03 command mask.
- #define **PLG4_COMMANDS**

  Plug04 command mask.
- #define **PPSMmsk**

  PPS mode manual (0: automatic, default)
- #define **PPSUmsk**

  PPS power at limit PCK_POWER_LIM_MAX.
- #define **PPSWI_COMMANDS**

  Power packet switching commands.
- #define **PPsXmsk**

  PPS max at limit (1: at 0.0 or PCK_POWER_LIM_MAX)
- #define **PUMP_STRT_POWR**

  Pump start heating power; see PUMP_STRT_TEMP.
- #define PUMP_STRT_TEMP

  Water (tank) temperature to start comfort pump when heating.
- #define **RISE_BATLOAD_COMMAND**

  rise battery loading power
- #define **RISE_PPSWI_COMMAND**

  rise PPSWI power
- #define SAFE_TEMP_WAT

  Upper limit of safe water (tank) temperature.
- #define SHARED_MEM_DATA_SIZE

  Size of defined master slave communication data in shared memory.
- #define **SHARED_MEM_FILL_SIZE**

  Size of extra fill array to have a standard shared memory size.

- #define **Smsk**

  Solar power is generated.
- #define **START_BATKEEP_COMMAND**

  start battery keep alive (with load)
- #define **START_BATKPLD_COMMAND**

  start battery keep or load
- #define **START_BATLOAD_COMMAND**

  start battery loading
- #define **START_BATUNL_COMMAND**

  start battery unloading
- #define **START_HWPUMP_COMMAND**

  start hot water comfort pump
- #define **STD_CARLOAD_COMMAND**

  set 3 phases and 16A (11kW)
- #define **STOP_BAT_COMMAND**

  stop battery unloading & loading
- #define **STOP_HWPUMP_COMMAND**

  stop hot water comfort pump
- #define **U_ENDRANGE**

  Upper end of battery operating range LiFePo.
- #define **U_ENDRANGE_SOC**

  SOC value assigned to :: U_ENDRANGE.
- #define **Umsk**

  Unload battery commanded.
- #define **UNUSED_COMMANDS**

  4 unused command bits (June 2023)
- #define **Wmsk**

  Would give away 250W or more.

Functions

- int batSOCbyU (float uBat)

  Battery capacity or state of charge (SOC) in % by voltage.

Variables

- cmdLookUp_t cmdLookUp [ ]

  The common command look up table.
- volatile float fLine

  Last valid power line frequency.
- volatile int invHasUnloadPow

  The miniJoule inverter has battery unload power.
- float const **phPckSwPow** [101]

  First (or only) phase packet switching device power look up.
- phPckSwSet_t const phPckSwSets [101]

  The packet switch control values.
- smdX30modbus_t smdX30modbus [2]

  Descriptive and state array for smart meters on Modbus.
- volatile int tempTankWater

Last value of tank water temperature.

- volatile uint8_t tempWaterBadCnt

  Tank water temperature bad read count.

- float const uBatBySOC [113]

  Battery voltage by capacity or state of charge (SOC) in %.

- valFilVal_t **valFilVal**

  All process values relevant for log files and HMI.

5.25.1 Detailed Description

Common types, values and functions for a smart home project.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|    |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  94 2.10.2025
Rev.  77+ 07.12.2017 :  new
Rev.    99 29.01.2018 :  storage battery load module voltage handling added
Rev.  167 19.06.2018 :  phPckSwPow [100]  950.00 W
Rev.  187 04.10.2018 :  wSumExp in valFilVal_t (unload guarded)
Rev.  190 12.02.2019 :  prepare VDE-AR-N 4105 (relays) handling
Rev.  217 05.09.2019 :  phase packet switch ballast:  three variants
Rev.  220 09.11.2019 :  Growatt values added to valFilVal_t
Rev.  245 27.02.2023 :  pps 100% power risen to 1983 W due to panel reorg.
Rev.  251 12.07.2023 :  phase packet switch power limit added to valFilVal_t
Rev.  259 04.08.2023 :  battery changed to ECO-WORTHY 12.8V 100Ah LiFePO4 Akku
Rev.  268 15.10.2024 :  float lookup Uload(pwm) range 0..141
Rev.  270 03.11.2024 :  semphore set & shared memory defined in weShareMem.h
Rev.    86 19.06.2025 :  water temperature limits reduced etc.
Rev.    89 28.07.2025 :  new Uload(pwm) table (prelim.)
Rev.    90 06.08.2025 :  battery state of charge (SOC)/% <-> Ubat
Rev.    92 15.08.2025 :  load unload values and SFCs
```

In the smart home's PV under control, we assume one smart meter for the whole house's (public) electricity supply and one for solar generators and battery storage. The (two, cf. ANZmodSLAVES) meters are Modbus controlled. Additionally we have home and PV related process control.
The process IO related definitions are mostly in include/sweetHome2.h

This include file collects some configuration and naming common to
a) the process control program (hometersControl)
b) a console HMI program (hometersConsol) and the
c) server side program(s) (meteRead, CGI) for the web interfaces

All those programs, running on the system for process control and I/O, are written in C. The client side programming for the web HMI is in Javascript.

The server side programs communicate via shared memory and a set of three (ANZ_SEMAS) semaphores.

5.25.2 Macro Definition Documentation

5.25.2.1 ANZmodSLAVES

```
#define ANZmodSLAVES
```

Number of smart Modbus meters.

Usually two.

5.25.2.2 cmdBits_t

```
#define cmdBits_t
```

Type for command bits.

Commands to the process control program from outside are transferred via shared memory as one bit set for every command to be executed. The bit position (0..31, as of May 2018) defines a concrete command.

"From outside" usually means from a web interface (html page with Javascript) and AJAX to a C written GCI program communicating via shared memory with the process control program. In this schema the CGI program sets bits for commands to be executed and the process control program clears the bit(s) in question on commands executed (or rejected).

Remark: On contradictory commands, ONyxz and OFFxyz, one will be executed and both will be cleared. In cases like this OFF... usually gets priority.

Remark 2: When exceeding 32 distinct commands we may switch to a uint64_t as was done from 16_t to 32_t in May 2018.

5.25.2.3 HIPPO_COMMANDS

```
#define HIPPO_COMMANDS
```

Mask for all Hippogreiff commands.

Hippogreiff stands for a relay controlled 12V supply from storage battery. It should be ON at night, or more precisely either between sunset and sunrise or from dusk to dawn.
One consumer on this rail is a green LED beam to a little Hippogreiff sculpture. Hence the name.

The Hippogreiff is mythical beast with similarities to Harry Potter's Hippogreif, as long as looked at from the front. Seen from side one realises him being another species.

5.25.2.4 PCK100PERC_POWER

```
#define PCK100PERC_POWER
```

Phase packet switching device.

Since Rev. 157 (07-2018) we have one single phase heating device with then 950 W power, raised 03.2020 to 1267W and 02.2023 to 1845. It is actuated by a zero crossing electronic switch (SSR) at pin PH_P_SSR1 controlling the amount of power in 1% (PCK1PERC_POWER) steps.
For robustness and safety this electronic relay sits behind a 10A relay.

Since march 2023 we have two heater elements of 2kW each:
heater element 1 phase packet switch SSR1 PH_P_SSR1) 0..100%
heater element 1 phase packet switch SSR1 PH_P_SSR1) 0, 50, 100%

While the first one is controlled in 101 steps as before, the second one got three states: off, half and full power. This effectively gives a range of 0 to about 4kW in 201 steps. In the present configuration any PV surplus can be handled as in-house-consumption (Eigenverbrauch).

5.25.2.5 SAFE_TEMP_WAT

```
#define SAFE_TEMP_WAT
```

Upper limit of safe water (tank) temperature.

The integer value for safe water (tank) temperature sensor reading is +65950 m℃ respectively 66 ℃. Above this value all (electric) heating must stop.

5.25.2.6 PUMP_STRT_TEMP

```
#define PUMP_STRT_TEMP
```

Water (tank) temperature to start comfort pump when heating.

The integer value for pump start water (tank) temperature sensor reading is +63950 m℃ respectively 64 ℃ (since 19.06.2025; was 62 ℃). Above this value electric heating with >= 1.9kW (surplus) power shall start the (comfort) circulation pump for 3 minutes.

This is done in the hope to disturb the temperature layers in the tank and, hence, reduce hot water outlet temperature.

See also

PUMP_STRT_POWR

PUMP_STRT_FOR

5.25.2.7 getNoPhas

```
#define getNoPhas( )
```

Get number of phases.

Returns

number of (set) phases available for car loading

5.25.2.8 bat2unload

```
#define bat2unload(
              x )
```

The battery load/undoad line (30A fuse) is connected to the unload step up converter and, hence, not to the PWM controlled charger.

Since 30.05.2025 this replaced the miniJoule input switching relays state.
N.b.: The Enversys two input inverter may now deliver power from PV panel

- battery unloading at the same time. Hence, its power meter (inherited from the miniJoule inverter) won't show battery unload power unambiguously when this function yields true and some seconds after due to the capacitors in the chain.

5.25.2.9 SHARED_MEM_DATA_SIZE

```
#define SHARED_MEM_DATA_SIZE
```

Size of defined master slave communication data in shared memory.

This macro calculates the size in bytes of the shared memory area, see valsSharMem_t. The size of the shared memory SHARED_MEMORY_SIZE should be chosen as a multiple of 256 (512) bytes. The extra bytes are usable as an array uint8_t fill[] of size SHARED_MEM_FILL_SIZE.

5.25.3 Function Documentation

5.25.3.1 batSOCbyU()

```
int batSOCbyU (
            float uBat )
```

Battery capacity or state of charge (SOC) in % by voltage.

This function yields the SOC (capacity) in % as integer 0..100 for a LiFePo4 12V battery. Values 101..111 cover the upper band of the operating range, where 110 (14.5V) is the max. charging voltage.

A value of -1 says Ubat is $<$ 10.00V the 0% value meaning really empty and outside the battery's operating range 10.0V (soc = 0) to 14.5V (soc = 110). A value of 111 says Ubat may be 14.6V which is the upper end of the allowed operating range. 112 says above 14.6V and hence outside allowed operation.

The values 101 to 110 may very well occur during charging and some time afterwards.

The index 0..100 is the SOC in % for the the idle state. That is no charging or discharging current worth mentioning, say less than 2A.

The values for 0, 10, 20 ... 90, 100, 109, 110 and 111 are from the EcoWorthy manual. The gaps were filled by linear interpolation.

The accuracy of the SOC values and the voltage measurement is about 10 mV and probably below. Hence two decimal places for U values as in the EcoWorthy manual are adequate. Nevertheless we partly use three decimal places for interpolated U values, to avoid equal values in adjacent entries in table uBatBySOC. So, this look up function batSOCbyU may yield any value in the range -1 .. 111 by binary search.

5.25.4 Variable Documentation

5.25.4.1 uBatBySOC

```
float const uBatBySOC[113]  [extern]
```

Battery voltage by capacity or state of charge (SOC) in %.

This table is the Ubat(SOC) function of the LiFePo4 12V battery. The index 0..100 is the SOC in % for the the idle state. That is no charging or discharging current worth mentioning, say less than 2A.

The values for 0, 10, 20 ... 90, 100 are from the EcoWorthy manual. The gaps were filled by linear interpolation. The values for [101..110] goto the limit of the charging voltage 14.6V. The value [111] is the upper end of the battery's operating range 10..14V. See also batSOCbyU.

5.25.4.2 smdX30modbus

```
smdX30modbus_t smdX30modbus[2]  [extern]
```

Descriptive and state array for smart meters on Modbus.

The number of meters is ANZmodSLAVES.

5.25.4.3 cmdLookUp

```
cmdLookUp_t cmdLookUp[]  [extern]
```

The common command look up table.

It must end with an entry {"", 0}.

The current (CGI) program uses linear search for the command mnemonic. Hence, and cause of structure, alphabetic sorting is of no avail.

5.25.4.4 phPckSwSets

```
phPckSwSet_t const phPckSwSets[101]  [extern]
```

The packet switch control values.

The array holds the number of on and off phases (i.e. 20 ms periods at 50 Hz line frequency) for each percentage of full power. The array length is 101; the index [0..100] is, hence, directly the percentage wanted.

To avoid too visible flicker, for no set (phPckSwSets[i].onPhases, phPckSwSets[i].offPhases) the smaller of the two values would be greater than 4 (80 ms); in most cases it is 1 or 2 (40 ms).

5.25.4.5 fLine

```
volatile float fLine  [extern]
```

Last valid power line frequency.

The measurement is taken from the more precise home three phase meter if communicative via Modbus. Otherwise the other meter's value is taken if available. Due to slow Modbus communication the values may be older than two seconds worst case.
This low sampling rate won't comply with VDE-AR-N 4105 cut off rules requiring a 0.1s reaction outside 47.5..51.↩ 5Hz. Nevertheless the current experimental set-up is a working proof-of-concept implementation (with very low power) — and a faster frequency measurement could easily be implemented.

Last valid power line frequency.

5.25.4.6 tempTankWater

```
volatile int tempTankWater  [extern]
```

Last value of tank water temperature.

This value will be the last good .tempTankTop (see valFilVal_t) or the last good .tempPipe. If neither is good for 251 measurements BAD_TEMP_READ (an incredibly high value) will be set.
This last tank water temperature will be checked against a safety limit to allow electric heating as ballast.
The value is in units of 1/1000 grdC.

5.25.4.7 tempWaterBadCnt

```
volatile uint8_t tempWaterBadCnt  [extern]
```

Tank water temperature bad read count.

This last tank water temperature will be checked against a safety limit to allow electric heating as ballast.

In case of too many bad reads the value must be fixed at 253

5.25.4.8 invHasUnloadPow

```
volatile int invHasUnloadPow  [extern]
```

The miniJoule inverter has battery unload power.

Or at least may still have due to step up converter capacitors.

5.26 include/sweetHome2.h File Reference

Types, values and functions for a smart home project.

```
#include "weBatt.h"
#include "weStateM.h"
#include "sweetHome.h"
#include "weGPIOd.h"
#include "mqttHome.h"
#include "we1wire.h"
#include <errno.h>
#include "weModbus.h"
```

Macros

- #define **BATu**

  Battery unload (hi active via open drain; gr/gr-ws)
- #define BEFORE_RISE

  Before sunrise timer offset.
- #define CHS_CP_OFFSET

  CP signal PWM correction offset.
- #define **CONcarLd**

  Contactor (relay) power to car is ON (low active)
- #define **CONcarRq**

  Car (CP resistor 2k7) connected / ready (low active)
- #define **HYPr**

  Bat. to /ref Hippogreiff (dto. ws/gn)
- #define **INVu**

  two relays switching unused inverter input plugs +&-
- #define **isOnPPSrel**()

Check if the phase power switch control relay is on.

- #define **LED9**

  life LED hi active

- #define **LEDx**

  other LED hi active (currently unused, always on)

- #define offPort(N)

  Switch port N off.

- #define offRel(N)

  Switch relay N off.

- #define onPort(N)

  Switch port N on.

- #define onRel(N)

  Switch relay N on.

- #define **PCK_POWER_IND_MAX**

  phase packet control limit 200%

- #define **PCK_POWER_LIM_DEF**

  phase packet default limit 3,6kW

- #define **PCK_POWER_LIM_MAX**

  phase packet max. limit

- #define **PCK_POWER_REL**

  phase packet switch control relay

- #define PDEL_BALEND

  Minimal delivery power to leave ballast loading SFC.

- #define PDEL_BALINC

  Maximal delivery power not to add ballast.

- #define PDEL_BALRED

  Minimal delivery power to reduce ballast.

- #define PDEL_SGCONS

  Minimal delivery power (W) to signal consumer.

- #define PDEL_SGGIVE

  Maximal delivery power to signal give away.

- #define **PH_P_SSR1**

  Phase packet switch SSR1 (heater element 1)

- #define **PH_P_SSR2**

  Phase packet switch SSR2 (heater element 2)

- #define POWH

  Power module voltage control (li/br-ws).

- #define **PWMcarLd**

  PWM to control max. car load current (per phase)

- #define SENS0PATH

  Temperature of water tank (top level).

- #define SENS1PATH

  Temperature of hot water pipe (from tank top).since 12 23: 28-6fb4d443009b.

- #define SENS2PATH

  Temperature of water tank (bottom level).

- #define switchPPSrel(V)

  Actuate phase power switch control relay.

- #define switchRel(N, V)

  Switch relay N on or off.

Functions

- void changeBatLoadPWM (int pwmChg)

  Change battery loader module PWM.
- void logBatteryState ()

  Log battery state on outLog as line with time stamp.
- uint8_t pckSwPec (float power)

  Set and get package switch percentage by power.
- void setBatLoadPWM (int pwm)

  Set battery loader module PWM.
- uint8_t setPckSwPerc (uint8_t perc)

  Set package switch percentage.
- float setPhPckLimit (float powerLimit)

  Set and get package switch power limit.
- void switchBatToStepUp (uint8_t on)

  Switch battery to step up converter.
- void switchHotWpump (uint8_t const on)

  Hot water comfort pump turn on/off.

Variables

- state_t **batCntBalSeq**

  Battery controlled load as ballast.
- state_t **batCntLodSeq**

  Battery loading and keeping.
- state_t batKeepInh

  Inhibit battery keep alive loading.
- int batLoadAllowed

  Battery loading allowed.
- volatile uint8_t batLodTst

  Battery loader test modus.
- volatile int batModPWM

  The actual battery load module's PWM input.
- int batUnloadAllowed

  Battery unload allowed.
- state_t **batUnloadSeq**

  Battery controlled unload via inverter.
- uint8_t batVoltValid

  The measured battery voltage is valid.
- state_t befRiseTimer

  Before sunrise timer.
- state_t consumeGiveHyst

  Give away hysteresis.
- state_t consumeGiveSFC

  Give away state machine / SFC.
- state_t dawnTimer

  Dawn timer.
- state_t duskTimer

  Dusk timer.
- uint8_t **heaterAllowed**

phase packet load enabled (always)

- int hippoSwitchMode

  Hippogreiff on/off times.
- state_t **load250Wcont**

  Controlled load SFC.
- volatile int nologBatCap

  Control logging inhibit charging battery due to capacity limit.
- volatile uint8_t **phPckCnt**

  current switch state duration counter
- volatile uint8_t **phPckOff**

  current phase packet switch OFF duration
- volatile uint8_t **phPckOn**

  current phase packet switch ON duration
- volatile uint8_t **phPckRelOffDelay**

  PPS relay off delay.
- volatile uint8_t **phPckS2**

  heater 2 pps switch state: 0 off; 1 on
- volatile uint8_t **phPckSw**

  phase packet switch state: 0 off; 1 on
- volatile uint8_t phPckSwIndex

  Actual index (0..200%) determining power.
- volatile uint8_t **phPpow2**

  heater 2 power ∗ 50% (0:0% .. 2:100%)
- oneWireDevice_t **sensors** [3]

  The 1-wire sensors used.
- state_t solarPowerHyst

  Solar power producer hysteresis.
- state_t sunriseTimer

  Sunrise timer.
- state_t sunsetTimer

  Sunset timer.
- state_t wouldGive250WHyst

  Would give away 250W hysteresis.
- state_t wouldGiveAwayHyst

  Would give away hysteresis.

5.26.1 Detailed Description

Types, values and functions for a smart home project.

```
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weinert-automation.de       a-weinert.de
    /         /      /\
   /         /___    /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \     /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  94 2.10.2025
Rev.    99 29.01.2018 :  load module voltage handling added
Rev.  148 16.06.2018 :  battery ballast handling improved, Hippogreiff relay
Rev.  170 24.07.2018 :  temperature sensors documentation
Rev.  190 12.02.2019 :  remove 4 status relay output as (minimal) preparation
                        for VDE-AR-N 4105 evaluation and inverter cut off
Rev.  218 07.09.2019 :  MQTT excerpted to mqttHome.h
Rev.  241 12.08.2021 :  battery values updated (200Ah ++)
Rev.  252 17.08.2023 :  ECar loading ++
```

```
Rev.  255 17.03.2024 :  flexible /ref Hippogreiff switching times
Rev.  256 19.06.2024 :  max.  (lead acid) battery load voltages reduced
Rev.  259 04.08.2024 :  battery changed to ECO-WORTHY 12.8V 100Ah LiFePO4
Rev.    79 21.03.2025 :  meterPi and Hager contactor to M2=L3
Rev.    85 14.06.2025 :  miniJoule inverter replaced - cleanup
Rev.    87 03.07.2025 :  solarPowerHyst values and discharge limit
Rev.    89 28.07.2025 :  minor comment improvement
Rev.    90 06.08.2025 :  battery SOC/% <-> Ubat; loader test prep.
Rev.    92 15.08.2025 :  load unload values and SFCs (Rev.  92..94, 02.09.)
```

This file is the addendum to sweetHome.h and sweetHome.c. It contains process IO related issues. These are not necessary for programs related to pure HMI, logging and the like. For those programs sweetHome.h and sweetHome.c will be sufficient.

In the smart home under control, there's one smart meter for the whole house's public electricity supply and one for solar generators and battery storage. The (two, cf. ANZmodSLAVES) meters are connected by Modbus. Additionally and also via Modbus, a Growatt inverter offers power and other values. Those are made available via an extra Pi acting as Modbus to MQTT bridge.

GPIO usage

See also file /forDSocu/Raspi3ioPinsMeterPi.ods

GPIO pins are used to control relays, LEDs and one button in the Pi's immediate neighbourhood. Three open drain (module) outputs control slightly remote (10m) periphery via shielded cable.

This program uses eight relays (one 10A change over contact each) in an eight relays module. The relays are energised by an active low "Din" (n:1..8) signal.

Eight 10A relays module connected via RS485 converter/shield pin connectors

```
module   :  Gnd  Di1  Di2  Di3  Di4  Di5  Di6  Di7  Di8  3V3     Gnd  5V
colour   :  brn  blk  wht  gry  vio  blu  grn  yel  ora  red     brn  red
RS conv.:  Gnd   P0   P1   P2   P3   P4   P5   P6   P7  3.3V    Gnd  5V
Pi Pin   :  6&c   11   12   13   15   16   18   22    3  1 &c    6&c  2&3
GPIO Pi3:              17   18   27   22   23   24   25    2
IO name  :          REL1 REL2 REL3 REL4 REL5 REL6 REL7 REL8
```

Other process IO see project file /forDocu/Raspi3ioPinsMeterPi.ods .

Notes on process IO functions

```
  REL1 :    defect XX   (ex PPS-SSR pre-relay)
  REL2 :    off miniJoule's Ferraris meter on battery unload (out of use 6'23)
  REL3 :    not used (ex VDE-AR-N 4105)
  REL4 :    phase packet switch (PPS-SSR) pre-relay for heater contactor
  REL5 :    would give away more than 250 W          (prolonged 2h)
  REL6 :    not used (ex VDE-AR-N 4105)
  REL7 :    not used (ex VDE-AR-N 4105)
  REL8 :    hot water circulation pump  (comfort function)
  Note :    When searching relay usages search for macros onRel(N), offRel(N)
          and switchRel(N, V).
  LED9 :    red LED; Modbus slave indicator;  on:  Modbus slave index > 0
  LEDx :    green LED; no function at the moment, always on
  HWPB :  start hot water pump (button to GND)
  POWH :    Battery load power module voltage control (via open drain)
          PWM for adjustable 11..14V 10A power module
          lo or off:  for lowest voltage
  BATu :    Battery unload (hi active);  battery to step up
          when battery surveyor signal is OK
  CONb :    Step up to miniJoule inverter (32V) | not used miniJoule out 1.6.25
  INVu :    two relays switching unused inverter input plugs +&-:  ex CONb
  HYPr :    Battery to Hippogreiff
PH_P_SSR1:  Phase packet switch SSR1 (heater element 1) 0..100%
PH_P_SSR2:  Phase packet switch SSR2 (heater element 2) 0, 50, 100%
PWMcarLd :  PWM to control max.  car load current (per phase)
CONcarLd :  Contactor (relay) "power to car" is set ON  (low active OC in)
CONcarRq :  Car (i.e.  CP resistor 2k7) is connected (low active OC in)
```

MQTT usage

The MQTT protocol is used for remote process IO within "sweet home's" private (W)LAN:
a) battery surveillance and voltage measurement by specialised ESP8266
b) For Sonoff S20 plug switches modified to be MQTT clients (Tasmota).

```
PLG1 "would give 250 W" = parallel to REL5
PLG2 sunset to sunrise  (since 03.03.2018; as Hippogreiff)
PLG3 just controlled by web interface (since August 2019 used
     for outside air monitor's supply, to enable remote reset)
PLG4 "actually giving away" (neg.  supply) warning
```

5.26.2 Macro Definition Documentation

5.26.2.1 SENS0PATH

```
#define SENS0PATH
```

Temperature of water tank (top level).

This is the address of the 1-wire sensor's value file provided by the 1-wire-temp kernel module.

5.26.2.2 SENS1PATH

```
#define SENS1PATH
```

Temperature of hot water pipe (from tank top).since 12 23: 28-6fb4d443009b.

See also SENS0PATH.

5.26.2.3 SENS2PATH

```
#define SENS2PATH
```

Temperature of water tank (bottom level).

See also SENS0PATH.

5.26.2.4 PDEL_BALEND

```
#define PDEL_BALEND
```

Minimal delivery power to leave ballast loading SFC.

Value: 410.2 W

5.26.2.5 PDEL_BALRED

```
#define PDEL_BALRED
```

Minimal delivery power to reduce ballast.

Value: 61.02 W

5.26.2.6 PDEL_BALINC

```
#define PDEL_BALINC
```

Maximal delivery power not to add ballast.

Value: 1.02 W

5.26.2.7 PDEL_SGCONS

```
#define PDEL_SGCONS
```

Minimal delivery power (W) to signal consumer.

See consumeGiveHyst.

Value: 45.4 W

5.26.2.8 PDEL_SGGIVE

```
#define PDEL_SGGIVE
```

Maximal delivery power to signal give away.

See consumeGiveHyst.

Value: 14.3 W

5.26.2.9 CHS_CP_OFFSET

```
#define CHS_CP_OFFSET
```

CP signal PWM correction offset.

The CP signal's duty cycle to E-car (+/-12V) might deviate from the s control signal (TTL); explanation see at DEF_CP_OFFSET.

-27 is the correct value for the (modified) Analog EVSE. Due to asymmetries caused by the optocoupler input the change to Hi state is propagated faster than the one to Lo.

5.26.2.10 POWH

```
#define POWH
```

Power module voltage control (li/br-ws).

See loadModUlookup

5.26.2.11 switchPPSrel

```
#define switchPPSrel(
              V )
```

Actuate phase power switch control relay.

For safety reasons there is a contactor (Hager 4 $*$ 40A) in front of the electronic zero crossing switches (solid state relays SSR) for the two heater elements.

The PPS relay (4) actuates this contactor. The Hager contactor consumes about 9W, when actuated. The meterPi and Hager contactor were move from M3=L3 to M2=L3 as not to spoil the ballast load sum.

Parameters

V	0: off; else: on

5.26.2.12 onPort

```
#define onPort(
              N )
```

Switch port N on.

Parameters

N	port name (LEDx, BATu, INVu; CONb and miniJoule out 1.6.25 ..)

5.26.2.13 offPort

```
#define offPort(
              N )
```

Switch port N off.

Parameters

N	port name (LEDx, BATu, INVu; CONb and miniJoule out 1.6.25 ..)

5.26.2.14 switchRel

```
#define switchRel(
              N,
              V )
```

Switch relay N on or off.

Parameters

N	relay number 1..8
V	0: off; else: on

5.26.2.15 onRel

```
#define onRel(
              N )
```

Switch relay N on.

Parameters

N	relay number 1..8

5.26.2.16 offRel

```
#define offRel(
              N )
```

Switch relay N off.

A module with 8 relays controlled directly by Pi output pins.

Parameters

N	relay number 1..8

5.26.2.17 BEFORE_RISE

```
#define BEFORE_RISE
```

Before sunrise timer offset.

See also: befRiseTimer value: 248 minutes (since 12.08.2021; 188 before)

5.26.3 Function Documentation

5.26.3.1 logBatteryState()

```
void logBatteryState ( )
```

Log battery state on outLog as line with time stamp.

Logs the battery voltage in the format
/0123456789x123456789v123456789t123456789q123456789c123456789s123456789S1234567
/ 2019-05-01 11:58:16.600 # battery 1?.05 V, pwmL 000: 13.08V; 1234.6W   .
/linefeed

5.26.3.2 pckSwPec()

```
uint8_t pckSwPec (
            float power )
```

Set and get package switch percentage by power.

Besides determining an returning the percentage(power), this function sets the process control values via setPckSwPerc() returns its value.

Parameters

power	in W

Returns

the phase packet percentage 0..100

5.26.3.3 setPhPckLimit()

```
float setPhPckLimit (
            float powerLimit )
```

Set and get package switch power limit.

This function sets the PPS power limit in the range 0.0 ... PCK_POWER_LIM_MAX.

Parameters

powerLimit	PPS power limit in W

Returns

the (new) power limit

5.26.3.4 setPckSwPerc()

```
uint8_t setPckSwPerc (
            uint8_t perc )
```

Set package switch percentage.

This function sets phPckSwIndex by the parameter value in the range 0..200; respectively PCK_POWER_IND_MAX. Additionally it adjusts the current phPckCnt should its value be higher than by the new setting.

On transitions from respectively to 0 the control relay (PCK_POWER_REL) is actuated before respectively after actuating the electronic switch.

This function also sets .phPckpower in valFilVal according to the values in table (array) phPckSwPow.

Parameters

perc	0..200; values above PCK_POWER_IND_MAX will have no effect and return the current setting un-altered

Returns

the actual (new) phase packet percentage 0..200

5.26.3.5 switchHotWpump()

```
void switchHotWpump (
            uint8_t const on )
```

Hot water comfort pump turn on/off.

It turns the hot water comfort circulation pump on respectively off.

Parameters

on	!= 0 : on; else, ==0 : off

5.26.3.6 switchBatToStepUp()

```
void switchBatToStepUp (
            uint8_t on )
```

Switch battery to step up converter.

When the parameter is !=0 respectively ON, this function switches the battery to the step up converter.

When the parameter is off, this function switches the battery to the (max. 20 A) battery loader / keep alive module .

Parameters

on	true: switch battery to step up converter; 0, false: switch battery to load modul.

5.26.3.7 setBatLoadPWM()

```
void setBatLoadPWM (
            int pwm )
```

Set battery loader module PWM.

This function sets the battery load module power PWM signal and hence its output voltage. 0 is the lowest and 255 the highest possible setting. While this function allows setting to 0, the highest value is limited to BAT_LDMX_PWM.

Parameters

pwm	the pwm ratio 0: 0%; 255: 100%

5.26.3.8 changeBatLoadPWM()

```
void changeBatLoadPWM (
             int pwmChg )
```

Change battery loader module PWM.

This function adds the parameter pwmChg's value to the current one limits the result to BAT_NOLD_PWM ... BAT_LDMX_PWM and sets it (see setBatLoadPWM).

Parameters

pwmChg	the change of the pwm value

5.26.4 Variable Documentation

5.26.4.1 batVoltValid

```
uint8_t batVoltValid  [extern]
```

The measured battery voltage is valid.

When not 0 the last MQTT battery voltage measurement respectively message is not older than 2.4s and hence considered the actual valid value.

5.26.4.2 nologBatCap

```
volatile int nologBatCap  [extern]
```

Control logging inhibit charging battery due to capacity limit.

1: log next time when it occurs and (always) decrement 0: or high value log no more this day. n: inhibit the next 2∗n seconds while continually trying

5.26.4.3 batUnloadAllowed

```
int batUnloadAllowed  [extern]
```

Battery unload allowed.

Bit 0 (1): allow after sunset
Bit 1 (2): allow before sunrise
Bit 3 (4): allow when Pimp $>$ 400W, i.e. allow also at daylight.
Bit 4 (8): default (usually 2 in winter and 3 in summer)
Start value: 8 = default
Note: Must be a standard integer (no uint_8 e.g.) for use in getopt_long.

See also

BAT_UNL_SUMM

BAT_UNL_WINT

5.26.4.4 batLoadAllowed

```
int batLoadAllowed  [extern]
```

Battery loading allowed.

Bit 0 (1): allow ballast loading
Bit 1 (2): allow automatic / controlled loading
start value: 3 = all allowed
Note: Must be a standard integer (no uint_8 e.g.) for use in getopt_long.

See also

batUnloadAllowed

BAT_LOAD_FORBID

5.26.4.5 hippoSwitchMode

```
int hippoSwitchMode  [extern]
```

Hippogreiff on/off times.

Bit 0,1 (3): switch at sunset resp. sunrise (winter)
Bit 2,3 (12): switch at dusk resp. dawn (summer)
start value: 12 (/ref Hippogreiff summer)

5.26.4.6 phPckSwIndex

```
volatile uint8_t phPckSwIndex  [extern]
```

Actual index (0..200%) determining power.

This is the control variable for the electric heater elements in the hot water tank. Until June 2023 there was one such element of PCK100PERC_POWER W and this variable had a range of 0..100%. Since July 2023 there are two heater elements of equal power. The range of this control variable was extended to 0..200%. The power distribution between the two heater elements is done by software; see setPckSwPerc(uint8_t const perc) and PCK_POWER_IND_MAX

5.26.4.7 batLodTst

```
volatile uint8_t batLodTst  [extern]
```

Battery loader test modus.

A value 0 means normal loading, keeping or idle mode.
Other values mean test modus, i.e. have stable PWM values to allow test measurements. These PWM values are usually set manually.

See also BAT_LDTEST_MAX_PWM, BAT_LDTEST_MIN_PWM, BAT_LDTEST_UPS_PWM, BAT_LDTEST_↩ DWN_PWM, setBatLoadPWM

5.26.4.8 batModPWM

```
volatile int batModPWM  [extern]
```

The actual battery load module's PWM input.

The range of the Pi's pwm output control register 0 for 0 % or permanent off to 255 for 100% respectively permanent on. The eight bit register, hence, is to be fed with an unsigned 8 bit value which was for many years the type of this variable.
A new loader module since August 2025 uses the full range 0..255. This variable was made a standard int to simplify underflow and overflow detection.
Note: Keeping this variable's value in the range 0 .. +255 is essential!

5.26.4.9 batKeepInh

```
state_t batKeepInh  [extern]
```

Inhibit battery keep alive loading.

This timer will be started after battery loading and unloading for a specific time BATkeepInhContLoad, BATkeepInhUnload or BATkeepInhByCmd. This timer is initially OFF and will be stopped in advance by battery keep command via HMI/GUI.
It will be started after battery unload, after battery ballast load and by battery off command via GUI.
When running out it will start battery keep alive with BAT_KEEP_PWM.

Note: The feature seems/is unnecessarily complicated due to its lead acid battery past

5.26.4.10 sunriseTimer

```
state_t sunriseTimer  [extern]
```

Sunrise timer.

This timer will run out every day at (approximated) sunrise. For the "every day" behaviour, its state change function will — after all due actions — restart this timer for the next 24h to hit (very approximately) the next sunrise. This acceptable guess will be adjusted at day change or at program start.

5.26.4.11 sunsetTimer

```
state_t sunsetTimer  [extern]
```

Sunset timer.

This timer will run out every day at (approximated) sunset. See also sunriseTimer

5.26.4.12 dawnTimer

```
state_t dawnTimer  [extern]
```

Dawn timer.

This timer will run out every day at (approximated) dawn, meaning the beginning of civil twilight. See also sunriseTimer and duskTimer

5.26.4.13 duskTimer

```
state_t duskTimer  [extern]
```

Dusk timer.

This timer will run out every day at (approximated) dusk, meaning the end of civil twilight. About this time street lamps and position lights may be lit. See also sunriseTimer

5.26.4.14 befRiseTimer

```
state_t befRiseTimer  [extern]
```

Before sunrise timer.

This timer will run out every day at about 180 min before (approximated) sunrise. The offset must be sufficient time to unload the battery before sunrise.
See also: sunriseTimer BEFORE_RISE

5.26.4.15 solarPowerHyst

```
state_t solarPowerHyst  [extern]
```

Solar power producer hysteresis.

The limits of the power of the biggest (or all) PV panels to recognise the availability / generation of solar power.
Current limits 7.9W (off), 40.0 W (on); since 03.07.2025
Former values 4.8, 12.02

5.26.4.16 consumeGiveHyst

```
state_t consumeGiveHyst  [extern]
```

Give away hysteresis.

thresholds: PDEL_SGGIVE, PDEL_SGCONS

5.26.4.17 consumeGiveSFC

```
state_t consumeGiveSFC  [extern]
```

Give away state machine / SFC.

Status ON means consumer: OK.
Status OFF means very low power consumption: Inhibit power delivery.

5.26.4.18 wouldGiveAwayHyst

```
state_t wouldGiveAwayHyst  [extern]
```

Would give away hysteresis.

thresholds (04.03.18): -/+ 7W

5.26.4.19 wouldGive250WHyst

```
state_t wouldGive250WHyst  [extern]
```

Would give away 250W hysteresis.

thresholds (04.03.18): -250 / -178W

5.27 include/sweetHomeLocal.h File Reference

Localisation and geographical values for the smart home laboratory project.

5.27.1 Detailed Description

Localisation and geographical values for the smart home laboratory project.

```
Copyright  (c)  2018   Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  49 5.05.2023
Rev.  144 12.06.2018 :  new
Rev.  164 11.07.2018 :  sunset/sunrise location parameters; local macros
Rev.  190 13.02.2019 :  minor, comments only
```

This file contains some localisation, geographical and individual technical data for the current smart home experimental / demonstrator set-up. When porting to other locations etc. do change the values in question or, better, define a new LOCATION.

5.28 include/sysBasic.h File Reference

Some very basic definitions.

```
#include <stdint.h>
#include <basicTyCo.h>
#include <time.h>
#include <stdio.h>
#include <string.h>
```

Macros

- #define ABS_MONOTIME

  /def ABS_MONOTIME
- #define DAY_EQNOX_AUTUMN

  Day of the autumn equinox.
- #define DAY_EQNOX_SPRING

  Day of the spring equinox.
- #define **MS100_ns**

  Hundred milliseconds in ns.
- #define **MS10_ns**

  Ten milliseconds in ns.
- #define **MS1_ns**

  One millisecond in ns.
- #define SETPRGDATA

  Frame for program data definition.

Typedefs

- typedef struct timespec timespec

  The Linux time structure.

Functions

- float cosDay (short int dayInYear)

  Cosine of day in year, function.
- uint8_t **errLogIsStd** (void)

  Error log (errLog) is standard stream or outLog.
- int formatDec2Digs (char *targTxt, uint32_t value)

  Format number as two digit decimal number with leading zeroes.
- int formatDec3Digs (char *targTxt, uint32_t value)

  Format number as three digit decimal number with leading zeroes.
- int formatTmTim (char *rTmTxt, struct tm *rTm)

  Format broken down real time and date as standard text.
- int formatTmTiMs (char *rTmTxt, struct tm *rTm, int millis)

  Format broken down real time clock+ms as standard text.
- __time_t getDaySunrise (short int const dayInYear, uint32_t const meanSunriseSec, uint16_t const halfRiseDeltaMin)

  Get sunrise in s from UTC midnight.
- __time_t getDaySunset (short int const dayInYear, uint32_t const meanSunsetSec, uint16_t const halfSetDeltaMin)

  Get sunset in s from UTC midnight.
- uint8_t isFNaN (float const val)

  Floating point NaN.
- uint8_t littleEndian ()

  Actual runtime / architecture is little endian.
- void logEventText (char const *txt)

  Log an event/log message on outLog.
- void monoTimeInit (timespec *timer)

  Absolute timer initialisation.
- uint8_t **outLogIsStd** (void)

  Event log (outLog) is standard stream.
- void printNamRevDat (void)

  Print the program name, SVN revision and date.
- void printRevDat (void)

  Print the program SVN revision and date.
- char const * progDat ()

  The program date.
- char const * progNam ()

  The program name.
- char const * progNamB ()

  The program name with blank.
- uint8_t progNameLen ()

  The program's name length.
- uint8_t progNameOutp ()

  The program's name was output.
- char const * progRev ()

  The program revision.
- size_t strlcat (char *dest, char const *src, size_t num)

  String concatenation with limit.
- size_t strlcpy (char *dest, char const *src, size_t const num)

  String copy with limit.
- int switchErrorLog (char const *const errFilNam)

Switch errlog to other file.

- int switchEventLog (char const *const logFilNam)

  Switch outLog to other file.

- void timeAddNs (timespec *t1, long ns)

  Add a ns increment to a time overwriting it.

- int timeStep (timespec *timeSp, unsigned int micros)

  A delay to an absolute step specified in number of s to a given time.

- void updateReaLocalTime (void)

  Update local real time.

Variables

- timespec **actRTime**

  Actual time (structure, real time clock).

- struct tm actRTm

  Actual time (broken down structure / local).

- float const cosDiY [192]

  Cosine of day in year, look up.

- short int const cosDiY60 [192]

  *Cosine of day in year * 60.*

- char const dec2digs [128][2]

  Format two digit decimal, leading zero, by lookup.

- char const dec3digs [1024][4]

  Format three digit decimal, leading zero, 0-terminated, by lookup.

- char const dow [9][4]

  English weekdays, two letter abbreviation.

- FILE * errLog

  Error log output.

- char const fType [16][8]

  Translation of directory entry typed to 8 char text.

- char const *const lckPiGpioPth

  Common path to a lock file for GpIO use.

- __time_t localMidnight

  Actual local midnight.

- uint32_t noLgdEvnt

  Number of events logged.

- FILE * outLog

  Event log output.

- char const prgNamPure [ ]

  The pure program name.

- char const prgSVNdat [ ]

  The complete SVN date string.

- char const prgSVNrev [ ]

  The complete SVN revision string.

- int retCode

  Basic start-up function failure.

- int todayInYear

  Today's day in year.

- int useErrLogFiles

  Log on files.

- uint8_t useOutLog4errLog

  Use outLog for errors too.
- __time_t utcMidnight

  Actual (local) UTC midnight.
- char const zif2charMod10 [44]

  The digits 0..9 repeated as 44 characters.

5.28.1 Detailed Description

Some very basic definitions.

```
Copyright  (c)  2020   Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  89 28.07.2025
Rev.  66+ 16.11.2017 :  new, excerpted from weUtil.h V.66
                        weModbus.h V.66 (and others)
Rev.  147 16.06.2018 :  time handling enhanced improved, Hippogreiff relay
Rev.  152 21.06.2018 :  some definitions put to basicTyCo.h
Rev.  164 11.07.2018 :  sunset/sunrise location parameters; string functions
Rev.  190 14.02.2019 :  minor, comments only
Rev.  209 22.07.2019 :  work around a Doxygen bug
Rev.  229 23.07.2020 :  UTF 8 BOM for log and error file
Rev.    76 25.02.2025 :  progNamLen() and stdint.h
```

This file contains some definitions concerning system values and platform properties, made and probed with Raspberry Pis.

5.28.2 Macro Definition Documentation

5.28.2.1 SETPRGDATA

```
#define SETPRGDATA
```

Frame for program data definition.

To prevent Doxygen to duplicate the documentation of extern variables, like prgNamPure, prgSVNrev, prgSVNdat etc., in the program's source frame those definition in #if SETPRGDATA ... #endif.

5.28.2.2 ABS_MONOTIME

```
#define ABS_MONOTIME
```

/def ABS_MONOTIME

Clock used for absolutely monotonic delays, cycles and intervals.

This clock must never jump and just run on in a monotonic way. We accept it
A) having no relation to any calendar date and time and
B) getting no corrections by NTP clients, DCF77 receivers or what else, as well as
C) this clock being slightly inaccurate and (cf. B)) never be tuned or corrected.

Short note on A): In most literature it is said the monotonic clocks would start at boot. Even if this is observed, it is not mandatory. Assume an arbitrary zero-point.

The inaccuracy C) is explained by some implementations deriving monotonic clocks with no further ado from an μC's quartz oscillator, usually the same oscillator used for communication links timing. On Raspberry Pi 3s with Raspian Jessie (early 2017) we observed +5s in an 24h interval (i.e. being a bit late) growing linear. This stable deviation is in the range of mid prized quartz watches.

Until August 2017, we had adapted to C) by allowing a millisecond used for chained steps or as base for delays not having 1000000ns of this (ABS_MONOTIME) clock, allowing up to +-110ns difference. The value (vcoCorrNs) was then preset at compile by a device specific macro. Its default value -40 was good for a couple of Raspberry Pi 3s. An automatic correction of this adjusted millisecond by standard time sources (with simplified VCO PLL algorithm) was used.

Update on C) since August 2017:
In the latest Jessies (8) CLOCK_MONOTONIC is frequency adjusted to NTP. Hence B) and C) above are obsolete and vcoCorrNs will be initialised as 0. Nevertheless, this corrective +/-100 ns value vcoCorrNs is kept for catching up or slowing down the derived second tick to CLOCK_REALTIME after the latter's jumps due to corrections. As the derived (monotonic) second's tick is started synchronised with the CLOCK_REALTIME one's, this would hardly happen. On a leap second 1000s slow down (the current "solution) on a leap second, we would 1000s slow down and afterwards catch up, without getting an extra "monotonic" second.

Candidates (Raspbian lite) for an absolute monotonic clock are:
CLOCK_MONOTONIC (should always be available and OK, default)
CLOCK_MONOTONIC_RAW (same without NTP tuning)

value: CLOCK_MONOTONIC (NTP tuning now assumed)

5.28.2.3 DAY_EQNOX_SPRING

```
#define DAY_EQNOX_SPRING
```

Day of the spring equinox.

This is the day in year number (79) of the spring equinox (March 20th). From thence the time between sunrise and sunset is more than 12 hours.

See also

todayInYear
DAY_EQNOX_AUTUMN

5.28.2.4 DAY_EQNOX_AUTUMN

```
#define DAY_EQNOX_AUTUMN
```

Day of the autumn equinox.

This is the day in year number (265) of the autumn equinox (Sept. 22nd). From thence the time between sunrise and sunset is less than 12 hours. This value and DAY_EQNOX_SPRING is used for battery handling (defaults).

5.28.3 Typedef Documentation

5.28.3.1 timespec

```
typedef struct timespec timespec
```

The Linux time structure.

This is the timespec structure consisting of two (type obfuscated) long variables: tv_sec and tv_nsec.
Note: This is to allow using timespec without prepending struct, only.

5.28.4 Function Documentation

5.28.4.1 progNameOutp()

```
uint8_t progNameOutp ( )
```

The program's name was output.

This function returns a value not 0 if the programs name etc. was probably logged or output.

Returns

the programs name's length if output, 0 else

5.28.4.2 progNameLen()

```
uint8_t progNameLen ( )
```

The program's name length.

This function determines the programs name's length and prepares the program strings if not yet done.

See also

progNam() progNamB() progRev() progDat()

Returns

the programs name's length

5.28.4.3 progNam()

```
char const * progNam ( )
```

The program name.

Returns

the program's name as pure text, "homeDoorPhone", e.g.

5.28.4.4 progNamB()

```
char const * progNamB ( )
```

The program name with blank.

Same as progNam but with at least one trailing blank or so many blanks to get a minimal length of 17, , "home↩ DoorPhone ", e.g.

Returns

the program's name with trailing blank(s)

5.28.4.5 progRev()

```
char const * progRev ( )
```

The program revision.

Returns

the program's SVN revision as pure text, "0", "341" e.g.

5.28.4.6 progDat()

```
char const * progDat ( )
```

The program date.

Returns

the program's SVN date "2020-07-23" e.g., length 10

5.28.4.7 printRevDat()

```
void printRevDat (
             void  )
```

Print the program SVN revision and date.

This function prints a line in the form (4 leading blanks)
`Revision  229 (2020-07-23)`

to outLog

5.28.4.8 printNamRevDat()

```
void printNamRevDat (
             void  )
```

Print the program name, SVN revision and date.

This function prints a line in the form (4 leading blanks)
`theLittleProg    R.  229 (2020-07-23)`

to outLog

5.28.4.9 littleEndian()

```
uint8_t littleEndian ( )
```

Actual runtime / architecture is little endian.

This boolean function is evaluated by char* to int comparison.

To save runtime resources use the marco PLATFlittlE instead, which would fall back to littleEndian() (this function) when no target platform informations on endianness are available.

Returns

true when platform is little endian (evaluated at run time)

5.28.4.10 isFNaN()

```
uint8_t isFNaN (
            float const val )
```

Floating point NaN.

Parameters

val	the floating point value to be checked for IEEE754 NaN

Returns

0xFF (true) when not a number, else 0

5.28.4.11 switchErrorLog()

```
int switchErrorLog (
            char const *const errFilNam )
```

Switch errlog to other file.

Parameters

errFilNam	the name of the file to switch to; NULL or empty: switch (back) to stderr

Returns

96 : file name can't be opened for append, old state kept; 97 : useOutLog4errLog is ON, nothing done 0 : OK

5.28.4.12 switchEventLog()

```
int switchEventLog (
            char const *const logFilNam )
```

Switch outLog to other file.

If useOutLog4errLog is ON the errLog file will point to the same named file on success.

Parameters

logFilNam	the name of the file to switch to; NULL or empty: switch (back) to stdout

Returns

96 : file name can't be opened for append; old state kept.

5.28.4.13 logEventText()

```
void logEventText (
            char const * txt )
```

Log an event/log message on outLog.

If txt is not null it will be output to outLog and outLog will be flushed. No line feed will be appended; the text is put as is.

Parameters

txt	text to be output; n.b not LF appended and not counted as line

5.28.4.14 strlcpy()

```
size_t strlcpy (
            char * dest,
            char const * src,
            size_t const num )
```

String copy with limit.

This function copies at most num - 1 characters from src to dst. If not terminated by a 0 from src, dest[num-1] will be set 0. Hence, except for num == 0, dest will be 0-terminated.

The value returned is the length of string src; if this value is not less than num truncation occurred.

Hint: This function resembles the one from bsd/string.h usually not available with standard Linuxes and Raspbians .

Parameters

dest	the character array to copy to; must not be shorter than num
src	the string to copy from
num	the maximum allowed string length of dest

Returns

the length of src

5.28.4.15 strlcat()

```
size_t strlcat (
            char * dest,
            char const * src,
            size_t num )
```

String concatenation with limit.

This function appends at most num - 1 characters from src to the end of dest. If not terminated by a 0 from src, dest[num-1] will be set 0. Hence, except for num == 0, dest will be 0-terminated.

The value returned is the length of string src (if no truncation occurred).

Hint: This function resembles the one from bsd/string.h usually not available with standard Linuxes and Raspbians .

Parameters

dest	the character array to copy to; must not be shorter than num
src	the string to copy from
num	the maximum allowed string length of dest

Returns

the length of src

5.28.4.16 monoTimeInit()

```
void monoTimeInit (
            timespec * timer )
```

Absolute timer initialisation.

This function sets the time structure provided to the current absolute monotonic ABS_MONOTIME (default↩ : CLOCK_MONOTONIC).

Note: Error returns, suppressed here, cannot occur, as long as the time library functions and used clock IDs are implemented. Otherwise all else timing done here would fail completely.

Parameters

timer	the time structure to be used (never NULL!)

5.28.4.17 timeStep()

```
int timeStep (
            timespec * timeSp,
            unsigned int micros )
```

A delay to an absolute step specified in number of s to a given time.

This function does an absolute monotonic real time delay until timer += micros;

Chaining this calls can give absolute triggers relative to a given start. One must initialise the time structure timespec before every start of a new cycle chain. Afterwards the structure time must not be written to. See timeAddNs, ABS_MONOTIME and monoTimeInit (or clock_gettime).

Chaining absolute delays accomplishes long term exact periods respectively cycles. See also explanations in ABS_MONOTIME (default: CLOCK_MONOTONIC).

Parameters

timeSp	the time structure to be used (never NULL!)
micros	delay in s (recommended 100s .. 1h)

Returns

sleep's return value if of interest (0: uninterrupted)

5.28.4.18 timeAddNs()

```
void timeAddNs (
            timespec * t1,
            long ns )
```

Add a ns increment to a time overwriting it.

Parameters

t1	the time structure to add to (not NULL!, will be modified)
ns	the increment in nanoseconds

5.28.4.19 updateReaLocalTime()

```
void updateReaLocalTime (
            void  )
```

Update local real time.

This function initialises / updates both actRTime and actRTm.

5.28.4.20 cosDay()

```
float cosDay (
            short int dayInYear )
```

Cosine of day in year, function.

This function provides the cosine by the day of the year very efficiently by using a lookup table (cosDiY) and cosine's periodic properties.

For the main purpose of approximate sunrise or sunset time determination the usual (approximate) algorithm relates to shortest day (23.12.). In this case add 8 to the real day in the year.

Parameters

dayInYear	the day in the year; 0: 1.1. (respectively 23.12.)

5.28.4.21 getDaySunrise()

```
__time_t getDaySunrise (
            short int const dayInYear,
            uint32_t const meanSunriseSec,
            uint16_t const halfRiseDeltaMin )
```

Get sunrise in s from UTC midnight.

The value will be approximately (but very fast) calculated on base of the the location's (and optimally year's) sunrise data.
Caveat: Consider the units and bases of the parameters.

Parameters

dayInYear	day in the year
meanSunriseSec	location's mean sunrise time in s from midnight UTC
halfRiseDeltaMin	the location's half sunrise time swing in minutes

Returns

that days's sunrise in seconds from UTC midnight

5.28.4.22 getDaySunset()

```
__time_t getDaySunset (
            short int const dayInYear,
            uint32_t const meanSunsetSec,
            uint16_t const halfSetDeltaMin )
```

Get sunset in s from UTC midnight.

The value will be approximately (but very fast) calculated on base of the the location's (and optimally year's) sunset data.
Caveat: Consider the units and bases of the parameters.

Parameters

dayInYear	day in the year (0 is January 1st)
meanSunsetSec	location's mean sunset time in s from midnight UTC
halfSetDeltaMin	the location's half sunset time swing in minutes

Returns

that days's sunset in seconds from UTC midnight

5.28.4.23 formatDec2Digs()

```
int formatDec2Digs (
            char * targTxt,
            uint32_t value )
```

Format number as two digit decimal number with leading zeroes.

The format is: 00 to 99

The length is always 2. There is no trailing character zero appended.
returned is the number of leading zeroes in the range 0 o 1. N.B. the value 0 yielding "00" is considered to have one leading zero.

See also

dec2digs formatDec3Digs

Parameters

targTxt	pointer to the target text buffer, must have place for 3 characters (!)
value	the value to be formatted; values outside 0 .. 999 will yield incorrect results

Returns

the number of leading zeroes (0 or 1)

5.28.4.24 formatDec3Digs()

```
int formatDec3Digs (
            char * targTxt,
            uint32_t value )
```

Format number as three digit decimal number with leading zeroes.

The format is: 000 to 999

The length is always 3. There is no trailing character zero appended.
returned is the number of leading zeroes in the range 0 to 2. N.B. the value 0 yielding "000" is considered to have 2 leading zeroes.

See also

dec3digs formatDec2Digs

Parameters

targTxt	pointer to the target text buffer, must have place for 3 characters (!)
value	the value to be formatted; values outside 0 .. 999 will yield incorrect results

Returns

the number of leading zeroes (0..2)

5.28.4.25 formatTmTim()

```
int formatTmTim (
            char * rTmTxt,
            struct tm * rTm )
```

Format broken down real time and date as standard text.

The format is: Fr 2017-10-20 13:55:12 UTC+20 .....0123456789x123456789v123456789t The length is 29. See formatTmTiMs() for a longer format with 3 digit ms.

Parameters

rTmTxt	pointer to the target text buffer, must have place for 30 characters (!)
rTm	pointer to broken down real time; NULL will take actRTm

Returns

the number of characters put (should be 28) or 0: error (rTmTxT NULL)

5.28.4.26 formatTmTiMs()

```
int formatTmTiMs (
            char * rTmTxt,
            struct tm * rTm,
            int millis )
```

Format broken down real time clock+ms as standard text.

/code The format is: Fr 2017-10-20 13:55:12.987 UTC+20 .....0123456789x123456789v123456789t123 +3 .....0123456789x123456789v123456789t /endcode The length is 33. See formatTmTim() for a shorter format without ms.

Parameters

rTmTxt	pointer to the target text buffer, must have place for 34 characters (!)
rTm	pointer to broken down real time; NULL will take actRTm
millis	milliseconds 0..999 supplement to rTm

Returns

the number of characters put (should be 32) or 0: error (rTmTxT NULL)

5.28.5 Variable Documentation

5.28.5.1 prgNamPure

```
char const prgNamPure[]  [extern]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.28.5.2 prgSVNrev

```
char const prgSVNrev[]  [extern]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.28.5.3 prgSVNdat

```
char const prgSVNdat[]  [extern]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.28.5.4 retCode

```
int retCode  [extern]
```

Basic start-up function failure.

Allows for compact code without saving the (error) return:
if (openLock(lckPiGpioPth, ON)) return retCode;

Storage for return/error codes. Used by: openLock(char const *, uint8_t) theCyclistStart(int) theCyclistWaitEnd()

Value: 0: OK, else: error

5.28.5.5 lckPiGpioPth

```
char const* const lckPiGpioPth  [extern]
```

Common path to a lock file for GpIO use.

Programs using GPIO in any form usually (and forced by some libraries) have to do this exclusively. This is implemented here by locking a file named ~/bin/.lockPiGpio
Make the lock file by: touch /home/[user]/bin/.lockPiGpio or by touch ~/bin/.lockPiGpio

Without locking this file those programs must not start.
So, deleting this file inhibits the start even by cron etc.

5.28.5.6 useErrLogFiles

```
int useErrLogFiles  [extern]
```

Log on files.

If true (default) logging and errors go to files or one file, otherwise to console

5.28.5.7 outLog

```
FILE* outLog  [extern]
```

Event log output.

default: standard output; may be put to a file.

5.28.5.8 noLgdEvnt

```
uint32_t noLgdEvnt  [extern]
```

Number of events logged.

Counter for lines put to or events logged on outLog.

5.28.5.9 useOutLog4errLog

```
uint8_t useOutLog4errLog  [extern]
```

Use outLog for errors too.

When set true errLog will be set to outLog when using files. In this case there is just one event log file. Hence, doubling the same entry to both errLog and outLog should be avoided.

5.28.5.10 errLog

```
FILE* errLog  [extern]
```

Error log output.

default: standard error; may be put to a file.

5.28.5.11 actRTm

```
struct tm actRTm  [extern]
```

Actual time (broken down structure / local).

This structure is initialised may be updated by some timing and cyclic functions. See initStartRTime() and others.

5.28.5.12 todayInYear

```
int todayInYear  [extern]
```

Today's day in year.

The value should be set at start (will be by updateReaLocalTime()) and updated at midnight.

5.28.5.13 utcMidnight

```
__time_t utcMidnight  [extern]
```

Actual (local) UTC midnight.

This is the actual "local" UTC midnight. "Local" means that on early hours, i.e. those within zone offset, UTC midnight will be corrected to the next (east of Greenwich) respectively previous day (west). The rationale is to point to the same day or date at day time (around Europe).
Or, to put it simple, utcMidnight is to be set so, that the equation
local Midnight = utcMidnight - UTCoffset
holds.

The value will will be set correctly by updateReaLocalTime(). It should be updated at day change (if used).

5.28.5.14 localMidnight

```
__time_t localMidnight  [extern]
```

Actual local midnight.

This is the UTC Linux time stamp of the actual day's / time's local midnight. See also utcMidnight for explanations.

Note: On days with DST changes this value will shift within the day. It's mostly better to make calculations relative to day start — sunrise and sunset e.g. — relative to UTC midnight.

5.28.5.15 cosDiY

```
float const cosDiY[192]  [extern]
```

Cosine of day in year, look up.

This lookup table provides the cosine by the day of the year without resource eating floating point arithmetic or math.h. The rationale is the approximate calculation of sunrise and sunset times based on earliest, latest and delta for any given location within the arctic circles.

The length of the look up table is abundant 192. According to cosine's periodic properties it shall be used in the range 0..183 by applying the following operations to the day in year value
absolute when $<$ 0,
modulo FOURYEARS when $>=$ FOURYEARS,
modulo 365 when $>=$ 365 and
x = 365 - x when $>$ 190.

Note: These rules are implemented in the function cosDay() and in the function cosDay60() using the look up table cosDiY60

5.28.5.16 cosDiY60

```
short int const cosDiY60[192]  [extern]
```

Cosine of day in year * 60.

This look up table is the same as cosDiY, except the values being multiplied by 60 which includes minutes to seconds conversion, avoiding a multiplication and all floating point operations for some applications.

lenght: 192

5.28.5.17 zif2charMod10

```
char const zif2charMod10[44]  [extern]
```

The digits 0..9 repeated as 44 characters.

By using a number 0..43 as index this will give modulo 10 respectively the last decimal digit as character.

5.28.5.18 dec2digs

```
char const dec2digs[128][2]  [extern]
```

Format two digit decimal, leading zero, by lookup.

"00" .. "99" + "00", "_1" .. "_7"

5.28.5.19 dec3digs

```
char const dec3digs[1024][4]  [extern]
```

Format three digit decimal, leading zero, 0-terminated, by lookup.

"000" .. "999" + "000" .. "023"

5.28.5.20 dow

```
char const dow[9][4]  [extern]
```

English weekdays, two letter abbreviation.

Monday (Mo) is 1; Sunday (Su) is 7 or, also, 0.

5.28.5.21 fType

```
char const fType[16][8]  [extern]
```

Translation of directory entry typed to 8 char text.

direntry.d_type as index in the range 0..15 gives an 8 character short type text. Note: Only 0, 1, 2, 4, 6, 8, 10, 12 and 14 are defined d_type values. The undefined ones give undef3 .. undefF

5.29 include/we1wire.h File Reference

Common types and values for 1-wire sensors.

```
#include "sysBasic.h"
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>
```

Data Structures

- struct oneWireDevice_t

  A structure for 1-wire devices.

Macros

- #define BAD_TEMP_FLOAT

  Bad temperature reading as float string.
- #define BAD_TEMP_READ

  Bad temperature reading.
- #define STD_DEVICES_PATH

  The standard devices location.
- #define STD_DEVICES_PATH_LEN

  Standard 1-wire device path length.

Functions

- int getTemp (oneWireDevice_t *const tempSensor)

  Get temperature.
- void initTempSensor (oneWireDevice_t *const tempSensor, char const *const name, char const *const valueFile)

  Initialise a 1-wire sensor structure.

5.29.1 Detailed Description

Common types and values for 1-wire sensors.

```
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weinert-automation.de        a-weinert.de
    /         /      /\
   /         /___   /  \      |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  51 30.06.2023
Rev.  168 21.07.2018 :  new
Rev.  190 12.02.2019 :  safe water temperature reduced to 65C
Rev.  222 18.03.2020 :  safe water temperature set to 69C
```

1-wire devices and especially 1-wire temperature sensors are an attractive way to enrich Raspberry's process I/O repertoire. Up to some dozen devices can share one digital I/O pin; the default is GPIO04 (Pin7).

In most Linuxes and in Raspbian 1-wire devices are accessed by Linux's "device as file" approach. The behaviour is being implemented in kernel modules (i.e. .so files) which must be activated in OS's configuration files. Access to a 1-wire device's I/O values, configuration data etc. is done by a) opening, b) reading from respectively writing to and, finally, c) closing the corresponding (pseudo) file. The sheer number of files for a small un-complicated device and the content semantics seam neither clearly designed nor documented. One order principle is to have those pseudo files in one directory named according to 1-wire devices' unique readable serial number.

As the I/O pin used for 1-wire (default GPIO04, Pin7) is governed by those kernel modules no other process control software must touch this port directly.

This include file introduces some types and functions to handle 1-wire.

5.29.2 Macro Definition Documentation

5.29.2.1 STD_DEVICES_PATH

```
#define STD_DEVICES_PATH
```

The standard devices location.

This is the directory wer each device's sub-directory is located.
Value: /sys/bus/w1/devices/

5.29.2.2 STD_DEVICES_PATH_LEN

```
#define STD_DEVICES_PATH_LEN
```

Standard 1-wire device path length.

This is the length of "/sys/bus/w1/devices/" without the trailing '/' respectively the index of that trailing slash.

This path length +1 would be the index of the device directory name "28-..." in "/sys/bus/w1/devices/28-01e63c07010c/".

This path length +15 — i.e. + STD_DEVICES_PATH_LEN — would be the end of the concrete device's directory path respectively the index of its trailing respectively separating slash.

5.29.2.3 BAD_TEMP_READ

```
#define BAD_TEMP_READ
```

Bad temperature reading.

The integer value for bad temperature sensor reading is +987650 m℃ respectively +987.650 ℃ far beyond the 1-wire temperature sensors range.

Rationale for choosing a (too) high value as bad value: The usual and safe "turn XYZ off" when temperature exceeds xyC" requires no special treatment for sensor outage.

5.29.2.4 BAD_TEMP_FLOAT

```
#define BAD_TEMP_FLOAT
```

Bad temperature reading as float string.

The integer value for bad temperature sensor reading as ℃ string is "987.6 " (float string, 6 characters including trailing blank.

5.29.3 Function Documentation

5.29.3.1 getTemp()

```
int getTemp (
            oneWireDevice_t *const tempSensor )
```

Get temperature.

This function tries a new measurement on the 1-wire temperature sensor provided. On success the new value is returned. On failure the last good value is returned, but at most 7 times after 7 good readings before. On total failure -99900 (-99.9 ℃, 0 K, BAD_TEMP_READ) is returned.

Additionally on temperature changes, the integer reading (.value) and the floating point string (valueGrdC[]) will be set in the structure.

Parameters

tempSensor	pointer to the sensor's structure

Returns

the actual or last reading or -2721500 if no good / not enough past good readings

5.29.3.2 initTempSensor()

```
void initTempSensor (
            oneWireDevice_t *const tempSensor,
            char const *const name,
            char const *const valueFile )
```

Initialise a 1-wire sensor structure.

This function does basic initial settings for a 1-wire temperature sensor. tempSensor.name and tempSensor.value↩ File are set by the respective parameters.
The temperature values are set to bad value; see BAD_TEMP_READ and BAD_TEMP_FLOAT

Parameters

tempSensor	pointer to the sensor's structure (never NULL!)
name	the sensor's short name or its directory name; NULL / empty: no change
valueFile	the canonical absolute path to its value file; NULL / empty: no change

5.30 include/weAR_N4105.h File Reference

Definitions for VDE-AR-N 4105.

```
#include "sysBasic.h"
#include "weStateM.h"
```

Macros

- #define **L1Msk**

  arn4105state L1 voltage mask
- #define **L2Msk**

  arn4105state L2 voltage mask
- #define **L3Msk**

  arn4105state L3 voltage mask
- #define **LeMsk**

  arn4105state line status error mask
- #define **LfMsk**

  arn4105state line frequency mask
- #define **LwMsk**

  arn4105state line status warning mask
- #define newLineFcheck(N, C)

  Define a five band checker for line frequency.
- #define newLineUcheck(N, C)

  Define a five band checker for phase voltage.

Functions

- void setARN4105state (uint8_t const state, uint8_t const select)

  Set AR-N 4105 frequency and voltage states.
- void switchARN4105 (uint8_t const cutOff)

  AR-N 4105 implementation function.

Variables

- uint8_t arn4105state

  AR-N 4105 frequency and voltage states.
- state_t arn4105Timer

  AR-N 4105 control timer.
- state_t checkL1_U

  The (one) five band checker for line L1 voltage.
- state_t checkL2_U

  The (one) five band checker for line L2 voltage.
- state_t checkL3_U

  The (one) five band checker for line L3 voltage.
- state_t checkLineFrq

  The (one) five band checker for line frequency.

5.30.1 Detailed Description

Definitions for VDE-AR-N 4105.

```
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weinert-automation.de      a-weinert.de
    /          /      /\
   /          /___    /  \       |
   \         /____\ /____\ |  _|__
    \  /\  / \     /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  88 13.07.2025
Rev.  195 01.03.2019 :  new
Rev.  249 26.06.2023 :  No more relays assigned for ARN4105 cut off
Rev.    88 13.07.2025 :  typos (and new repository)
```

5.30.2 Macro Definition Documentation

5.30.2.1 newLineFcheck

```
#define newLineFcheck(
              N,
              C )
```

Define a five band checker for line frequency.

A state machine of this type is to be fed with the actual line frequency (nominal 50 Hz) as an analogue (float) value sampled regularly. This value is compared to four thresholds namely
47.7 49.5 -OK- 50.5 51.5 Hz
defined by VDE-AR-N 4105 as good / warning / bad criteria for the grid frequency separating those five bands:
...badLO | critLo | OK | critHi | badHi...

On badHi or badLo distributed small generators must be cut off reliably from public power lines. For being switched on to the grid at OK often at least 10 minutes out of bad ist required for both frequency and voltage(s).

For state values and parameters see newFiveBand

This macro is the initialisation expression for a five band checker requiring the unique name and the fitting on↩ StateChange function.

Parameters

N	name as string literal
C	onStateChange function

5.30.2.2 newLineUcheck

```
#define newLineUcheck(
              N,
              C )
```

Define a five band checker for phase voltage.

A state machine of this type is to be fed with the actual phase voltage (Ln-N, nominal 230 V) as an analogue (float) value sampled regularly. This value is compared to four thresholds namely
184 207 -OK- 253 264 V
defined by VDE-AR-N 4105 as good / warning / bad criteria for publicpower grid voltage separating those five bands:
...badLO | critLo | OK | critHi | badHi...

On badHi or badLo distributed small generators must be cut off reliably from public power lines. For being switched to the grid at OK often at least 10 minutes out of bad ist required.

For state values and parameters see newFiveBand

This macro is the initialisation expression for a five band checker requiring the unique name and the fitting on↩ StateChange function.

Parameters

N	name as string literal
C	onStateChange function

5.30.3 Function Documentation

5.30.3.1 setARN4105state()

```
void setARN4105state (
             uint8_t const state,
             uint8_t const select )
```

Set AR-N 4105 frequency and voltage states.

This function is called internally by the respective five band checker's state_t.onStateChange function.

Parameter selection mask must be one of LfMsk, L1Msk - L3Msk.

Parameters

state	state_t.status of the five band checker in question
select	selection mask

5.30.3.2 switchARN4105()

```
void switchARN4105 (
            uint8_t const cutOff )
```

AR-N 4105 implementation function.

This is the VDE-AR-N 4105 cut off function to be provided site specific by user / application software. It does the cut off respectively switch back on the generators and optionally log the event.

Parameters

cutOff	not 0: do the cut off, 0: switch generators back on

5.30.4 Variable Documentation

5.30.4.1 checkLineFrq

```
state_t checkLineFrq  [extern]
```

The (one) five band checker for line frequency.

See newLineFcheck

5.30.4.2 checkL1_U

```
state_t checkL1_U  [extern]
```

The (one) five band checker for line L1 voltage.

In a one phase system this will be the only one fed with values by fiveBandTick.

See newLineUcheck

5.30.4.3 checkL2_U

```
state_t checkL2_U  [extern]
```

The (one) five band checker for line L2 voltage.

See newLineUcheck

5.30.4.4 checkL3_U

```
state_t checkL3_U  [extern]
```

The (one) five band checker for line L3 voltage.

See newLineUcheck

5.30.4.5 arn4105state

```
uint8_t arn4105state  [extern]
```

AR-N 4105 frequency and voltage states.

If all is OK this status byte is 0. The meaning of bits set is

```
|   7    |   6    |   5    |   4    ||   3    |   2    |   1    |   0    |
|   L3   |   L2   |   L1   |   f    ||   L3   |   L2   |   L1   |   f    |
|       voltage error       |  error ||      voltage warning     | warning|
```

If any error bit is set the respective generators has to be cut off.
Ten minutes after the last warning bit is gone the respective generators may be put back to power line.
The timer arn4105Timer will be handled accordingly.

User software should not touch this variable (except when knowing the consequences.

5.30.4.6 arn4105Timer

```
state_t arn4105Timer  [extern]
```

AR-N 4105 control timer.

When this timer is running distributed small generators must be cut off. When this timer stops the respective generators may be put back to power line.

User software must provide a function switchARN4105 doing the cutoff and switch back plus optionally logging. It will be called by this timer and, hence, in the end by the frequency and voltage checkers.

The user/application software must check (timerTickCheck) regularly to enable switch back.

5.31 include/weBatt.h File Reference

Common types and values for buffer battery handling.

```
#include "basicTyCo.h"
```

Macros

- #define BAT_BAL_STRT_PWM

  Start value for loading (LiFePo4).
- #define BAT_KEEP_PWM

  Battery keep alive PWM setting (LiFePo4).
- #define BAT_LD8H_PWM

  Battery maximum load for 8 hours PWM setting (LiFePo4).
- #define BAT_LDBAL_STR_PWM

  PWM start value for ballast loading.
- #define BAT_LDBAL_TIM

  Maximum time for battery loading as ballast.
- #define BAT_LDMX_PWM

  Battery maximum load PWM setting (LiFePo4).
- #define BAT_LDTEST_MAX_PWM

  Battery maximum test PWM setting (LiFePo4).
- #define BAT_LOAD_PWM

  Value for permanent loading.
- #define BAT_MXBL_PWM

  Battery maximum ballast load for PWM setting (LiFePo4).
- #define BAT_NOLD_PWM

  Battery no load no keep setting (LiFePo4).
- #define BAT_TNUM

  Battery type number.
- #define BAT_TYPE

  Battery type.
- #define BATkeepInhByCmd

  Inhibit battery keep loading after battery Off command.
- #define BATkeepInhContLoad

  Inhibit battery keep loading after controlled loading.
- #define BATkeepInhUnload

  Inhibit battery keep loading after unloading.
- #define BATmaxUNLODtime

  Upper time limit (s) to stop discharging (LiFePo4).
- #define BATVOLT_LO_LIM_UNLD

  Voltage limit to start unload.
- #define BATVOLT_LO_STP_UNLD

  Lower voltage limit to stop discharging (LiFePo4).
- #define BATVOLT_MX_STRT_LOAD

  Upper voltage limit with no load to start loading (LiFePo4).
- #define BATVOLT_UP_LIM_LOAD

  Upper voltage limit to stop loading.
- #define ESP_U_CORR

  Correction factor for ESP battery voltmeter.
- #define PDEL_MINP_INV

  Minimum power from public electricity for discharge inverter start.
- #define PDEL_MINP_UNL

  Minimum power from public electricity supplier to start discharging.
- #define PDEL_STOP_UNL

  Minimum power from public electricity to stop discharging.
- #define PINV_MIN_ON

  Minimum discharge power to consider discharge inverter on.

Variables

- uint16_t hundredsV

  The battery voltage in 0.01V units.

5.31.1 Detailed Description

Common types and values for buffer battery handling.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  94 2.10.2025
Rev.  159 04.07.2018 :  new
Rev.  191 15.02.2019 :  comment text changes; upper ballast limit reduced
Rev.  200 16.04.2019 :  battery keep inhibit until low stress
Rev.  223 24.04.2020 :  comment clarifications, voltage adjustments
Rev.  259 04.08.2022 :  battery changed to ECO-WORTHY 12.8V 100Ah LiFePO4 accu
Rev.  260 06.08.2024 :  correct LiFePO4 accumulator values (hopefully)
Rev.  263 06.10.2024 :  lead acid put to include file, better LiFePo limits
Rev.  266 10.10.2024 :  battery unload TO increased from 4 to 5h
Rev.  268 15.10.2024 :  ESP_U_CORR introduced to correct ESP voltmeter
Rev.    75 25.02.2025 :  lead acid batteries ("type 1") cancelled
Rev.    79 21.03.2025 :  values changed due to "unload experiences", keep 36
Rev.    83 30.05.2025 :  BATVOLT_MX_STRT_LOAD new start loading limit (80%)
Rev.    88 05.07.2025 :  battery unload limit Ubat++, Psuppl++, etc
Rev.    89 21.07.2025 :  typos,  battery unload limit 11.9V,
         26.07.2025 :  ESP_U_CORR for 13,4 <-- 13,26 discrepancy
Rev.    91 10.08.2025 :  values for new load module 0..24V 20A
Rev.    92 26.08.2025 :  load unload values and SFCs  (Rev.  92..94, 02.09.)
Rev.    94 24.09.2025 :  charge module settings changed, hence pwm settings &c.
Rev.    96 12.10.2025 :  BATVOLT_LO_STP_UNLD 12.49
```

In the smart home buffer batteries are used.

Originally, we had an array of parallel 12V (6 cell) lead acid batteries. It summed up to about 200Ah and should allow buffering 1 kWh. The usable capacity of the batteries formerly used in cars and glider starting winches was much less, due to the age and principal limits of lead acid accumulators.

In August 2024 all were replaced by one and since February 2025 two 12,8V 100Ah LiPoFe accumulators (by ECO-WORTHY). In consequence all loading, keeping and unloading constants and procedures had to be changed. Their 200Ah now allow 1 real kWh and sometimes more.

Battery voltage is measured at the battery clamps by an own MQTT device (using this software mqttHome.h, sweetHome2.c). It uses WLAN and has a 12V supply. It just "lives" directly on the battery at an own fuse needing no extra hardware.

5.31.2 Macro Definition Documentation

5.31.2.1 PDEL_MINP_UNL

```
#define PDEL_MINP_UNL
```

Minimum power from public electricity supplier to start discharging.

If public power consumption is below this limit battery unloading shall not be started respectively inhibited. The current value is 200 W.
Rationale: Battery power shall not flow into public power grid or be used to heat domestic hot water. See also PDEL_MINP_INV

5.31.2.2 PDEL_MINP_INV

```
#define PDEL_MINP_INV
```

Minimum power from public electricity for discharge inverter start.

This is the lower equivalent to PDEL_MINP_UNL. If public power consumption is fallen below this value while waiting for the inverter to start discharging we consider the pre-condition gone.
This event is not quite probable. So this feature may be removed (after not seeing "noCons" for a year in the log).

5.31.2.3 PINV_MIN_ON

```
#define PINV_MIN_ON
```

Minimum discharge power to consider discharge inverter on.

The current value is 53W.

5.31.2.4 PDEL_STOP_UNL

```
#define PDEL_STOP_UNL
```

Minimum power from public electricity to stop discharging.

We inhibit all power delivery to the public grid. Especially we do not discharge the batteries when not consuming battery power. As we can't control discharge power and re-starting discharge takes long (thanks to VDE-AR-N 4105, a German "unique selling point") we allow very low negative power hardly / not fully measured by Ferraris counters biased to start on minimal positive values. See also PDEL_MINP_INV PDEL_MINP_UNL

5.31.2.5 ESP_U_CORR

```
#define ESP_U_CORR
```

Correction factor for ESP battery voltmeter.

Due to tolerances the value delivered via MQTT is a bit too low. This factor is a good average correction and may be put into the ESP voltmeter ome day.
On the other hand changing this factor on Pi C Eclipse ... environment is loads more easy and less (hardware) error prone than handling an ESP.

5.31.2.6 BAT_TNUM

```
#define BAT_TNUM
```

Battery type number.

The battery type as integer number co-responding to the text, see BAT_TYPE. LiFePo4 has number 2 and LeadAcid has 1.
LeadAcid batteries were dumped as not fit for PV buffering. That type (1 = LeadAcid, 12V, 200Ah) isn't implemented any more.

5.31.2.7 BAT_TYPE

```
#define BAT_TYPE
```

Battery type.

The battery type as text, like LiFePo4 or LeadAcid.
As C's macro handling is too stupid to compare strings we have a co-responding integer type number BAT_TNUM 2.

5.31.2.8 BATmaxUNLODtime

```
#define BATmaxUNLODtime
```

Upper time limit (s) to stop discharging (LiFePo4).

The normal discharge end condition in the unload SFC would be battery voltage (BATVOLT_LO_STP_UNLD). Additionally there is this time limit of currently 8h (as of 26.08.2025).

5.31.2.9 BATkeepInhUnload

```
#define BATkeepInhUnload
```

Inhibit battery keep loading after unloading.

Start battery keeping immediately after unloading would most probably be unnecessary charging as we are on the discharge curve. As we have ample reserve we may consider the base load 10..20W as mildly unloading.
The current value is 6h20min.

5.31.2.10 BATkeepInhContLoad

```
#define BATkeepInhContLoad
```

Inhibit battery keep loading after controlled loading.

The current value is 2 hours.

5.31.2.11 BATkeepInhByCmd

```
#define BATkeepInhByCmd
```

Inhibit battery keep loading after battery Off command.

The current value is 20 minutes from now. If the inhibit timer is running already its end time will eventually be prolonged but not shortened.

5.31.2.12 BATVOLT_LO_LIM_UNLD

```
#define BATVOLT_LO_LIM_UNLD
```

Voltage limit to start unload.

This is the minimal voltage to allow starting an unload sequence.
Current value 13.06V (20% on the idle curve).

See also

BATVOLT_LO_STP_UNLD

5.31.2.13 BATVOLT_LO_STP_UNLD

```
#define BATVOLT_LO_STP_UNLD
```

Lower voltage limit to stop discharging (LiFePo4).

This is the minimal voltage, measured under 5..10% cap unload, to stop a running unload sequence for providing buffer capacity needed.

This is a critical value. Choosing a value too high reduces the usable buffer capacity (the battery's purpose in life). A value too low endangers the battery.

To allow for permanent loads without being forced to load within the next 24 hours we intend to stop in the range 30..20%.
The current value is 12.49 (less than 10% on idle curve).

See also

BATVOLT_LO_LIM_UNLD BAT_KEEP_PWM

5.31.2.14 BAT_LDBAL_TIM

```
#define BAT_LDBAL_TIM
```

Maximum time for battery loading as ballast.

This time limit is the last resort to stop overloading as ballast for surplus power.
This feature is not necessary as the LiPoFe batteries protect themselves against over charging and the current loading module max. voltage of 14.75V (+ 0.4V for the Schottky diodes 15.15V) is within the limits.

5.31.2.15 BAT_LDBAL_STR_PWM

```
#define BAT_LDBAL_STR_PWM
```

PWM start value for ballast loading.

The current value 233 to have a quick start. See also BAT_LDTEST_MAX_PWM

5.31.2.16 BAT_LDTEST_MAX_PWM

```
#define BAT_LDTEST_MAX_PWM
```

Battery maximum test PWM setting (LiFePo4).

Max. PWM for battery charging module. The current module allows 255 = 100% = 14.75V (+0.4V when the Schottky voltage drop disappears at very low current) is well within the batteries operating range.

See also BAT_LDTEST_MAX_PWM, BAT_LDTEST_MIN_PWM, BAT_LDTEST_UPS_PWM, BAT_LDTEST_↩ DWN_PWM, setBatLoadPWM

5.31.2.17 BAT_NOLD_PWM

```
#define BAT_NOLD_PWM
```

Battery no load no keep setting (LiFePo4).

This is the PWM setting for neither charging nor keeping. Until August 2024 it was 0 for the array of old lead acid starter batteries.

"LiFePO4 battery cells have a maximum discharge depth of 98% to 100%. This is longer than any other battery technology currently in the market. This means that you can safely discharge these batteries to their full capacity. However, most manufacturers recommend still using a 80% depth of discharge for these batteries to prolong their lifespan. Even if you occasionally use 100% of the battery capacity, the battery will not get harmed." cited from [https://ecotreelithium.co.uk/news/lifepo4-battery-depth-of-discharge/]

For neither keeping or loading we permanently back the battery with 12.5V (+0.4V on no current) to keep about 10%. The relation between BATVOLT_LO_STP_UNLD and BAT_NOLD_PWM shall not lead to start keeping immediately after unloading. Check regularly.

See also

BATVOLT_LO_STP_UNLD loadModUlookup

5.31.2.18 BATVOLT_UP_LIM_LOAD

```
#define BATVOLT_UP_LIM_LOAD
```

Upper voltage limit to stop loading.

The battery loading SFCs would stop when this voltage is reached. Full loading would require 14.6 V and for safety reasons one should be more below, perhaps. 14.88V is overcharge protection and 14.4V is the cell equalising start voltage. On the other hand EcoWorth's LiFePo4 12V 100Ah has a built in battery management system (BSM), which would cut of at overvoltage.

See also

BAT_LDMX_PWM BAT_LD8H_PWM

5.31.2.19 BAT_KEEP_PWM

```
#define BAT_KEEP_PWM
```

Battery keep alive PWM setting (LiFePo4).

This is the PWM setting for the battery load module, see loadModUlookup, for permanently keeping the battery at live by preventing self discharge and feeding low permanent loads.
Value since 24.09.2025, 111 LiFePo4: 12.85V = 10%

5.31.2.20 BAT_LDMX_PWM

```
#define BAT_LDMX_PWM
```

Battery maximum load PWM setting (LiFePo4).

Intended charger max. voltage 14.25V
Note: The value 14.6 for pwm 255 is the value for full loading. Without load current the voltage will be at least by the 0.4V drop for of the Schottky diodes higher. Hence monitoring BATVOLT_UP_LIM_LOAD is essential and this value, probably should be lower than the current (14.9.25) value.
See also BAT_LD8H_PWM, BAT_LDMX_PWM for future adjustments

5.31.2.21 BAT_LD8H_PWM

```
#define BAT_LD8H_PWM
```

Battery maximum load for 8 hours PWM setting (LiFePo4).

The current value is the same as BAT_LDMX_PWM. Having different constant constant macros was for the sake of (past) lead acid batteries.

5.31.2.22 BAT_MXBL_PWM

```
#define BAT_MXBL_PWM
```

Battery maximum ballast load for PWM setting (LiFePo4).

Intended charger max. voltage is 14.2V for ballast loading. This is the 80% voltage on the LiFePo charging curve.

5.31.2.23 BATVOLT_MX_STRT_LOAD

```
#define BATVOLT_MX_STRT_LOAD
```

Upper voltage limit with no load to start loading (LiFePo4).

When without load worth speaking of, say 24W / 2A for 200Ah capacity, the battery voltage is above this limit the start of any load sequence is inhibited. The value is not used for stopping a load process as the allowed voltages on the LiFePo4 loading curve are significantly higher.
Note: The current no load value of 13.35V is 80% capacity on the idle curve. A running load process may load to a higher capacity rate, but we won't start loading over 80%.

5.31.2.24 BAT_BAL_STRT_PWM

```
#define BAT_BAL_STRT_PWM
```

Start value for loading (LiFePo4).

The value is 81 (= 13.37V).

5.31.2.25 BAT_LOAD_PWM

```
#define BAT_LOAD_PWM
```

Value for permanent loading.

The value is 63 (= 13.12V = 25%).
See also BAT_BAL_STRT_PWM

5.31.3 Variable Documentation

5.31.3.1 hundredsV

```
uint16_t hundredsV  [extern]
```

The battery voltage in 0.01V units.

This is just an integer value consistent to the last valid battery voltage measurement valFilVal.batVolt. Contrary to valFilVal.batVolt which is set to -0.9 to indicate invalidity after 2.4s without new (MQTT) measurements, this value will be kept (forever).
It is preset with 1289 (12.89 V) lest have battery low before the first valid MQTT measurement / message.
Receiving a good MQTT message from the battery voltmeter will set valFilVal.batVolt, batVoltValid and this value.
Use formFixed16(&textStart, hundredsV, 2) to format as "12.89" without trailing zero.

See also

formFixed16 valFilVal batVoltValid

5.32 include/weCGIajax.h File Reference

Types, functions and values for Web interfaces with AJAX, CGI etc.

```
#include "weUtil.h"
```

Macros

- #define **QS_MAX_KEY_LEN**

  key's / name's max. length including final zero
- #define **QS_MAX_STRING_LEN**

  Query string's maximum length including final zero.
- #define **QS_MAX_VAL_LEN**

  key's / name's max. length including final zero

Functions

- int getQSparam (char const ∗name, char ∗const value, int const vLen)

  Get the query string parameter value for a unique and known key.
- int getQueryString ()

  Fetch and store the query string.
- int jsonBinForm (uint8_t const indent, char const ∗const name, uint8_t const value, char ∗end)

  Output an eight bit value binary formated as JSON name:value.
- int jsonBreading (uint8_t const indent, char const ∗const name, uint8_t const value, char ∗end)

  Output a boolean value as JSON name:value.
- int jsonFPreadingT (uint8_t const indent, char const ∗const name, uint16_t const valueLo, uint16_t const valueHi, uint8_t dotPos, char const ∗const unit, char ∗end, char ∗title)

  Output a physical value as JSON {object} with name, 32 bit FP value and unit.
- int jsonFreading (uint8_t const indent, char const ∗const name, float const value, char const ∗const unit, uint8_t const fractional, char ∗end)

  Output a float (physical value as JSON {object} with name, value and unit.
- int jsonFreadingT (uint8_t const indent, char const ∗const name, float const value, char const ∗const unit, uint8_t const fractional, char ∗end, char ∗title)

  Output a float value as JSON {object} with name, value, unit and help text.
- int jsonIreading (uint8_t const indent, char const ∗const name, int const value, char ∗end)

  Output an int value as JSON name:value.
- int jsonSreadingT (uint8_t const indent, char const ∗const name, char ∗const value, char const ∗const unit, char ∗end, char ∗title)

  Output a physical value as JSON {object} with name, value as String and unit.

Variables

- char **actQSPvalue** [64]

  to be used for actual parameter
- char **queryString** [512]

  holding the query string
- char const ∗ **requestMethod**

  to hold (environment's) REQUEST_METHOD

5.32.1 Detailed Description

Types, functions and values for Web interfaces with AJAX, CGI etc.

```
Copyright  (c)  2018   Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  38 2.02.2021
Rev.    82 14.12.2017 :  new
Rev.  187 14.10.2018 :  minor typos
```

In process control applications featuring a web HMI one approach is to use a CGI program communicating with control program by shared memory and semaphores. Both programs and their libraries are written in C. The CGI program is made known to / runnable by the web sever – Apache 2.4 here.

The HMI is a HTML web page using CSS, Javascript etc. communicating with the CGI program by AJAX. The answers (asynchronously) returned may be plain text, plain HTML XML or, preferably JSON.

5.32.2 Function Documentation

5.32.2.1 getQueryString()

```
int getQueryString ( )
```

Fetch and store the query string.

This function gets the raw query string storing it (on success) in queryString. Raw means, all the ugly '+' and 'AB' things are still there.

Returns

0: from get; 1: from get, truncated; 2: from post; 3: from get, truncated; -1: program probably not run as CGI, no query string

5.32.2.2 getQSparam()

```
int getQSparam (
            char const * name,
            char *const value,
            int const vLen )
```

Get the query string parameter value for a unique and known key.

This simple method would fetch the value to a known query string parameter.

Warning: Longer names/keys with the same prefix must come first. When having "carlength=91&length=300", this (simple) function will get "91" for "length".

Parameters

name	the parameter's name or key
value	character array (string) to store the value to, the result may be empty (on name\0, name=\0 or name&)
vLen	value's length including the terminating 0

Returns

0: OK, got value; -1: got no value (no name, no value, ...) 1: got value truncated to vLen -1 characters

5.32.2.3 jsonIreading()

```
int jsonIreading (
            uint8_t const indent,
            char const *const name,
            int const value,
            char * end )
```

Output an int value as JSON name:value.

This function puts an integer value as "name": "999" respectively "name": "-1" to the standard output.

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	the property's name
value	the integer value (put as string)
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.32.2.4 jsonBreading()

```
int jsonBreading (
            uint8_t const indent,
            char const *const name,
            uint8_t const value,
            char * end )
```

Output a boolean value as JSON name:value.

This function puts a boolean value as "name": true or as "name": false to the standard output.

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	the property's name
value	0: false; else: true
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.32.2.5 jsonBinForm()

```
int jsonBinForm (
            uint8_t const indent,
            char const *const name,
            uint8_t const value,
            char * end )
```

Output an eight bit value binary formated as JSON name:value.

This function puts a boolean value as "name": "1001_1100" to the standard output.

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	the property's name
value	0..255 i.e 0000_0000 .. 1111_1111
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.32.2.6 jsonFreading()

```
int jsonFreading (
            uint8_t const indent,
            char const *const name,
            float const value,
            char const *const unit,
```

```
            uint8_t const fractional,
            char * end )
```

Output a float (physical value as JSON {object} with name, value and unit.

This function puts a float value as e.g. {"name": "Wimp", "value": "15.22", "unit": "kWh"}

The text by parameter end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
value	the float value
unit	0-terminated string being the value's physical unit
fractional	0..9 number of fractional digits 0: value will be taken as int
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.32.2.7 jsonFreadingT()

```
int jsonFreadingT (
            uint8_t const indent,
            char const *const name,
            float const value,
            char const *const unit,
            uint8_t const fractional,
            char * end,
            char * title )
```

Output a float value as JSON {object} with name, value, unit and help text.

This function puts a float value as e.g. {"name": "Wimp", "value": "15.22", "unit": "kWh"}

The text by parameter end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " ",\n" "\n") may enhance human readability.

The text by parameter title will be used as such, acting as hover help text (not title) by html tradition. This text must not be NULL nor empty. When wanting no help text use jsonFreading() instead.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
value	the float value
unit	0-terminated string being the value's physical unit
fractional	0..9 number of fractional digits 0: value will be taken as int
end	0-terminated string to put at the end
title	0-terminated string as help text

Returns

>=0: OK; <0: error

5.32.2.8 jsonSreadingT()

```
int jsonSreadingT (
            uint8_t const indent,
            char const *const name,
            char *const value,
            char const *const unit,
            char * end,
            char * title )
```

Output a physical value as JSON {object} with name, value as String and unit.

This function puts a value given as String "15.22" e.g. in the form {"name": "Wimp", "value": "15.22", "unit": "kWh"}

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
value	the float value
unit	0-terminated string being the value's physical unit
end	0-terminated string to put at the end
title	0-terminated string as help text (NULL no title)

Returns

>=0: OK; <0: error

5.32.2.9 jsonFPreadingT()

```
int jsonFPreadingT (
            uint8_t const indent,
            char const *const name,
            uint16_t const valueLo,
            uint16_t const valueHi,
            uint8_t dotPos,
            char const *const unit,
            char * end,
            char * title )
```

Output a physical value as JSON {object} with name, 32 bit FP value and unit.

This function puts a value given as 32 bit fixed point value in two 16 bit parts in the form {"name": "Wimp", "value": "15.22", "unit": "kWh"}. Accepting the vale as two parts solves problems with 32 bit integers or fixed point values delivered as two 16 bit Modbus registers in arbitrary order. The value is specified by the parameters valueLo, valueHi and dotPos.
With valueHi == 0 valueLo is considered as 16 bit value

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
valueLo	the least significant 16 bits of the fixed point value
valueHi	the most significant 16 bits of the fixed point value
dotPos	position where the fixed point is 0..6; 0 means integer
unit	0-terminated string being the value's physical unit
end	0-terminated string to put at the end
title	0-terminated string as help text (NULL no title)

Returns

>=0: OK; <0: error

5.33 include/weDCF77.h File Reference

DCF77 decoder on Raspberry Pi.

```
#include <basicTyCo.h>
#include "weGPIOd.h"
#include "weUtil.h"
```

Data Structures

- struct dcf77recPerData_t

  Data for one received DCF77 AM period.
- struct durDiscrPointData_t

  Values for discrimination of duration.

Macros

- #define DCF77inpDEF

  Default GPIO for the DCF77 receiver's AM signal input.
- #define DCF77recCNTdef

  Recommended default GPIO for the receiver control output.
- #define DCF77RINGbufWRAP

  Ring buffer maximum Index for modulation period data received.
- #define **MXUI32**

  Maximum value for uint32_t.

Functions

- void dcf77receiveRec (int pi, unsigned gpio, unsigned level, uint32_t tick)

  DCF77 receive recorder.
- int dcf77receiveRecDeregister (void)

  DCF77 receive function de-registration.
- int dcf77receiveRecRegister (void)

  DCF77 receive recorder registration.
- durDiscrPointData_t * disc5 (durDiscrPointData_t table[ ], uint32_t const value)

  Discriminating a value.
- uint32_t initDCF77io ()

  Initialise the DCF77 signal input GPIO / pin.
- void setReceiver (int const level)

  Set receiver On control.

Variables

- unsigned curBCDnum

  Number decoded from period sequence parts.
- int **dcf77callbackID**

  PiGpioD's call back ID for receiver function.
- unsigned dcf77glitch

  DCF77 input's glitch filter time setting.
- unsigned dcf77inp

  Input GPIO for the DCF77 receiver's AM signal.
- unsigned dcf77invInp

  Inverted DCF77 receiver's signal.
- unsigned dcf77lastLevel

  Last DCF77 modulation level.
- unsigned dcf77PUD

  DCF77 input's pull resistor setting.
- unsigned dcf77recCnt

  Control output GPIO of the DCF77 receiver's control.
- unsigned dcf77recCntInv

  Receiver On control inverted.
- dcf77recPerData_t **dfc77actRecPer**

  The actual respectively last modulation period data received.
- dcf77recPerData_t **dfc77ringBrecPer** [ ]

  Ring buffer of modulation period data received.
- uint8_t **dfc77ringBrecWInd**

  Modulation period data received ring buffer write index.
- unsigned const **num02st** [5]

  see numBCDinit, values 0 2
- unsigned const **num04st** [5]

  see numBCDinit, values 0 4
- unsigned const **num08st** [5]

  see numBCDinit, values 0 8
- unsigned const **num10st** [5]

  see numBCDinit, values 0 10
- unsigned const **num20st** [5]

see numBCDinit, values 0 20

- unsigned const **num40st** [5]

  see numBCDinit, values 0 40

- unsigned const **num80st** [5]

  see numBCDinit, values 0 80

- unsigned const numBCDinit [5]

  Initialisation or least significant BDC digit for modulation time.

- durDiscrPointData_t perDiscH [5]

  Discrimination values for the modulation period.

- durDiscrPointData_t perDiscP [5]

  Discrimination values for the modulation period.

- durDiscrPointData_t * perDiscUsed

  Discrimination values for the modulation period used.

- durDiscrPointData_t timDiscH [5]

  Discrimination values for the 15% modulation time.

- durDiscrPointData_t timDiscHs [5]

  Discrimination values for the 15% modulation time.

- durDiscrPointData_t timDiscP [5]

  Discrimination values for the 15% modulation time.

- durDiscrPointData_t * timDiscUsed

  Discrimination values for the 15% modulation time.

5.33.1 Detailed Description

DCF77 decoder on Raspberry Pi.

```
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weinert-automation.de     a-weinert.de
```

Revision history

```
Rev.  57 29.10.2023
Rev.  233 17.10.2020 :  new
Rev.  234 05.12.2020 :  minor, comment
Rev.  239 02.03.2021 :  functions from dcf77onPi.c ported here
```

This is a supplementary basic library to handle the signal of a DCF77 receiver. In the case of AM (amplitude) modulation a 1 (high) at the signal input means 15% amplitude and a 0 (low) 100% respectively full amplitude. The other way round is marked as dcf77invInp.

Receivers

Devices used and tested are the AM receiver modules from several sources. See the `blog post` for results.
The first one is relatively cheap and widespread but a bit of low grade (to put it mildly) in the sense of inserting spiky 1 signals and sensitivity to electromagnetic interferences (EMI).
On the other hand, being able to extract sensible DCF77 from the Pollin module's signal is good report for the decoding and filtering algorithms and or extra circuitry used.

5.33.2 Macro Definition Documentation

5.33.2.1 DCF77recCNTdef

```
#define DCF77recCNTdef
```

Recommended default GPIO for the receiver control output.

This is the default setting for the receiver control output dcf77recCnt. It is currently PIN23, i.e. GPIO 11 on Pi3/4/0.

5.33.2.2 DCF77inpDEF

```
#define DCF77inpDEF
```

Default GPIO for the DCF77 receiver's AM signal input.

This is the default setting for the modulation signal input dcf77inp. The current setting is PIN10, i.e. GPIO 15 (UART in) on Pi3/4/0. The UART in special function of PIN10 might enable the use of raw DCF77 input drivers for NTP servers. Their implementors chose to use a UART instead of a simple binary input for the AM signal.

5.33.2.3 DCF77RINGbufWRAP

```
#define DCF77RINGbufWRAP
```

Ring buffer maximum Index for modulation period data received.

In the current implementation the value is fixed to 255 as it uses uint8_t for all indexes and counters utilising the wrap around. For any other value change all code in question.

Hint for changes;
The value should cover more than two minutes for handling startup and receiver noise.
And it should be (a power of 2) - 1.

5.33.3 Function Documentation

5.33.3.1 setReceiver()

```
void setReceiver (
            int const level )
```

Set receiver On control.

Parameters

level	set receiver ON or OFF

See also

dcf77recCnt, dcf77recCntInv

5.33.3.2 initDCF77io()

```
uint32_t initDCF77io ( )
```

Initialise the DCF77 signal input GPIO / pin.

The signal input dcf77inp and control output dcf77recCnt are initialised.

Returns

the bank mask of the output dcf77recCnt if given, 0 if PINig

5.33.3.3 dcf77receiveRec()

```
void dcf77receiveRec (
            int pi,
            unsigned gpio,
            unsigned level,
            uint32_t tick )
```

DCF77 receive recorder.

This is a pigpiod callback function for an AM DCF77 receiver. It does no filtering nor decoding. It just fills dfc77actRecPer for the current modulation period and stores it in dfc77ringBrecPer when the next period begins.

5.33.3.4 dcf77receiveRecRegister()

```
int dcf77receiveRecRegister (
            void  )
```

DCF77 receive recorder registration.

This function registers the call back function dcf77receiveRec with the PiGpioDaemon.

Returns

register or error number; also stored in dcf77callbackID

5.33.3.5 dcf77receiveRecDeregister()

```
int dcf77receiveRecDeregister (
            void  )
```

DCF77 receive function de-registration.

This function de-registers the call back registered under dcf77callbackID.

Returns

0: OK, pigif_callback_not_found: otherwise

5.33.3.6 disc5()

```
durDiscrPointData_t * disc5 (
            durDiscrPointData_t table[],
            uint32_t const value )
```

Discriminating a value.

In a discrimination table / array of length 5 this function returns a pointer to the highest table entry with value >= table[i].v
The entry returned must be treated as const.

Parameters

table	discrimination table of length 5. With other lengths the function will fail. Must not be null.
value	the number to be discriminated

Returns

the lowest table entry with value < table[i].v

5.33.4 Variable Documentation

5.33.4.1 dcf77recCnt

```
unsigned dcf77recCnt  [extern]
```

Control output GPIO of the DCF77 receiver's control.

This output, if used and connected, controls the amplitude modulation (AM) receiver's control (On/Off) signal. If there is no such output (PINig) The receiver either has no such control input or it is tight to On.

default PINig; see also dcf77recCntInv, setReceiver()

5.33.4.2 dcf77recCntInv

```
unsigned dcf77recCntInv  [extern]
```

Receiver On control inverted.

The receiver control output (dcf77recCnt), when used, would be set to ON (Hi, 3V) to enable the receiver. And it would be set OFF for a short time to reset a panicing or inactive receiver.
If dcf77recCntInv is true it is the other way round. The common receiver chips control input is low active, hence inverted and dcf77recCntInv should be true. As an open collector stage near the Pi for this output is highly recommended, nevertheless the default value is FALSE.

default FALSE; see also dcf77recCnt, setReceiver()

5.33.4.3 dcf77inp

```
unsigned dcf77inp  [extern]
```

Input GPIO for the DCF77 receiver's AM signal.

This is the amplitude modulation (AM) level signal; the level is either 100% or 15% (for 100 or 200ms).

default PIN08; see also dcf77invInp, dcf77PUD, dcf77glitch

5.33.4.4 dcf77invInp

```
unsigned dcf77invInp  [extern]
```

Inverted DCF77 receiver's signal.

In the case of AM (amplitude) modulation a 1 (high) at the signal input dcf77inp means 15% amplitude and a 0 (low) 100% respectively full amplitude, when dcf77invInp is OFF. ON, obviously, means other way round.

default: OFF; see also dcf77inp

5.33.4.5 dcf77PUD

```
unsigned dcf77PUD  [extern]
```

DCF77 input's pull resistor setting.

default: PI_PUD_KEEP; see also dcf77inp

5.33.4.6 dcf77glitch

```
unsigned dcf77glitch  [extern]
```

DCF77 input's glitch filter time setting.

The value for pigpiod's input filter time in μs. The allowed range is 0 ... 30000. The filtering only works for pins sampled by a callback function (like dcf77receiveRec()).

default: 0; glitch filter off; see also dcf77inp

5.33.4.7 dcf77lastLevel

```
unsigned dcf77lastLevel  [extern]
```

Last DCF77 modulation level.

ON means 15% modulation amplitude; i.e. the signal.
OFF means 100% amplitude; i.e. just the 77,5 kHz carrier.

This variable is set by the receiver (callback) function and must not be modified by user software.

5.33.4.8 timDiscP

```
durDiscrPointData_t timDiscP[5]  [extern]
```

Discrimination values for the 15% modulation time.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::tim values.
The only good outcomes of discrimination are indices (durDiscrPointData_t::i) 1 and 3 meaning a recognisable bit 0 respectively 1.
Hint: index bit 0 set means no error.
Hint2: Name ending with P means designed for low grade AM receiver modules. The criteria values are extended quite far for guessing the meaning in the presence of timing faults. Spikes would have to be filtered in a next stage by combining two to four faulty periods in one. Low grade receivers would be not usable without such (complex) filter algorithms.

5.33.4.9 perDiscP

```
durDiscrPointData_t perDiscP[5]  [extern]
```

Discrimination values for the modulation period.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::per values.
The only good outcomes of discrimination are indices (durDiscrPointData_t::i) 1 and 3 meaning an acceptable 1s respectively 2s period.
Hint: See hints at timDiscP.

5.33.4.10 timDiscH

```
durDiscrPointData_t timDiscH[5]  [extern]
```

Discrimination values for the 15% modulation time.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::tim values.
The good outcomes have indices (durDiscrPointData_t::i) 1 and 3 meaning a recognisable bit 0 (FALSE) respectively 1 (TRUE).
Hint: index bit 0 set means no error.

Hint2: Name ending with H means designed for high grade AM receiver modules with virtually no timing faults or spikes. Hence, the criteria values are relatively tight, to recognise EMI or short outages as such. Trying to interpret those with filter algorithms may not be worth the effort with good receivers.

Hint3: Some lower grade AM receiver modules were enhanced with an inverting NPN transistor stage with a low capacity collector to ground capacitor implemented by three meter shielded signal and supply cable. This adding of a simple inverter stage is recommended for all receiver modules not equipped with an open collector (OC) output stage. And for some of them its a necessary filter stage.

5.33.4.11 timDiscHs

```
durDiscrPointData_t timDiscHs[5]  [extern]
```

Discrimination values for the 15% modulation time.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::tim values.
It is the same as timDiscH except for the extra note/hint 4.

Hint 4: The price for turning bad to good receivers by the circuit of Hint 3 was good pulses shortened well below 100 respectively 200 ms. Therefore this table allows for such shortened pulses noting it by the name's suffix s.

5.33.4.12 perDiscH

```
durDiscrPointData_t perDiscH[5]  [extern]
```

Discrimination values for the modulation period.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::per values.
The only good outcomes of discrimination are indices (durDiscrPointData_t::i) 1 and 3 meaning an acceptable 1s respectively 2s period.
Hint: See hints at timDiscHs.

5.33.4.13 perDiscUsed

```
durDiscrPointData_t* perDiscUsed  [extern]
```

Discrimination values for the modulation period used.

This is a pointer to an array of fixed length 5 to discriminate dcf77recPerData_t::per values. The purpose is to hold the current filter values.
default: perDiscP

5.33.4.14 timDiscUsed

```
durDiscrPointData_t* timDiscUsed  [extern]
```

Discrimination values for the 15% modulation time.

This is a pointer to an array of fixed length 5 to discriminate dcf77recPerData_t::per values. The purpose is to hold the current filter values.
default: timDiscP

5.33.4.15 curBCDnum

```
unsigned curBCDnum  [extern]
```

Number decoded from period sequence parts.

This variable holds the (current) number evaluated by considering the sequence of disc5(timDiscUsed, modulation↩ Time) in question. Here, with number sequences a false (level 1, 'F') means 0 and a true (level 3, 'T') means 1, 2, 4, 8, 10, 20, 40 or 80 depending on the place within the BCD coded number. Any other level (0 spike, 3 undef, 4 error) invalidates the whole number.
Values 0..99 (max year) are OK, a value above means an error in the sequence.

See also

disc5 timDiscUsed timDiscHs

5.33.4.16 numBCDinit

```
unsigned const numBCDinit[5]  [extern]
```

Initialisation or least significant BDC digit for modulation time.

For the durDiscrPointData_t i value as index this constant array yields 0 or 1 — or respectively 2, 4 , 8, 10, 20, 40, 60 and 80 — for valid times and a high error value else.
The rationale is just adding up yields a correct value in the BCD range of 0 .. 99 while any higher value means error.

See also

timDiscUsed timDiscHs disc5() curBCDnum

5.34 include/weEcarLd.h File Reference

Some functions for E-Car loading on a Raspberry Pi using pigpiod.

```
#include "weGPIOd.h"
#include "sweetHome2.h"
```

Macros

- #define **DEF_BEG_PHASES**
  E-Car AC loading start value: 3 phases.
- #define DEF_CP_INVERTED
  CHS_CP_INVERTED: CP signal PWM is inverted.
- #define DEF_CP_OFFSET
  CHS_CP_OFFSET: CP signal PWM correction offset.
- #define **DEF_CURRENT_LIM_BEG**
  E-Car start loading imit 8.7A per phase.
- #define **DEF_MAX_PHASES**
  current station offers (max.) 3 phases 6 for test

Functions

- int chsItoDutyC (float ldCurrLim)
  Calculate CP dutycycle for current limit per phase.
- void initAsCPilot (int thePi, unsigned gpio, uint8_t init)
  Initialise a GPIO pin as pilot drive.
- void setChStControl (float ldCurrLim)
  Control E-Car charging current limit per phase by PWM.
- float setChStLimit (float ldCurrLim)
  Set and get E-Car charging current limit per phase.
- uint8_t setChStNoPhases (uint8_t assumedNofPhases)
  Set and get charging E-Car's actual number of phases.
- void setCPilot (uint8_t set)
  Set CP signal to constant ON or OFF.
- void setCPilotPWM (int duty)
  Set CP signal PWM.

5.34.1 Detailed Description

Some functions for E-Car loading on a Raspberry Pi using pigpiod.
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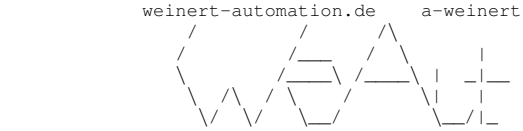
weinert-automation.de a-weinert.de



Revision history
Rev. 253 7.10.2023
Rev. 253 07.09.2023 : new

GPIO usage

an input: connected to the charging station and not ready for charging
an input: line power fed to car by a contactor
an output: CP signal as TTL to be amplified to +/-12V ba EVSE)

Note: All three signals between Pi and the load controller (EVSE, Electric Vehicle Supply Equipment) should be fed over optocouplers. Those might (preferably) be integrated in the EVSE.

Values for the loading equipment are defined by default macros defined here with named starting by DEF_ (like e.g. DEF_CURRENT_LIM_MAX 34.0). This default can be overridden in earlier include file by defining a marcro starting with CHS_ instead (like e.g. CHS_CURRENT_LIM_MAX 16.0).

Default values:

```
CHS_CURRENT_LIM_MAX  34.0  A per phase  (CHS_CURRENT_LIM_MIN fixed 6.0 A)
CHS_CURRENT_LIM_BEG   8.7  A per phase
CHS_BEG_PHASES          3  phases start value
CHS_MAX_PHASES          3  phases maximum
CHS_CP_OFF_LEV          1  1:    +12V is constant off, -1:  -12V
CHS_CP_OFFSET           0  &permil; or
CHS_CP_INVERTED         0  not inverted TTL hi outputs +12V
```

5.34.2 Macro Definition Documentation

5.34.2.1 DEF_CP_OFFSET

```
#define DEF_CP_OFFSET
```

CHS_CP_OFFSET: CP signal PWM correction offset.

The CP signal's duty cycle to E-car (+/-12V) might deviate from the s control signal (TTL).
Example: If the CP's On state is 3.3% resp. 33‰ or 33ider than the TTL signal, the latter will have to be corrected by 33‰. This number (-33) would then be the value of CHS_CP_OFFSET.

The default 0 assumes (almost) perfect symmetry of the signal change propagation. Note: CHS_CP_OFFSET 0 will slightly shorten the code.

5.34.2.2 DEF_CP_INVERTED

```
#define DEF_CP_INVERTED
```

CHS_CP_INVERTED: CP signal PWM is inverted.

In the not inverted case (0) CP signal = LO would output -12V and hi +12V. In the inverted case (1) it's the over way round. This is a fixed property of the EVSE electronic and the connection to the PI.

The default for CHS_CP_INVERTED is 0 = not inverted.
If otherwise define CHS_CP_INVERTED as 1 in an earlier include file.

5.34.3 Function Documentation

5.34.3.1 initAsCPilot()

```
void initAsCPilot (
            int thePi,
            unsigned gpio,
            uint8_t init )
```

Initialise a GPIO pin as pilot drive.

This function initialises the GPIO pin like initAsHiDrive() and (additionally) sets the PWM frequency to 1kHz and the duty cyle range to 0..1000. The parameter init when 0 (FALSE) sets the CP output to -12V signalling EVSE being not ready. init when 1 (TRUE) sets the CP output to +12V signalling EVSE ready.

This function must be called before all other CP control functions, as it sets the CP's GPIO henceforth.

A value outside this range will turn the 1kHz CP signal off; see CHS_CP_OFF_LEV.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)
init	0: off (-12V) 1: on (+12V)

5.34.3.2 setCPilot()

```
void setCPilot (
            uint8_t set )
```

Set CP signal to constant ON or OFF.

This function sets the CP either constant ON (+12V) or OFF (-12V). It will stop any 1kHz square wave.

Parameters

set	0: off (-12V) 1: on (+12V)

5.34.3.3 setCPilotPWM()

```
void setCPilotPWM (
            int duty )
```

Set CP signal PWM.

This function sets the CP duty cycle in the range 0..1000‰ applying offset (CHS_CP_OFFSET) and inversion (CHS_CP_INVERTED) if applicable.

Note: 50‰ (5%) signals the of a digital protocol (not implemented here).
The range for signalling current limit per phase is 10..970‰; see chsItoDutyC(float).

Parameters

duty	dutycycle in ‰ (parts per mille)

5.34.3.4 chsItoDutyC()

```
int chsItoDutyC (
            float ldCurrLim )
```

Calculate CP dutycycle for current limit per phase.

The IEC CP dutycycle(current) curve will be applied and the outcome limited to 100..970‰ resp. 6..80A per phase.

This function just implements the standard and its limits, that is without offsets or inversion in the CP signal handling. Those, if applicable will be handled by setCPilotPWM(int) and setChStControl(float).

Parameters

ldCurrLim	the current limit

Returns

dutycycle in ‰ (per mille)

5.34.3.5 setChStControl()

```
void setChStControl (
            float ldCurrLim )
```

Control E-Car charging current limit per phase by PWM.

This function sets the the control pilot (CP) PWM signal to the charging station.

This function should only be called with a current value within actual limits (6...32A, e.g.). It only limits the CP duty cycle to the range 10..97% corresponding to 6..80A.

Parameters

ldCurrLim	current limit in A per phase

5.34.3.6 setChStNoPhases()

```
uint8_t setChStNoPhases (
            uint8_t assumedNofPhases )
```

Set and get charging E-Car's actual number of phases.

This function sets the (assumed) number of phases for E-Car AC charging in the range 1..CHS_MAX_PHASES. The default is CHS_BEG_PHASES.

The value set will be used to calculate and eventually limit the maximum loading power. The real number of phases depends on the car(s) connected.

Warning: There exist E-car types using only one phase even when offered three!

Parameters

assumedNofPhases	number of phases 1.. CHS_MAX_PHASES

Returns

the (new) number of phases

5.34.3.7 setChStLimit()

```
float setChStLimit (
            float ldCurrLim )
```

Set and get E-Car charging current limit per phase.

This function sets the charging stations current limit in the range 6.0 ... CHS_CURRENT_LIM_MAX.

Note: This function just sets/changes the internal limit value. It will not influence any signal (CP) to the EVSE.

Parameters

ldCurrLim	load current in A (per phase)

Returns

the (new) current limit

5.35 include/weGPIOd.h File Reference

IO functions for Raspberry Pis.

```
#include "arch/config.h"
#include "weUtil.h"
#include <pigpiod_if2.h>
```

Macros

- #define PI_PUD_DEFAULT

  Leave pull resistor setting as defaulted.
- #define PI_PUD_KEEP

  Leave pull resistor setting unchanged.
- #define PINig

  Defines a disabled GPIO.

Functions

- uint8_t gpio4pin (int const pin)

  Pin number to GPIO number lookup.
- void initAsDrive (int thePi, unsigned gpio, unsigned init)

  Initialise a GPIO pin as output.
- void initAsHiDrive (int thePi, unsigned gpio, unsigned init)

  Initialise a GPIO pin as high drive.
- void initAsHiInput (int thePi, unsigned gpio)

  Initialise a GPIO pin as input with pull down.
- void initAsInput (int thePi, unsigned gpio)

  Initialise a GPIO pin as input.
- void initAsInputs (unsigned const lesGPIOs[ ])

  Initialise one or more GPIO pin as input.
- void initAsLoInput (int thePi, unsigned gpio)

  Initialise a GPIO pin as input with pull up.
- uint32_t initAsOutput (int thePi, unsigned gpio)

  Initialise a GPIO pin as output.
- uint32_t initAsOutputs (unsigned const lesGPIOs[ ])

  Make one or more GPIO pins output.
- uint8_t pin4GPIO (int const gpio)

  GPIO number to pin number lookup.

- uint32_t releaseOutputs (int const thePi)

  Release all GPIO pins set as output.
- uint32_t releaseOutputsReport (int const thePi)

  Release all GPIO pins set as output with report.
- void reportPinOp (char const *op, unsigned const lesGpio[])

  Report an arbitrary operation on a list of GPIOs.
- void setOutput (unsigned const gpio, unsigned const level)

  Set a GPIO output pin.
- void setOutputs (uint32_t const lesOuts, unsigned const level)

  Set a list/mask of GPIO output pins.
- void setPadStrength (int thePi, unsigned mA)

  Set the output drive capacity of GPIO ports 0..27.

Variables

- uint32_t const gpio2bit [36]

  GPIO number to bank pin number lookup.
- uint8_t const gpio2pin [ ]

  GPIO number to pin number lookup.
- uint8_t const pin2gpio [44]

  Pin number to GPIO number lookup.
- char const **pudTxt** [5][6]

  Names for input's pull resistor settings.
- int thePi

  The standard Pi for gpio(d) IO of the program.

5.35.1 Detailed Description

IO functions for Raspberry Pis.

```
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weinert-automation.de         a-weinert.de
    /         /      /\
   /         /___   /  \      |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  55 9.10.2023
Rev.  232 12.08.2020 :  common functions collected and consolidated
Rev.  233 12.10.2020 :  initAsHiInput() added
Rev.  237 01.03.2021 :  documentation (Doxygen) corrected/improved
Rev.  251 15.08.2023 :  documentation corrected/improved
Rev.  252 17.08.2023 :  ECar loading ++
```

The IO functions will work with the gpio/gpiod library – daemon running – as defined in pigpiod_if2.h.

This is a supplementary basic library to be used in conjunction with the pigpio library (linked by: -lpigpiod_if2 -lrt).

5.35.2 Macro Definition Documentation

5.35.2.1 PI_PUD_KEEP

```
#define PI_PUD_KEEP
```

Leave pull resistor setting unchanged.

This is an illegal value (4) just one above the legal ones (0..2). Its purpose is to state the current whatever pull setting shall be left untouched.

5.35.2.2 PI_PUD_DEFAULT

```
#define PI_PUD_DEFAULT
```

Leave pull resistor setting as defaulted.

This is an illegal value (3) just one above the legal ones (0..2). Its purpose is to state that an otherwise defined default value shall be used. If no such default value is known, the current pull setting shall be left untouched.

5.35.2.3 PINig

```
#define PINig
```

Defines a disabled GPIO.

This is an illegal GPIO value (33) which some IO functions recognise as "disabled". Hence they can be just called in the normal program flow doing no I/O on a disabled port.

5.35.3 Function Documentation

5.35.3.1 pin4GPIO()

```
uint8_t pin4GPIO (
            int const gpio )
```

GPIO number to pin number lookup.

Parameters

gpio	a GPIO number (>= 0) available on the Pi's 40 respectively 26 pins IO connector

Returns

the GPIO's pin number (1..40 resp. 26) on the IO connector;
0 means not available in the Pi IO connector or even undefined

5.35.3.2 gpio4pin()

```
uint8_t gpio4pin (
            int const pin )
```

Pin number to GPIO number lookup.

Parameters

pin	1..40 (26) is the legal IO connector pin number

Returns

0..56 the GPIO number; 90: ground (0V);
93: 3.3V; 95: 5V; 99: undefined, i.e. illegal pin number

5.35.3.3 initAsInputs()

```
void initAsInputs (
            unsigned const lesGPIOs[] )
```

Initialise one or more GPIO pin as input.

This functions sets the pins listed as GPIOs to input mode. This is also used to release them from any output modes as input means hi impedandance.

The Pi for the IO operation is thePi.

Parameters

lesGPIOs	array of GPIO numbers (0..53); use 0x7F as end marker

5.35.3.4 reportPinOp()

```
void reportPinOp (
            char const * op,
            unsigned const lesGpio[] )
```

Report an arbitrary operation on a list of GPIOs.

The report lines on outLog will be
`progNam  ___operation GPIO: 13 pin:  27`

Parameters

op	the operation displayed as 12 characters right justified.
lesGpio	a GPIO list (terminated by a value $>$ 56)

5.35.3.5 initAsOutputs()

```
uint32_t initAsOutputs (
            unsigned const lesGPIOs[] )
```

Make one or more GPIO pins output.

This functions sets the pins listed as GPIOs to output mode.
Normally, at program end, the same list of outputs should be released to high impedance by initAsInputs().

The Pi for the IO operations is thePi.

Parameters

lesGPIOs	array of GPIO numbers (0..53); use 0x7F as end marker

Returns

the bank mask of the outputs set so by this function; 0 means non set (complete failure)

5.35.3.6 setOutputs()

```
void setOutputs (
            uint32_t const lesOuts,
            unsigned const level )
```

Set a list/mask of GPIO output pins.

This functions sets the (output) pins set in the bank mask ON or OFF.

The Pi for the IO operations is thePi.

Parameters

lesOuts	bank mask of outputs to be set
level	OFF or ON (0 or 1)

5.35.3.7 setOutput()

```
void setOutput (
            unsigned const gpio,
            unsigned const level )
```

Set a GPIO output pin.

This functions sets an output pin gpio ON or OFF.
If gpio is $>$ 31 nothing is done. That handles the meaning of gpio 33 (within a bank) as unused.

The Pi for the IO operations is thePi.

Parameters

gpio	an output pin (that should have been set as such!)
level	OFF or ON (0 or 1)

5.35.3.8 initAsOutput()

```
uint32_t initAsOutput (
            int thePi,
            unsigned gpio )
```

Initialise a GPIO pin as output.

This sets a GPIO as output and puts it in the list of GPIOs used as outputs by the program if in the range of 0..31 (resp. 2..27).

All functions setting setting as output should use this function.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..31); PINig means no action

Returns

the bank mask of this output if set (0 no action or error)

5.35.3.9 releaseOutputs()

```
uint32_t releaseOutputs (
            int const thePi )
```

Release all GPIO pins set as output.

This releases all GPIO in the range 0..27 that this program has set as outputs (by setting those as inputs).
The order of this operation is by increasing GPIO number. If another order or extra actions are required this must be done before or afterwards.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)

Returns

the bank mask of the previous resp. released outputs

5.35.3.10 releaseOutputsReport()

```
uint32_t releaseOutputsReport (
            int const thePi )
```

Release all GPIO pins set as output with report.

Same as releaseOutputs() plus a "releaseToIn" for every output released.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)

Returns

the bank mask of the previous resp. released outputs

5.35.3.11 initAsInput()

```
void initAsInput (
            int thePi,
            unsigned gpio )
```

Initialise a GPIO pin as input.

This sets a GPIO as input and removes it form the list of GPIOs set as output if in the range of 0..31 (resp. 2..27).

All functions setting as input should use this function.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)

5.35.3.12 initAsLoInput()

```
void initAsLoInput (
            int thePi,
            unsigned gpio )
```

Initialise a GPIO pin as input with pull up.

This initialisation is for an input sensing a switch (button) or transistor (optocoupler) connected to ground (gnd, 0V). This is the normal configuration instead of switching to Hi (3.3V).
In most of the cases the Pi's internal pull up resistor (about 50 kOhm) is sufficient for Lo-switches and should then be used.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)

5.35.3.13 initAsHiInput()

```
void initAsHiInput (
            int thePi,
            unsigned gpio )
```

Initialise a GPIO pin as input with pull down.

This initialisation is for an input sensing an electronic device delivering a voltage about 3 V when active respectively ON. Some of those devices require a pull down to deliver clean signals.
The Pi's internal pull down resistor (about 50 kOhm) may be sufficient for Hi-switches and should then be used.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)

5.35.3.14 initAsHiDrive()

```
void initAsHiDrive (
            int thePi,
            unsigned gpio,
            unsigned init )
```

Initialise a GPIO pin as high drive.

Of course, Raspberry's (BCM2837's) GPIO pins are high and low drivers as output. Hi-drive is provided by turning on pull-up as to allow broken wire diagnosis when shortly switching to input.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)
init	0 or 1: the initial output value; else: leave unchanged

5.35.3.15 initAsDrive()

```
void initAsDrive (
            int thePi,
            unsigned gpio,
            unsigned init )
```

Initialise a GPIO pin as output.

This function sets the GPIO pi as output, optionally sets the drive capacity and leaves a pull resistor setting unchanged.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)
init	0 or 1: the initial output value; else: leave unchanged

5.35.3.16 setPadStrength()

```
void setPadStrength (
            int thePi,
            unsigned mA )
```

Set the output drive capacity of GPIO ports 0..27.

For pins set as output (by initAsHiDrive() or initAsDrive() e.g.) this function sets the drive capacity in the range of 2..16 mA.
Note 1: All 27 pins get the same common value. Hence, one has to set the maximum needed for any pin.
Note 2: This value is no current limit nor pin overload protection. It is the maximum load current, which a valid 0 or 1 output voltage can be guaranteed under. Note 3: The BCM processor can set the strength in 2mA steps (2, 4.. 14, 16). Nevertheless, this function accepts all values 2..16 incrementing odd values.

Parameters

the↩ Pi	the Raspberry's identifier as got from initialising gpio(d)
mA	2..16: output drive capacity for providing legal low or high; else: leave drive capacity unchanged

5.35.4 Variable Documentation

5.35.4.1 gpio2pin

```
uint8_t const gpio2pin[]  [extern]
```

GPIO number to pin number lookup.

Index [0..39] is a GPIO number available on the Pi's 40 (26) pins connector. Result 1..40: The GPIO's pin number on the IO connector;
0: not available in the Pi IO connector or even undefined
Outside [0..39] index out of bound.
See also gpio2bit, pin2gpio

5.35.4.2 gpio2bit

```
uint32_t const gpio2bit[36]  [extern]
```

GPIO number to bank pin number lookup.

Index [0..31] is a GPIO number partly (2..27) available on the Pi's 40 (26) pins connector. Result 0x00000001..0x80000000: a 32 bit with exactly one bit set corresponding to place in a 32 bit bank mask.
Outside [0..31] index out of bound.
See also gpio2pin, pin2gpio

5.35.4.3 pin2gpio

```
uint8_t const pin2gpio[44]  [extern]
```

Pin number to GPIO number lookup.

Index [1..40 (26)] is the legal pin number.
Result 0..56: GPIO number; 90: ground (0V); 93: 3.3V; 95: 5V;
99: undefined (for pin 0 and 41 (27)..44).
Outside [0..43] index out of bound.
See also gpio2bit, gpio2pin

5.35.4.4 thePi

```
int thePi  [extern]
```

The standard Pi for gpio(d) IO of the program.

This global variable is provided to hold the main pi used by a program doing process IO via piGpIO[d]. In most local use cases
```
thePi = pigpio_start(NULL, NULL);
```

it will be 0 = this local Pi. After usage don't forget to terminate the connection to the pigpio daemon by
```
pigpio_stop(thePi);
```

5.36 include/weLockWatch.h File Reference

Process control helpers for Raspberry Pi: lock and watchdog.

```
#include "sysBasic.h"
#include <sys/file.h>
```

Functions

- void **closeLock** (void)

  Unlock the lock file

- int initWatchdog (void)

  Get and initialise or arm the watchdog.
- int justInitWatchdog (void)

  Get and initialise or arm the watchdog.
- int justLock (char const *lckPiGpioFil)

  Open and lock the lock file.
- int openLock (char const *lckPiGpioFil, uint8_t const perr)

  Open and lock the lock file.
- void stopWatchdog (void)

  Stop and disarm the watchdog.
- void triggerWatchdog (void)

  Trigger the watchdog.

Variables

- int lockFd

  Lock file handle.
- int useIOlock

  Do use IO lock.
- int useWatchdog

  flag to use watchdog; default ON

5.36.1 Detailed Description

Process control helpers for Raspberry Pi: lock and watchdog.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  55 9.10.2023
Rev.  227 12.08.2020 :  common functions collected and consolidated
Rev.  243 09.09.2022 :  typo
```

This is a supplementary basic library to handle locks and a watchdog.

5.36.2 Function Documentation

5.36.2.1 justLock()

```
int justLock (
             char const * lckPiGpioFil )
```

Open and lock the lock file.

This function is the basic implementation of openLock. Applications not wanting its optional logging or doing their own should use this function directly.

Parameters

lckPiGpioFil	lock file name

Returns

0: OK, locked; 97: fd does not exist; 98: can't be locked

5.36.2.2 openLock()

```
int openLock (
             char const * lckPiGpioFil,
             uint8_t const perr )
```

Open and lock the lock file.

This function may use logging and streams not available on smaller applications. Those applications not wanting that optional logging or doing their own should use the function justLock().

Parameters

lckPiGpioFil	lock file path name
perr	make error message when lock file does not exist or can't be locked

Returns

0: OK, locked; 97: fd does not exist; 98: can't be locked

5.36.2.3 initWatchdog()

```
int initWatchdog (
            void  )
```

Get and initialise or arm the watchdog.

If the watchdog is to be used, i.e. useWatchdog is ON. this function tries to get it. Otherwise it does nothing but return 0 (success).

On no success 1 is returned and useWatchdog is set OFF and the misfortune is logged. Use justInitWatchdog() :: for silence.

Returns

0: watchdog OK or not to be used (useWatchdog OFF); 1: error while trying to get the watchdog

5.36.2.4 justInitWatchdog()

```
int justInitWatchdog (
            void  )
```

Get and initialise or arm the watchdog.

This function justInitWatchdog() is the basic implementation of initWatchdog() without logging failure.

Returns

0: watchdog OK or not to be used (useWatchdog OFF); 1: error while trying to get the watchdog

5.36.2.5 stopWatchdog()

```
void stopWatchdog (
            void  )
```

Stop and disarm the watchdog.

If the watchdog is to be used, i.e. useWatchdog is ON, this function stops and disarms it.
useWatchdog is then OFF .

5.36.2.6 triggerWatchdog()

```
void triggerWatchdog (
            void  )
```

Trigger the watchdog.

If the watchdog is to be used, i.e. useWatchdog is ON, this function triggers it.
If the watchdog is armed (by initWatchdog()) not triggering it at least once about every 15 s will lead to system reset.

5.36.3 Variable Documentation

5.36.3.1 useIOlock

```
int useIOlock  [extern]
```

Do use IO lock.

When ON (default) justLock, openLock and closeLock try to fulfil their mission. When OFF they do nothing (except saying OK). flag to use IO (singleton) lock; default on

Do use IO lock.

5.36.3.2 lockFd

```
int lockFd  [extern]
```

Lock file handle.

Do not use directly.

5.36.3.3 useWatchdog

```
int useWatchdog  [extern]
```

flag to use watchdog; default ON

flag to use watchdog; default ON

5.37 include/weModbus.h File Reference

Modbus functions for Raspberry Pis.

```
#include <modbus-private.h>
#include <modbus.h>
#include "weUtil.h"
```

Data Structures

- struct modRS_t

  Structure for Modbus RS485 (RTU).
- struct modTCP_t

  Structure for Modbus TCP.

Typedefs

- typedef enum modRS485state_t modRS485state_t

  A definition for possible states of a Modbus RS485 interface.

Enumerations

- enum modRS485state_t {
  RS_OFF , RS_ON , RS_INICOM , RS_ERR_ANY ,
  RS_ERR_CTX , RS_ERR_CON , RS_ERR_SLA , RS_ERR_BAD ,
  RS_OFF , RS_ON , RS_INICOM , RS_ERR_ANY ,
  RS_ERR_CTX , RS_ERR_CON , RS_ERR_SLA , RS_ERR_BAD }

  A definition for possible states of a Modbus RS485 interface.

Functions

- void modRSclose (modRS_t ∗modRS)

  Close a Modbus RS link and destroy the (libmodbus) structure.
- int modRSconnect (modRS_t ∗modRS, int currentSlave)

  Connect a the Modbus (libmodbus) structure for RS485 (RTU).
- int modRSctxNew (modRS_t ∗modRS, int currentSlave)

  Make a new Modbus (libmodbus) structure for RS485.
- int modRSswitchSlave (modRS_t ∗modRS, int currentSlave)

  Switch the slave on a connected Modbus (libmodbus) structure for RS485.
- void modTCPclose (modTCP_t ∗modTCP)

  Close a Modbus TCP and destroy the (libmodbus) structure.
- int modTCPconnect (modTCP_t ∗modTCP)

  Connect a the Modbus (libmodbus) structure for TCP.
- int modTCPctxNew (modTCP_t ∗modTCP)

  Make a new Modbus (libmodbus) structure for TCP.
- int modTCPlisten (modTCP_t ∗modTCP)

  Listen at the Modbus (libmodbus) structure for TCP.
- int parseModPort (const char ∗str)

  Parse a string as Modbus TCP port number with checks.
- void reg2val32 (dualReg_t ∗const dest, dualReg_t const ∗const source)

  Copy float (32 bit) Modbus input to correctly ordered value.
- uint16_t regs2string (char ∗dest, uint16_t ∗source, int n)

  Copy a sequence of character pairs from registers to a string.
- void regs2vals32 (float ∗const dest, dualReg_t const ∗const source, int const n)

  Copy n float (32 bit) Modbus input to correctly ordered values.
- int setIP4add (char ∗dest, const char ∗src)

  Set an IPv4 address as string with syntax checks.

5.37.1 Detailed Description

Modbus functions for Raspberry Pis.

```
Copyright (c) 2019 Albrecht Weinert
weinert-automation.de a-weinert.de
```

Revision history

```
Rev. 83 15.05.2025
Rev. 38 22.08.2017 : new
Rev. 187 14.10.2018 : minor typos
Rev. 191 15.02.2019 : minor comment text changes
Rev. 212 04.08.2019 : regs2string added
Rev. 216 31.08.2019 : modRS_t int conErr removed (never used)
Rev. 270 07.11.2024 : the old include before meterpi crash ("BC")
```

This is a supplementary (basic) library. The functions and structures defined here will work with Stéphane Raimbault's Modbus library libmodbus.

Some structures and utilities are to support smart meters like e.g. SDM230Modbus, SMD630Modbus and SDM538Modbus as servers/slaves, especially their handling of (32 bit) float values.

```
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weinert-automation.de a-weinert.de
```

Revision history

```
Rev. 83 15.05.2025
Rev. 38 22.08.2017 : new
Rev. 187 14.10.2018 : minor typos
Rev. 191 15.02.2019 : minor comment text changes
Rev. 212 04.08.2019 : regs2string added
Rev. 216 31.08.2019 : modRS_t int conErr removed (never used)
Rev. 260 06.11.2024 : functions reduced to Modbus RTU for smart meters
```

This was a supplementary (basic) library. The functions and structures defined here did work with Stéphane Raimbault's Modbus library libmodbus.

Some structures and utilities are to support smart meters like e.g. SDM230Modbus, SMD630Modbus and SDM538Modbus as servers/slaves, especially their handling of (32 bit) float values.

5.37.2 Typedef Documentation

5.37.2.1 modRS485state_t

```
typedef enum modRS485state_t modRS485state_t
```

A definition for possible states of a Modbus RS485 interface.

With Modbus TCP one has not to handle the (Ethernet or WLAN) interface. One just has to listen at a port or connect to IPadress:port. The handling of multiple connections on the network is done by the operating system and the network infrastructure.

With an RS485 "bus" connecting Modbus devices it's different. Every device's software has to handle the physical interface. Usually only Modbus devices can be at that "bus" — 2 to 247. The communication is client request --> server response (as always), but request response pairs to/from different servers cannot overlap. (Additionally the telegrams are short and slow.)

Hence with RS485 (RTU) the handling of multiple (server) connections has to be implemented in the client application, and the RS485 interface/bus state has to be separated from (multiple) server-link states.
With RS232 the complications and disadvantages are the same while being restricted to point to point (P2P, no bus).

5.37.3 Enumeration Type Documentation

5.37.3.1 modRS485state_t

```
enum modRS485state_t
```

A definition for possible states of a Modbus RS485 interface.

With Modbus TCP one has not to handle the (Ethernet or WLAN) interface. One just has to listen at a port or connect to IPadress:port. The handling of multiple connections on the network is done by the operating system and the network infrastructure.

With an RS485 "bus" connecting Modbus devices it's different. Every device's software has to handle the physical interface. Usually only Modbus devices can be at that "bus" — 2 to 247. The communication is client request --> server response (as always), but request response pairs to/from different servers cannot overlap. (Additionally the telegrams are short and slow.)

Hence with RS485 (RTU) the handling of multiple (server) connections has to be implemented in the client application, and the RS485 interface/bus state has to be separated from (multiple) server-link states.
With RS232 the complications and disadvantages are the same while being restricted to point to point (P2P, no bus).

Enumerator

RS_OFF	do not use Modbus RS485 link (no ctx structure made)
RS_ON	may be usable, but totally uninitialised (no com.)
RS_INICOM	initialised (ready for communication)
RS_ERR_ANY	no concrete error, lower bound of all error states
RS_ERR_CTX	no structure made (hopeless when re-occurring)
RS_ERR_CON	open serial failed
RS_ERR_SLA	any slave error requiring re-open
RS_ERR_BAD	recurring error in usage (try conn. re-init)

5.37.4 Function Documentation

5.37.4.1 modTCPctxNew()

```
int modTCPctxNew (
            modTCP_t * modTCP )
```

Make a new Modbus (libmodbus) structure for TCP.

This function makes a new modTCP.ctx according to .addr and .port; it does NOT check NOR change .mlStat.

Parameters

modTCP	pointer to modTCP_t structure to be used

Returns

0 : OK; -1: error

5.37.4.2 modTCPconnect()

```
int modTCPconnect (
            modTCP_t * modTCP )
```

Connect a the Modbus (libmodbus) structure for TCP.

This function makes a new modTCP.ctx according to .addr and .port, if not yet made. Then it "connects" it. On success 0 is returned. On failure -1 is returned and modTCP.ctx will be destroyed.

This function does NOT check NOR change .mlStat.

Parameters

modTCP	pointer to modTCP_t structure to be used

Returns

0 : OK; -1: error

5.37.4.3 modTCPlisten()

```
int modTCPlisten (
            modTCP_t * modTCP )
```

Listen at the Modbus (libmodbus) structure for TCP.

This function makes a new modTCP.ctx according to .addr and .port, if not yet made. Then it "listens" on it. On success .s >= 0, that is the socket, is returned. On failure -1 is returned and modTCP.ctx will be destroyed. The number of connections is limited to one, here.

This function does NOT check NOR change .mlStat.

Parameters

modTCP	pointer to modTCP_t structure to be used

Returns

>=0 : OK, i.e the socket andmodTCP.s; -1: error

5.37.4.4 modTCPclose()

```
void modTCPclose (
            modTCP_t * modTCP )
```

Close a Modbus TCP and destroy the (libmodbus) structure.

This function closes the connection (if on) and destroys modTCP.ctx (if existing) .mlStat will be set to ML_OFF.

Parameters

modTCP	pointer to modTCP_t structure to be used

5.37.4.5 setIP4add()

```
int setIP4add (
            char * dest,
            const char * src )
```

Set an IPv4 address as string with syntax checks.

This function sets the parameter dest with src, doing syntactic checks to assure a valid IPv4 address being set.

Parameters

dest	the strtring to copy the IP address to
src	the IP string to copy to dest; NULL acts as "0.0.0.0"

Returns

0: syntax error or dest is NULL, dest unchanged; 1: OK

5.37.4.6 parseModPort()

```
int parseModPort (
            const char * str )
```

Parse a string as Modbus TCP port number with checks.

This function parses the string src as Modbus port number, doing validity checks: src must be a decimal number 502 or 1024..65535.

Parameters

str	the string to parse as (decimal) modPort; NULL acts as 502

Returns

0: syntax error, else valid Modbus port number (see above)

5.37.4.7 modRSctxNew()

```
int modRSctxNew (
            modRS_t * modRS,
            int currentSlave )
```

Make a new Modbus (libmodbus) structure for RS485.

This function makes a new modTCP.ctx according to .addr and .port; it does NOT check NOR change .rsState.

Parameters

modRS	pointer to modRS_t structure to be used
currentSlave	1..247 sets the slave number; sets .currentSlave

Returns

0 : OK; else: error: -1: modRS null; -2: slave number: -3: no ctx

5.37.4.8 modRSconnect()

```
int modRSconnect (
            modRS_t * modRS,
            int currentSlave )
```

Connect a the Modbus (libmodbus) structure for RS485 (RTU).

This function makes a new modRS.ctx according to .device and else. Then it "connects" it. On success 0 is returned. On failure -1 is returned and modTCP.ctx will be destroyed.

This function does NOT check NOR change .rsState.

Parameters

modRS	pointer to modRS_t structure to be used
currentSlave	if 1..247; sets the slave number to be used next and changes .currentSlave

5.37.4.9 modRSswitchSlave()

```
int modRSswitchSlave (
            modRS_t * modRS,
            int currentSlave )
```

Switch the slave on a connected Modbus (libmodbus) structure for RS485.

This function changes nothing on a functional and connected modRS.ctx setting than the slave number.

Modbus RS485 (RTU) can handle multiple slaves on the same serial interface. This has to be one at a time in a pure sequential matter: hence this slave switching.
With RS232 the one slave's number once correctly established would stay fixed.

Unfortunately (by a libmodbus deficiency) a communication error of one slave would require a total new connect (modRSconnect()) for all slaves; switching to a "good slave" won't help.

Parameters

modRS	pointer to modRS_t structure to be used
currentSlave	if 1..247; sets .currentSlave

Returns

-1: error wrong parameter or no modRS; 0: no change or no ctx; 1..247: changed currentSlave; OK

5.37.4.10 modRSclose()

```
void modRSclose (
            modRS_t * modRS )
```

Close a Modbus RS link and destroy the (libmodbus) structure.

This function destroys modRS.ctx (if existing). .rsState will not be changed.

Parameters

modRS	pointer to modRS_t structure to be used

5.37.4.11 reg2val32()

```
void reg2val32 (
            dualReg_t *const dest,
            dualReg_t const *const source )
```

Copy float (32 bit) Modbus input to correctly ordered value.

This function copies a 32bit (e.g.) float value input from Modbus — with correct byte ordering at 16 bit level (!) — to a correctly ordered (32 bit) value.
Destination and source pointers may be the same, but not NULL.
The swap of the 16-bit parts only occurs, when the platform is little endian.
See also: PLATFlittlE and regs2vals32()

Parameters

dest	the dual registers to store the result in
source	the dual registers with the potentially wrong endianess

5.37.4.12 regs2vals32()

```
void regs2vals32 (
            float *const dest,
            dualReg_t const *const source,
            int const n )
```

Copy n float (32 bit) Modbus input to correctly ordered values.

This function copies n 32bit (e.g.) float values input from Modbus — with correct byte ordering at 16 bit level (!) — to correctly ordered (32 bit) values.
Destination and source pointers may be the same, but not NULL.
The swap of the 16-bit parts only occurs, when the platform is little endian.
See also: PLATFlittlE and reg2val32()

Parameters

dest	the array of dual registers to store the result in
source	the array of dual registers with potentially wrong endianess
n	the number of dual registers to treat

5.37.4.13 regs2string()

```
uint16_t regs2string (
            char * dest,
            uint16_t * source,
            int n )
```

Copy a sequence of character pairs from registers to a string.

Growatt inverter holding registers, for example, deliver strings as pairs of ASCII characters in consecutive registers. If the number of characters is odd the last register holds just one character. Some of those strings in registers are 0-terminated and some are not. In the first case the transfer stops at the 0, in the latter case a 0 is appended to the destination string as n+1st character.
The sequence of the two characters in each register is (as usual with Modbus) in wrong order. Hence, memcopy and consorts would fail.

Parameters

dest	the array of characters to store the result in
source	the array registers with wrong character sorting
n	the number of dual registers to treat

Returns

the number of characters transfered to dest including the terminating 0

5.38 include/weSerial.h File Reference

Definitions for Raspberry Pi's serial communication.

```
#include "arch/config.h"
#include <termios.h>
#include "sysBasic.h"
#include <fcntl.h>
#include <unistd.h>
```

Functions

- tcflag_t baudFlag (unsigned int const speed)

  Baud flags by baud rate.
- unsigned int baudRate (tcflag_t baudFlag)

  Baud rate by baud flags.
- void closeUART ()

  Close the UART.
- int openUART ()

  Open the UART with given settings.

Variables

- tcflag_t **baud**

  The UART's baud rate as flag bits.
- struct termios **options**

  The UART's setting structure.
- unsigned int **speed**

  The UART's baud rate as value.
- timespec **startReceive**

  Time used for receive timing.
- int uartFilestream

  The UART as file (stream).
- char * uartPath

  The UART's path name.

5.38.1 Detailed Description

Definitions for Raspberry Pi's serial communication.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  75 19.02.2025
Rev.  209 09.07.2019 :  new
```

This is a (basic) library for serial communications. As far as Modbus is or can be supported this is independent of Stéphane Raimbault's Modbus library libmodbus; weModbus.h on the other hand is.

Some structures and utilities are to support smart meters like e.g. SDM230Modbus, SMD630Modbus and SDM538Modbus as servers/slaves, especially their handling of (32 bit) float values.

5.38.2 Function Documentation

5.38.2.1 baudFlag()

```
tcflag_t baudFlag (
            unsigned int const speed )
```

Baud flags by baud rate.

Parameters

speed	a legal baudrate 300 9600 19200 and so on

Returns

the corresponding flag bits if rate is available; otherwise 0 (error). This should be defaulted to a standard rate like 9600 e.g.

5.38.2.2 baudRate()

```
unsigned int baudRate (
            tcflag_t baudFlag )
```

Baud rate by baud flags.

The speed bits of the parameter baudFlag will be evaluated and the corresponding baud rate will be returned. In vase of no valid speed flag value 0 will be returned. 0 may be considered as error and should be defaulted to 9600.

Parameters

baudFlag	the speed bits of the flags parameter will be evaluated

Returns

the corresponding baud rate 300, 9600, 19200 or other standard rate

5.38.2.3 openUART()

```
int openUART ( )
```

Open the UART with given settings.

Returns

uartFilestream; -1 means open error

5.38.2.4 closeUART()

```
void closeUART ( )
```

Close the UART.

uartFilestream will be set to -1.

5.38.3 Variable Documentation

5.38.3.1 uartFilestream

```
int uartFilestream  [extern]
```

The UART as file (stream).

It is $>$ 0 ($>$2) when open and -1 when closed.

5.38.3.2 uartPath

```
char* uartPath  [extern]
```

The UART's path name.

It will be preset with the architecture's standard UART path.

5.39 include/weShareMem.h File Reference

One chunk of shared memory on a Raspberry Pi.

```
#include "weUtil.h"
#include <sys/shm.h>
#include <sys/stat.h>
#include <sys/sem.h>
#include <errno.h>
```

Data Structures

- union semCtlPar_t

  Parameter type for semctl().

Macros

- #define ANZ_SEMAS

  Standard semaphore set size.
- #define **PERM**

  access rights
- #define **SEMAPHORE_KEY**

  Semaphore unique key "Kfig25".
- #define **SHARED_MEMORY_KEY**

  Shared memory key "Buffer25".
- #define SHARED_MEMORY_SIZE

  Sweet home control (meterPi) shared memory size.

Functions

- int deleteSemas ()

  Delete the one semaphore set.
- int deleteSharedMem ()

  Delete and detach the shared memory.
- int **detachSharedMem** ()

  Detach the shared memory.
- int getSemas ()

  Get the one semaphore set.
- int initialiseSemas ()

  Initialise the one semaphore set.
- void * initialiseSharedMem ()

  Initialise shared memory.
- int semaphoreClt (int const semNum, int const op, semCtlPar_t par)

  Control semaphores of the set.
- int semaphoreLock (int const semNum, int ms)

  Lock one semaphore of the set.
- int semaphoreOperation (int const semNum, int const op, int ms)

  Operation on one semaphore of the set.
- int semaphoreUnlock (int const semNum)

  Unlock one semaphore of the set.

Variables

- int semLckErrCnt

  Semaphore lock error count.
- int **shMemErrno**

  Last error number of (some) semaphore operations.
- int shMemSem

  Semaphore set identifier.
- const semCtlPar_t **VAL0**

  value 0 for SETVAL
- const semCtlPar_t **VAL1**

  value 1 for SETVAL
- const semCtlPar_t **VAL9**

  value 9 for SETVAL

5.39.1 Detailed Description

One chunk of shared memory on a Raspberry Pi.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  79 23.03.2025
Rev.    80  11.11.2017 :  new
Rev.  175  28.07.2018 :  beauty
Rev.  191  15.02.2019 :  minor comment text changes
Rev.  270  03.11.2024 :  semphore set & shared memory defined here, only!
Rev.    76  24.02.2025 :  clarification of 64 bit OS malfunction
```

Provide one piece of shared memory to be used by multiple programs on one Pi, e.g. one process control program range and few (cgi) programs for (human) observation and control.

5.39.2 Macro Definition Documentation

5.39.2.1 ANZ_SEMAS

```
#define ANZ_SEMAS
```

Standard semaphore set size.

Standard semaphore set of three (3..10)

Usually three (3..10)

5.39.2.2 SHARED_MEMORY_SIZE

```
#define SHARED_MEMORY_SIZE
```

Sweet home control (meterPi) shared memory size.

It is 1K. 512 byte would be enough, but shared memory segments will probably come as multiples of PAGE_SIZE. With meterPi (32bit Raspbian) and growPi (64bit) the values are 4096.
Get the page size by /code meterPi:∼ $getconf PAGE_SIZE 4096 /endcode

5.39.3 Function Documentation

5.39.3.1 getSemas()

```
int getSemas ( )
```

Get the one semaphore set.

The one semaphore set, if existing, will be registered and used as is.

Returns

0: OK found existing semaphore set; -1: error (errno set and errorText generated)

5.39.3.2 initialiseSemas()

```
int initialiseSemas ( )
```

Initialise the one semaphore set.

The number of semaphores in the set is ANZ_SEMAS (default three). The one semaphore set, if existing, will be registered and used as is. If this is not possible it will be made and initialised.

Hint: This function has two OK return values!

Returns

1: OK semaphore set made new; 0: OK found existing semaphore set; -1: error (errno set and errorText generated)

5.39.3.3 semaphoreOperation()

```
int semaphoreOperation (
            int const semNum,
            int const op,
            int ms )
```

Operation on one semaphore of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)
op	the semaphore operation
ms	if 2..20000 a timeout in ms

Returns

0: OK; -1: error (errno set and errorText generated)

5.39.3.4 semaphoreLock()

```
int semaphoreLock (
            int const semNum,
            int ms )
```

Lock one semaphore of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)
ms	if 2..20000 a timeout in ms

Returns

0: OK; -1: error (errno set and errorText generated)

5.39.3.5 semaphoreUnlock()

```
int semaphoreUnlock (
            int const semNum )
```

Unlock one semaphore of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)

Returns

0: OK; -1: error (errno set and errorText generated)

5.39.3.6 semaphoreClt()

```
int semaphoreClt (
            int const semNum,
            int const op,
            semCtlPar_t par )
```

Control semaphores of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)
op	the semaphore operation, like e.g. SETVAL
par	op's parameter if any

Returns

0: OK; -1: error (errno set and errorText generated)

5.39.3.7 deleteSemas()

```
int deleteSemas ( )
```

Delete the one semaphore set.

Server operation only.

Returns

0: OK; -1: error (errno set and errorText generated)

5.39.3.8 initialiseSharedMem()

```
void * initialiseSharedMem ( )
```

Initialise shared memory.

Make or get and attach. return pointer to attached shared memory or (void *)-1

5.39.3.9 deleteSharedMem()

```
int deleteSharedMem ( )
```

Delete and detach the shared memory.

Server operation only.

5.39.4 Variable Documentation

5.39.4.1 shMemSem

```
int shMemSem  [extern]
```

Semaphore set identifier.

The value returned by e.g. semget() (within getSemas() etc.) On success, semget() returns the semaphore set identifier (a nonnegative integer). On failure, -1 is returned, and errno is set to indicate the error.

5.39.4.2 semLckErrCnt

```
int semLckErrCnt  [extern]
```

Semaphore lock error count.

Reset to 0 on success.

5.40 include/weStateM.h File Reference

States and state machines.

```
#include "sysBasic.h"
```

Data Structures

- struct state_t

  The structure for state machines.

Macros

- #define newFiveBand(N, C, V, T, R, S)

  Define a five band checker.
- #define newFloatHyst(N, C, O, R, S)

  Define a hysteresis (Schmitt trigger, float value) as state machine.
- #define newSeqCont(N, C, n, m, S)

  Define a sequential function chart as state machine.
- #define newSwitchDeb(N, C, S, R)

  Define a switch to be de-bounced as state machine.
- #define newTimer(N, C, S)

  Define a timer as state machine.

Typedefs

- typedef uint8_t(∗ enterState_t) (state_t ∗const me, uint32_t controlV)

  A state machine's own function to command entering the active state.
- typedef uint8_t(∗ **enterStateF_t**) (state_t ∗const me, float controlF)

  Substitute or addendum to enterState_t.
- typedef uint8_t(∗ **enterStateS_t**) (state_t ∗const me, char const ∗controlS)

  Substitute or addendum to enterState_t.
- typedef void(∗ genStateText_t) (char ∗stateText, state_t const ∗const me, char const ∗stamp)

  Generate text for state machine status.
- typedef uint8_t(∗ leaveState_t) (state_t ∗const me, uint32_t controlV)

  A state machine's own function to command leave the active state.
- typedef uint8_t(∗ **leaveStateF_t**) (state_t ∗const me, float controlF)

  Substitute or addendum to leaveState_t with float control value.
- typedef uint8_t(∗ **leaveStateS_t**) (state_t ∗const me, char const ∗controlS)

  Substitute or addendum to leaveState_t with text control value.
- typedef void(∗ onStateChange_t) (state_t ∗const me)

  The applications's call back function for state changes.
- typedef struct state_t state_t

  The structure for state machines.
- typedef uint8_t(∗ tickCheckState_t) (state_t ∗const me, uint32_t controlV)

  A machine's own function to be called to trigger / check state.
- typedef uint8_t(∗ **tickCheckStateF_t**) (state_t ∗const me, float controlF)

  Substitute or addendum to tickCheckState_t.
- typedef uint8_t(∗ **tickCheckStateN_t**) (state_t ∗const me)

  Substitute or addendum to tickCheckState_t.

Functions

- void endStateTextTims (char ∗stateText, state_t const ∗const me)

  Generate status text standard end with two times.
- uint8_t fiveBandDoEnter (state_t ∗const me, float analogueVal)

  Five band checker turn / force ON.
- uint8_t fiveBandDoLeave (state_t ∗const me, float analogueVal)

  Five band checker turn / force OFF.
- uint8_t fiveBandTick (state_t ∗const me, float controlV)

  Five band checker trigger.
- uint8_t floatHystDoEnter (state_t ∗const me, float analogueVal)

  Float value hysteresis turn / force ON.
- uint8_t floatHystDoLeave (state_t ∗const me, float analogueVal)

  Float value hysteresis turn / force OFF.
- uint8_t floatHystTick (state_t ∗const me, float controlV)

  Float value hysteresis trigger.
- void genStateText (char ∗stateText, state_t const ∗const me, char const ∗stamp)

  Generate text for state machine status.
- void logStateReason (state_t const ∗const me, char const ∗stamp, char const ∗cause)

  Log status text with cause and info.
- void logStateText (state_t const ∗const me, char const ∗stamp)

  Log status text.
- uint8_t seqContDoEnter (state_t ∗const me, char const ∗startCommand)

Sequential control entry.

- uint8_t seqContDoLeave (state_t *const me, char const *stopCommand)

  Sequential control leave.
- uint8_t seqContTick (state_t *const me)

  Sequential control tick or check.
- void startStateText (char *stateText, state_t const *const me, char const *stamp)

  Generate status text standard start.
- uint8_t switchDebDoEnter (state_t *const me, uint32_t controlV)

  Switch de-bounce turn / force ON.
- uint8_t switchDebDoLeave (state_t *const me, uint32_t controlV)

  Switch de-bounce turn / force OFF.
- uint8_t switchDebTick (state_t *const me, uint32_t controlV)

  Switch de-bounce trigger.
- uint8_t switchDebTickAC (state_t *const me, uint32_t controlV)

  Switch de-bounce trigger AC.
- uint8_t timerDoEnter (state_t *const me, uint32_t secFromNow)

  Timer entry.
- uint8_t timerDoLeave (state_t *const me, uint32_t ignored)

  Timer leave, that is stop timer.
- uint8_t timerDoStart (state_t *const me, uint32_t secFromNow)

  Timer unconditional entry and set.
- uint8_t timerDoStart4ever (state_t *const me)

  Timer unconditional entry and set forever or stop it.
- uint8_t timerDoTrigger (state_t *const me, uint32_t secFromNow)

  Timer entry or (pro-longing) re-trigger.
- uint8_t timerEndTrigger (state_t *const me, uint32_t const secUTCend)

  Timer entry or (pro-longing) re-trigger to absolute UTC end.
- uint8_t timerTickCheck (state_t *const me, uint32_t controlV)

  Timer trigger.

5.40.1 Detailed Description

States and state machines.

```
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weinert-automation.de           a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  93 30.08.2025
Rev.  104 05.02.2018 :  new
Rev.  154 26.06.2018 :  genStateText, logStateText threadsafe; timerEndTrigger
Rev.  175 28.07.2018 :  state machine structure made more clear and readable
Rev.  195 01.03.2019 :  Five band checker
Rev.  198 04.03.2019 :  justLogStateChg added
Rev.  200 16.04.2019 :  state expanded, logging improved
Rev.  223 23.06.2020 :  switchDebTickAC added
Rev.    76 24.02.2025 :  endStateTextTims function (log text with two times)
Rev.    86 22.06.2025 :  state machine less unions, more state
Rev.    92 20.08.2025 :  state machine (SFC part) documentation, clean up.
```

State machines are implemented in an object oriented way although C is in no way supporting objects. We do this by defining the state in a structure and the behaviour in a set of functions, regarding a defined structure variable plus the functions as an object modelling the state machine in question.
Of course, in C we don't have the object orientation principles, especially no encapsulation. There is no binding of behaviour (functions) to the state (structure variable), which leads to a structure pointer as first parameter of every related function. The only substitute is discipline.

As of Revision 193 (2019) there are five types of state machines:

1. Timer, seconds resolution, UTC stamp (type 0xAD)
2. switch de-bounce (type 0xDB)
3. Float value hysteresis (0xFF)
4. 5 band check ...badLO | critLo | OK | critHi | badHi... (0x5B)
5. sequential Control in Sequential Function Chart (SFC) mannor (0xFC)

5.40.2 Macro Definition Documentation

5.40.2.1 newTimer

```
#define newTimer(
              N,
              C,
              S )
```

Define a timer as state machine.

A state machine of this type "timer" is either running or inactive. It is set active or re-triggered by an amount of seconds from now. The end of the interval is stored as absolute (UTC s) time.

The check/tick function timerTickCheck would, by default be called every second at least near the end of the interval. It might as well be called more seldom if a coarser resolution is applicable and or the the timer end event shall be synchronised with other events, like e.g. second 15 in every second minute.

One strategy would be to have all timers in an array or list and check all timers every second. When this list is kept sorted to active timers with nearest end date first, one can stop checking on the first timer without change to inactive. This sorted list approach is worthwhile with many timers, only.

This macro is the initialisation expression for a timer requiring the unique name and the fitting onStateChange function, only. The other fields are preset as the timer state machine type demands.

Hint: A timer may be made periodic by restarting it accordingly in its onStateChange function.

Parameters

N	name as string literal
C	onStateChange function
S	genStateText function (NULL sets default / standard genStateText)

5.40.2.2 newSwitchDeb

```
#define newSwitchDeb(
              N,
```

```
                C,
                S,
                R )
```

Define a switch to be de-bounced as state machine.

A state machine of this type is to be provided with a switch/button input condition of either ON or OFF sampled at regular time intervals. It is constructed with a positive onThreshold (say 4) and a non-negative lower offThreshold (say 2, e.g.).
An internal counter is incremented by ON input when OFF from 0 to onThreshold. On OFF input and when ON the internal counter is decremented form offThreshold to 0.
As might have become obvious the state machine makes the OFF<->ON when these counters reach onThreshold respectively 0;

This macro is the initialisation expression for a switch de-bounce requiring the unique name and the fitting on↩ StateChange function as well as the (uint8_t) values for the off and on threshold.

Parameters

N	name as string literal
C	onStateChange function
S	offThreshold small non-negative integer
R	onThreshold small positive integer

5.40.2.3 newFloatHyst

```
#define newFloatHyst(
                N,
                C,
                O,
                R,
                S )
```

Define a hysteresis (Schmitt trigger, float value) as state machine.

A state machine of this type is to be provided with an analogue (float) value sampled regularly. It is constructed with an On and an Off threshold value. It must hold onThreshold >= offThreshold; recommended is onThreshold > offThreshold with a significant difference.

The significance of status,subStatus for this state machine is:
0,0 : Off, below
1,0 : On, above
1,1 : On, within from above
0,1 : Off, within from below
0,3 : do not know the level (pre-trigger, reset state)
0,2 : do not know On or Off, within from reset state

As might have become obvious the state machine makes a transition to ON (1,0) when the sampled value becomes > onThreshold and to Off (0,0) when <= offThreshold.

The state change call back function will be called on the following transitions:
To "Off, below" (0,0) from: 1,x and (0,2)

To "On, above" (1,0) from: 0,x and
To "Undefined, between" (0,2) from: reset (0,3)

Note: The call back function might ignore the subStatus; this would take "Undefined, between" as Off and one might see two consecutive transitions to "Off".

This macro is the initialisation expression for a float value hysteresis requiring the unique name and the fitting onStateChange function as well as the (float) values for the off and on threshold.

Parameters

N	name as string literal
C	onStateChange function
O	offThreshold valid float (i.e. non NaN)
R	onThreshold valid float (R >= O)
S	genStateText function (NULL sets default / standard genStateText)

5.40.2.4 newFiveBand

```
#define newFiveBand(
              N,
              C,
              V,
              T,
              R,
              S )
```

Define a five band checker.

A state machine of this type is to be fed with an analogue (float) value sampled regularly. This value is compared to four thresholds or borders separating those five bands:
...badLO | critLo | OK | critHi | badHi...
The state machine is to be constructed with four thresholds the un-equality
`::threshBadLo < ::threshCritLo < ::threshON < ::threshOFF`

must hold for. For VDE-AR-N 4105 e.g. one would take
47.7 49.5 -OK- 50.5 51.5 Hz resp. 184 207 -OK- 253 264 V
as thresholds.

The significance of status values for this state machine are:
2: bad Hi (0010)
1: critical Hi (0001)
0: OK (0000)
5: critical Lo (0101)
6: bad Lo (0110)
(4) 8: unknown / reset (1000)
subStatus is used as previous state. Hence 8,8 ist the reset state.

The state change call back function will called on all status transitions. realSecOff will be the time stamp of the last transition into OK (0) and realSecOn of the last transition out of it,

This macro is the initialisation expression for a five band checker requiring the unique name and the fitting on↩ StateChange function as well as legal (float) values for the four thresholds.

Parameters

N	name as string literal
C	onStateChange function
V	threshBadLo valid float (i.e. non NaN)
T	threshCritLo
R	onThreshold valid float
S	offThreshold (S > R > T > V)

5.40.2.5 newSeqCont

```
#define newSeqCont(
                N,
                C,
                n,
                m,
                S )
```

Define a sequential function chart as state machine.

A state machine of this type is simplified two leg sequential function chart with one leg leading via intermediate steps form OFF to ON state and the other leg the other way.

The OFF state is: state_t.status == 0 and state_t.subStatus == 0
Chain to ON is: state_t.status == 0 and state_t.subStatus == 1..n-1
The ON state is: state_t.status == 1 and state_t.subStatus == 0
Chain to OFF is: state_t.status == 1 and state_t.subStatus == 1..m-1

Chain to ON interrupted by seqContDoLeave changes status from 0 to 4.
Chain to OFF interrupted by seqContDoEnter changes status from 1 to 5.

Parameters

N	name as string literal
C	onStateChange function
n	length of chain to ON
m	length of chain to OFF
S	genStateText function (NULL sets default / standard genStateText)

5.40.3 Typedef Documentation

5.40.3.1 state_t

```
typedef struct state_t state_t
```

The structure for state machines.

The semantics and usage of most fields depends on the type state_t::typ of the state machine and often on concrete implementations (instance).
Fields normally unused by the design of the basic type state_t::typ may, with caution, be used by the code making or using concrete state machines.

5.40.3.2 enterState_t

```
typedef uint8_t(* enterState_t) (state_t *const me, uint32_t controlV)
```

A state machine's own function to command entering the active state.

Note: The enter function put in this function pointer may (and should) be called directly on fitting events. Nevertheless, the function put in this function pointer may be used by others, especially by a check/trigger function. Then, be sure not to have the wrong (default) function here.

Parameters

me	pointer to the machine itself; never null
controlV	controlValue defining the cause or extra information for the state machine; the usage and semantic of this parameter depends on the state machine type and instance

Returns

0: OK, state now or already entered respectively on its way else: entering the state not possible or inhibited. Depending on the concrete type the return value might give the reason.

5.40.3.3 leaveState_t

```
typedef uint8_t(* leaveState_t) (state_t *const me, uint32_t controlV)
```

A state machine's own function to command leave the active state.

Note: See note at enterState_t.

Parameters

me	pointer to own state; never null
controlV	control value defining the cause or extra information for thestate machine; the usage and semantic of this parameter depends on the state machine type and instance

Returns

0: OK state is now or was already inactive (or on its way there) else: leaving the state not possible or inhibited. Depending on the concrete type the value might give the reason.

5.40.3.4 tickCheckState_t

```
typedef uint8_t(* tickCheckState_t) (state_t *const me, uint32_t controlV)
```

A machine's own function to be called to trigger / check state.

Note: See note at enterState_t.

Parameters

me	pointer to the machine itself; never null never null
controlV	additional control value (float for tickCheckStateF_t)

Returns

0: state or, if applicable, sub-state changed; else: not

5.40.3.5 onStateChange_t

```
typedef void(* onStateChange_t) (state_t *const me)
```

The applications's call back function for state changes.

This function will only be called when (set and) the own state_t.status really changed. Depending on type (see state_t.typ), this function may also be called when the own state_t.subStatus changed.

Parameters

me	pointer to the machine itself

5.40.3.6 genStateText_t

```
typedef void(* genStateText_t) (char *stateText, state_t const *const me, char const *stamp)
```

Generate text for state machine status.

This is the minimal common standard for all status machines.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null!
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.40.4 Function Documentation

5.40.4.1 endStateTextTims()

```
void endStateTextTims (
            char * stateText,
            state_t const *const me )
```

Generate status text standard end with two times.

This sets a common standard end of a status text consisting of the two times me->realSecOn and me->realSecOff or me->endTime separated by a slash (∼) and terminated with (char) 0. ∼∼∼∼ /code //0123456789x123456789v1 "1234567890/1234567890" 14:51:12∼ 15:37:04 ∼∼∼∼ /endcode The standard start of this would be at stateText + 56. endTime is used when realSecOff < realSecOn.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null

5.40.4.2 startStateText()

```
void startStateText (
            char * stateText,
            state_t const *const me,
            char const * stamp )
```

Generate status text standard start.

This sets the common standard start of a status text in state text, like:
```
//0123456789x123456789v123456789t123456789q1
 " 2019-04-26 03:08:26.278 # befRiseTimer:  "
```

It ends with a blank at [40] after the colon at [39]. State machine type or instance specific text may be added from [40] or [41] up to (recommended) [76] followed by a terminating 0.

Hint: This function sets a 0 at [41] for robustness, i.e. having stateText always as string.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.40.4.3 genStateText()

```
void genStateText (
            char * stateText,
            state_t const *const me,
            char const * stamp )
```

Generate text for state machine status.

This is the minimal common standard for all status machines.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null!
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.40.4.4 logStateText()

```
void logStateText (
            state_t const *const me,
            char const * stamp )
```

Log status text.

The status as text will be generated in and then be output to outLog. outLog will be flushed.

Parameters

me	pointer to own state; not null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.40.4.5 logStateReason()

```
void logStateReason (
            state_t const *const me,
            char const * stamp,
            char const * cause )
```

Log status text with cause and info.

The status as text will be generated and then be output to outLog. outLog will be flushed.
The text will be:
stamp # state machine name: cause me->infoTxt
me->infoTxt has to be set/ provided by application software and will be output to a maximum / recommended length of 29. A standard format is one field of 7 and two fields of ten characters separated by spaces.

Parameters

me	pointer to own state; not null
stamp	(time) stamp to be prepended (max. length 23); default " - "
cause	the cause of the state change (max. length 6); default me->controlVS

was -29 check for homeDoor

5.40.4.6 timerTickCheck()

```
uint8_t timerTickCheck (
            state_t *const me,
            uint32_t controlV )
```

Timer trigger.

Parameters

me	pointer to own state; not null
controlV	current time stamp; mostly cycTaskEventData_t.realSec resp. getAbsS()

Returns

0: state changed, i.e. timer ended; 2: still running; 4: inactive

5.40.4.7 timerDoEnter()

```
uint8_t timerDoEnter (
            state_t *const me,
            uint32_t secFromNow )
```

Timer entry.

This function starts an inactive timer to end secFromNow s. It does nothing on a timer already active resp. running, especially, it does not re-trigger / prolong the timer's time.

This is the function set as (default) state_t.doEnter and not timerDoStart.

Parameters

me	pointer to own state; not null
secFromNow	time to run on from now (s)

Returns

0: OK, timer no or already ON

5.40.4.8 timerDoStart()

```
uint8_t timerDoStart (
            state_t *const me,
            uint32_t secFromNow )
```

Timer unconditional entry and set.

This function starts an inactive timer. The timer's end time will be set to (now + secFromNow s) no matter the timers previous state. This unconditional changing the end time of a timer already running is the difference to timerDoEnter.

This is not the function set as (default) state_t.doEnter; it is timerDoEnter.

Parameters

me	pointer to own state; not null
secFromNow	time to run on from now (s)

Returns

0: now started; 1: was running, probably end time changed

5.40.4.9 timerDoStart4ever()

```
uint8_t timerDoStart4ever (
            state_t *const me )
```

Timer unconditional entry and set forever or stop it.

This function starts an inactive timer. The timer's end time will be set to 2.2.2106 no matter the timers previous state. This date is considered as for ever in our 21st century. This does effectively stop the timer.

This function is intended to start or keep running a timer not to end before its time is to be set (by timerDoStart) to a sensible end time.
One use case is: A timer running forever is in error state.

This function is, of course, faster than timerDoEnter and timerDoStart.

Parameters

me	pointer to own state; not null

Returns

0: now started; 1: was running, probably end time changed

5.40.4.10 timerDoTrigger()

```
uint8_t timerDoTrigger (
            state_t *const me,
            uint32_t secFromNow )
```

Timer entry or (pro-longing) re-trigger.

This function starts an inactive timer to end secFromNow s. IF the timer is active and if (now + secFromNow) is later than the current end, the timer me's runtime will be prolonged accordingly (timer re-trigger).

Parameters

me	pointer to own state; not null
secFromNow	time to run on from now (s)

Returns

0: OK, timer starter or prolonged to new (later) time 1: running timer not prolonged

5.40.4.11 timerEndTrigger()

```
uint8_t timerEndTrigger (
            state_t *const me,
            uint32_t const secUTCend )
```

Timer entry or (pro-longing) re-trigger to absolute UTC end.

If secUTCend is now or in the past or if it is equal the the end of the already active timer, nothing will be done (returns 1).

This function starts an inactive timer to end at secUTCend. If the timer is active already secUTCend will be taken as new end time.

Parameters

me	pointer to own state; not null
secUTCend	end time

Returns

0: OK (started or re-triggered); 1: no state change (on and no prolonging, or secUTCend in past)

5.40.4.12 timerDoLeave()

```
uint8_t timerDoLeave (
            state_t *const me,
            uint32_t ignored )
```

Timer leave, that is stop timer.

Note: This function is usable for other state machine types, too, if appropriate.

Parameters

me	pointer to own state; not null
ignored	as the name says

Returns

0: state changed, 1: state hold

5.40.4.13 switchDebTick()

```
uint8_t switchDebTick (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce trigger.

Parameters

me	pointer to own state; not null
controlV	0: input OFF else: input ON

Returns

0: state changed, 1: state hold

See also

newSwitchDeb

5.40.4.14 switchDebTickAC()

```
uint8_t switchDebTickAC (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce trigger AC.

This function does essentially the same as switchDebTick, except for On ticks being counted twice. This is meant for half wave rectified AC signals sampled at multiples of their frequency. Obviously, half or 1/2 + 1 of the samples will always be Off. And, of course, the state machine has to be made with a on chain length being by the number of samples per period higher than the normal switch de-bounce filter time, to avoid spiky ON results.

Parameters

me	pointer to own state; not null
controlV	0: input OFF else: input ON

Returns

0: OFF, 1: ON

See also

newSwitchDeb

5.40.4.15 switchDebDoEnter()

```
uint8_t switchDebDoEnter (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce turn / force ON.

Parameters

me	pointer to own state; not null
controlV	irrelevant but recorded on state change

Returns

0: state changed, 1: state hold

5.40.4.16 switchDebDoLeave()

```
uint8_t switchDebDoLeave (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce turn / force OFF.

Note: this function is usable for other non timer stati, too;

Parameters

me	pointer to own state; not null
controlV	irrelevant but recorded on state change

Returns

0: state changed, 1: state hold

5.40.4.17 floatHystTick()

```
uint8_t floatHystTick (
            state_t *const me,
            float controlV )
```

Float value hysteresis trigger.

Parameters

me	pointer to own state; not null
controlV	the sampled analogue value

Returns

0: state change, 1: no change, 0xFF: fault i.e. controlV is NaN (no state change)

5.40.4.18 floatHystDoEnter()

```
uint8_t floatHystDoEnter (
            state_t *const me,
            float analogueVal )
```

Float value hysteresis turn / force ON.

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded

Returns

0: OK, state now ON; 0xFF: fault (me is NULL e.g.)

5.40.4.19 floatHystDoLeave()

```
uint8_t floatHystDoLeave (
            state_t *const me,
            float analogueVal )
```

Float value hysteresis turn / force OFF.

Note: this function is usable for other non timer stati, too;

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded; may take an (uint32_t) cast float

Returns

0: state change, 1: no change

5.40.4.20 fiveBandTick()

```
uint8_t fiveBandTick (
            state_t *const me,
            float controlV )
```

Five band checker trigger.

Parameters

me	pointer to own state; not null
controlV	the sampled analogue value

Returns

0: state change, 1: no change

5.40.4.21 fiveBandDoEnter()

```
uint8_t fiveBandDoEnter (
            state_t *const me,
            float analogueVal )
```

Five band checker turn / force ON.

This function puts the checker in state bad Hi (2) no matter the parameter value.

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded on state change

Returns

0: state change, 1: no change

5.40.4.22 fiveBandDoLeave()

```
uint8_t fiveBandDoLeave (
            state_t *const me,
            float analogueVal )
```

Five band checker turn / force OFF.

This function puts the checker in state OK (0) no matter the parameter value.

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded on state change

Returns

0: state change, 1: no change

5.40.4.23 seqContDoEnter()

```
uint8_t seqContDoEnter (
            state_t *const me,
            char const * startCommand )
```

Sequential control entry.

This function starts the sequence from OFF to ON.

Parameters

me	pointer to own state; not null
startCommand	the cause of the state change; 6 characters (max.) to be recorded and else irrelevant for his function

Returns

0: OK state now ON or on its way there; 1: already ON

5.40.4.24 seqContDoLeave()

```
uint8_t seqContDoLeave (
            state_t *const me,
            char const * stopCommand )
```

Sequential control leave.

This function starts the sequence from ON to OFF.

Parameters

me	pointer to own state; not null
stopCommand	It is recorded on state changes and else irrelevant for this function; see description on seqContTick

Returns

0: OK state now OFF or on its way there; else: other inhibit condition

5.40.4.25 seqContTick()

```
uint8_t seqContTick (
            state_t *const me )
```

Sequential control tick or check.

If this sequential control (me) is not in a stable OFF or ON state, that is state_t.status is 0 or 1 and state_t.subStatus is 0, this function should be called at regular intervals or on relevant conditions state changes.

The function must keep or advance the state.

It must react on interrupts by seqContDoEnter or seqContDoLeave recognisable by state_t.status == 5 respectively 4. Note: This is just for the case, that the individual call back function state_t.onStateChange does not handle this "interrupts" — what it really should.

This (basic) implementation advances the sub state from 1 to n-1 respectively m-1. Interrupts by seqContDoEnter or seqContDoLeave are handled by changing to sub state 1 of the opposite leg.

When this basic implementation is not sufficient for a concrete SFC, the application may provide an own tick/check function. However, in most cases seemingly complicated cases — nonlinear chains, wait conditions etc. — the specialised behaviour can most often be implemented by an individual state_t.onStateChange call back function.

Parameters

me	pointer to own state; not null

Returns

0: state or sub-state changed 0xFF: fault status panic ... else: current state kept, of course

5.41 include/weUSBscan.h File Reference

USB 1D / 2D scanners mimicking keyboards on Raspberry Pi.

```
#include "sysBasic.h"
#include <wchar.h>
#include <locale.h>
```

Variables

- char const deRawCoDisAltGrph [120]

  Key position number to character, AltGr, German keyboard.
- char const deRawCoDisNoShift [90]

  Key position number to character, no shift, German keyboard.
- char const deRawCoDisShifted [90]

  Key position number to character, shifted, German keyboard.
- wchar_t raw2wcharAltGrph [102]

  Key position number to character, with AltGR.
- wchar_t raw2wcharNoShift [60]

  Key position number to character, no shift.
- wchar_t raw2wcharShifted [60]

  Key position number to character, with shift.
- unsigned char scanKeyAction [32]

  The one keystroke read buffer.
- int scanKeybLang

  The keyboard language.
- wchar_t scanResult [162]

  The result of one scan.
- char const usRawCoDisNoShift [90]

  Key position number to character, no shift, US keyboard.
- char const usRawCoDisShifted [90]

  Key position number to character, shifted, US keyboard.

5.41.1 Detailed Description

USB 1D / 2D scanners mimicking keyboards on Raspberry Pi.

```
Copyright  (c)   2020     Albrecht Weinert
weinert-automation.de     a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  38 2.02.2021
Rev.  232 03.09.2020 :  new (extracted from testOnPi.c)
Rev.  234 05.12.2020 :  cosmetic changes
```

This is a supplementary basic library to handle USB barcode and QR code scanners. By plug'n play such scanner would normally appear as device
`/dev/hidraw0`

. To make this usable for scanner application programs run without sudo apply
`sudo chmod  664 /dev/hidraw0`

before.

Devices

The only device used and tested so far is a "USB Wired 2D Barcode Scanner" <MJ-8200>. It seems to ha a lot of bethren with similar software. Emulated non-US keyboards seem alien to the developers; see deRawCoDisNoShift.

5.41.2 Variable Documentation

5.41.2.1 usRawCoDisNoShift

```
char const usRawCoDisNoShift[90]  [extern]
```

Key position number to character, no shift, US keyboard.

This utf-8 or multibyte character array respectively string describes the translation of key number to character for a US keyboard.
It will have to be transfered as wide character array to raw2wcharNoShift.

5.41.2.2 usRawCoDisShifted

```
char const usRawCoDisShifted[90]  [extern]
```

Key position number to character, shifted, US keyboard.

See the explanation at usRawCoDisNoShift.

See also

raw2wcharShifted

5.41.2.3 deRawCoDisNoShift

```
char const deRawCoDisNoShift[90]  [extern]
```

Key position number to character, no shift, German keyboard.

This utf-8 or multibyte character array respectively string describes the translation of key number to character for a US keyboard.
It will have to be transfered as wide character array to raw2wcharNoShift.

Remarks on non US keyboard emulations by the "USB Wired 2D Barcode Scanner" <MJ-8200> and consorts:
We strongly recommend not to use them and refrain from applications using more than primitive USASCII. As "↩ German keyboard", e.g., the scanner does neither recognise nor send . Besides being called German without umlauts [sic!] the scanner is ignorant to some other characters on every German keyboard (which are probably there because of being used in Western Europe). Additionally the scanner when set to German inserts additional strings of characters with no obvious sense or system.
In the end we consider everything beyond factory reset (except low beeper volume) as not functional.
Without the hard bug of inventing characters and string not contained in the QR-code, the so called German keyboard would give us some extra characters — but not umlauts.

5.41.2.4 deRawCoDisShifted

```
char const deRawCoDisShifted[90]  [extern]
```

Key position number to character, shifted, German keyboard.

See the explanation at usRawCoDisNoShift.

See also

raw2wcharShifted deRawCoDisNoShift

5.41.2.5 deRawCoDisAltGrph

```
char const deRawCoDisAltGrph[120]  [extern]
```

Key position number to character, AltGr, German keyboard.

See the explanation at usRawCoDisNoShift.

See also

raw2wcharShifted deRawCoDisNoShift

5.41.2.6 raw2wcharNoShift

```
wchar_t raw2wcharNoShift[60]  [extern]
```

Key position number to character, no shift.

The length is 60. Valid characters are in the 4..56 key number range; there may be gaps. 0..3 are errors.

See also

usRawCoDisNoShift

5.41.2.7 raw2wcharShifted

```
wchar_t raw2wcharShifted[60]  [extern]
```

Key position number to character, with shift.

The length is 60. Valid characters are in the 4..56 key number range; there may be gaps. 0..3 are errors.

See also

usRawCoDisShifted

5.41.2.8 raw2wcharAltGrph

```
wchar_t raw2wcharAltGrph[102]  [extern]
```

Key position number to character, with AltGR.

The length is 60. Valid characters are in the 4..56 key number range; there will be many gaps. 0..3 are errors.

See also

usRawCoDisShifted

5.41.2.9 scanKeybLang

```
int scanKeybLang  [extern]
```

The keyboard language.

The language of the USB keyboard (see scanKeyAction) emulated by the scanner is stored here as: 0=US (default), 10=DE

5.41.2.10 scanResult

```
wchar_t scanResult[162]  [extern]
```

The result of one scan.

The result of consecutive keystrokes (see scanKeyAction) is stored here as array respectively string of wide characters.

5.41.2.11 scanKeyAction

```
unsigned char scanKeyAction[32]  [extern]
```

The one keystroke read buffer.

Keyboard input comes in blocks of 8 bytes each. Hence a length of 8 would be sufficient. Hence, 32 is a reserve for device errors or the driver not recognising the gap between blocks.

The 8 bytes are:

```
              Bit/Value:    0/1 1/2   2/4 3/8         4/16 5/32  6/64  7/128
[0]  Modifier keys Left:  cntl shift Alt Win  Right:  cntl shift AltGr Win
[1]  Reserved field                  always 0
[2]  Keypress 1                      in a funny code (4 is a)
[3]  2nd simultaneously pressed key
[4..7]  Keypress 3..6
```

As scanners won't "press" more than one key at a time only bytes [0] and [1] will contain information.
Byte[2] will be a crazy key code for a..z1..90... athwart to any utf or unicode. In the end the semantic of that "code" is a mixture of key value and key position on the keyboard. In the end few scanners get more than an American (and a Chinese?) keybord right. When setting the scanner to German keyboard you may miss one or two of .

On byte [0] one should see only three values: /code 0 : no modifier, no shift 2 : shift, that means a->A 64: altGr

5.42 include/weUtil.h File Reference

Some system related time and utility functions for Raspberry Pis.

```
#include "sysBasic.h"
#include <fcntl.h>
#include <unistd.h>
#include <sys/file.h>
#include <signal.h>
#include <stdlib.h>
#include <pthread.h>
```

Data Structures

- struct cycTask_t

  Cyclic or event driven task / threads structure.
- struct cycTaskEventData_t

  Event data for cyclic tasks.

Functions

- int advanceTmTim (struct tm *rTm, char *rTmTxt, uint8_t sec)

  Advance broken down real time by seconds.
- int char2hexDig (char c)

  Character to hexadecimal.
- int cycTaskDestroy (cycTask_t *cykTask)

  Destroy a cyclic task / threads structure.
- int cycTaskEvent (cycTask_t *cycTask, uint8_t noEvents, timespec stamp, cycTaskEventData_t cycTask↩EventData)

  Handle and signal events.
- int cycTaskInit (cycTask_t *cykTask)

  Initialise a cyclic task / threads structure.
- int cycTaskWaitEvent (cycTask_t *cycTask, uint32_t eventsThreshold, cycTask_t *cycTaskSnap)

  Wait on signalled event.
- int endCyclist (void)

  The cycles handler arrived.
- char * formEpocTime (char *target, uint32_t valueS)

  Format 32 bit unsigned epoch time as d.hh:mm:ss relative to today.
- char * formFixed16 (char *target, uint8_t targetLen, uint16_t value, uint8_t dotPos)

  Format 16 bit unsigned fixed point, right aligned.
- char * formFixed32 (char *target, uint8_t targetLen, uint32_t value, uint8_t dotPos)

  Format 32 bit unsigned fixed point, right aligned.
- char * formUnsByte (char *target, uint8_t value)

  Format 8 bit unsigned fixed point, right aligned.
- int genErrWithText (char const *txt)

  Generate error text (errorText) with system error text appended.
- uint8_t get10inS ()

  Get a 10th of second in s reading.
- uint32_t getAbsS ()

Get the absolute s reading.

- uint32_t getCykTaskCount (cycTask_t const *const cycTask)

  Get a cycle's/task's current event counter.

- uint16_t getMSinS ()

  Get a ms in s reading.

- void initStartRTime ()

  Initialise start (real) time.

- uint32_t ioSetClrSelect (uint8_t pin)

  Fetch a clear and set select bit for a GPIO pin.

- int isValidIp4 (char const *str)

  Check if a string is a valid IPv4 address.

- void logErrorText (void)

  Log the (last) common error text generated.

- void logErrText (char const *txt)

  Log an error text on errLog.

- void logErrWithText (char const *txt)

  Log error text (on errLog) with system error text appended.

- void logStampedText (char const *txt)

  Log an event or a message on outLog as line with time stamp.

- void monoTimeResol (timespec *timeRes)

  Absolute time (source) resolution.

- void onSignalExit (int s)

  On signal exit.

- void onSignalExit0 (int s)

  On signal exit 0.

- void onSignalStop (int s)

  On signal stop.

- unsigned int parse2Long (char *const optArg, long int *parsResult)

  Parse a string of integer numbers.

- int parsInt (const char *str, const int lower, const int upper, const int def)

  Parse int with checks.

- uint16_t stopMSwatch ()

  Get a (stop-watch) ms reading.

- void strLappend (char *dest, char const *src, int n)

  Append one char sequence left justified at another one.

- void strLinto (char *dest, char const *src, size_t n)

  Set one char sequence left justified into another one.

- void strRinto (char *dest, char const *src, size_t n)

  Set one char sequence right justified into another one.

- int theCyclistStart (int startMsDelay)

  Start the cycles handler.

- int theCyclistWaitEnd ()

  Wait for the end of the cycles thread.

- timespec timeAdd (timespec const t1, timespec const t2)

  Add two times as new structure.

- void timeAddTo (timespec *t1, timespec const t2)

  Add two times overwriting the first operand.

- int timeCmp (timespec const t1, timespec const t2)

  Compare two times.

- int timeSleep (unsigned int micros)

  Relative delay for the specified number of s.

Variables

- char actRTmTxt [ ]

  Actual broken down time (text).
- timespec allCycStart

  Common absolute / monotonic start time of all cycles.
- char const **bin8digs** [256][10]

  "0000_0000" .. "1111_1111"
- volatile uint8_t commonRun

  Common boolean run flag for all threads.
- const uint32_t **csBit** [ ]

  single bit set. 1 2 4 8 ... 0x80000000
- cycTask_t **cyc100ms**

  100ms cycle (data structure)
- cycTask_t **cyc10ms**

  10ms cycle (data structure)
- cycTask_t **cyc1ms**

  1ms cycle (data structure)
- cycTask_t **cyc1sec**

  1s cycle (data structure)
- cycTask_t **cyc20ms**

  20ms cycle (data structure)
- char const **dec8duns** [256][4]

  " 0" .. "255" byte to three char dec
- char errorText [182]

  Common error text.
- uint8_t have100msCyc

  Flag to enable the 100ms cycle.
- uint8_t have10msCyc

  Flag to enable the 10ms cycle.
- uint8_t have1msCyc

  Flag to enable the 1ms cycle.
- uint8_t have1secCyc

  Flag to enable the 1s cycle.
- uint8_t have20msCyc

  Flag to enable the 20ms cycle.
- long int parsResult [ ]

  Long array of length 14.
- volatile int sigRec

  Storage for the signal (number) requesting exit.
- timespec startRTime

  Start time (structure, monotonic real time clock).
- char const ∗const stmp23

  The current time as text.
- uint32_t const ∗const stmpSec

  The real time epoch seconds.
- int8_t **vcoCorrNs**

  external for test/debug only (don't change)

5.42.1 Detailed Description

Some system related time and utility functions for Raspberry Pis.

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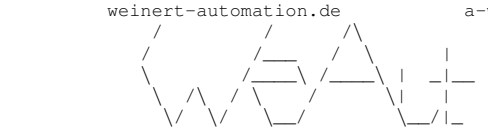

Revision history

```
Rev.  81 3.04.2025
Rev.  50+ 16.10.2017 :  cycTask_t->mutex now pointer (allows common mutex)
Rev.  54+ 23.10.2017 :  timing enhanced, common mutex forced/standard
Rev.  200 16.04.2019 :  logging improved; formatting enh.
Rev.  202 28.04.2019 :  timer macro change, more formatting functions
Rev.  209 22.07.2019 :  work around a Doxygen bug, formFixed..  not void
Rev.  233 26.09.2020 :  10 ms cycle added
Rev.  263 08.09.2024 :  formEpocTime added (to make logged timers readable)
Rev.    76 20.02.2025 :  define __USE_GNU
```

This file contains some definitions concerning system, time and IO. The IO part will work with the gpio/gpiod library as defined in the library's include file pigpiod_if2.h.

5.42.2 Function Documentation

5.42.2.1 strLinto()

```
void strLinto (
            char * dest,
            char const * src,
            size_t n )
```

Set one char sequence left justified into another one.

This function copies n characters from src to dest left justified. If the length of src is less than n the remaining length on right in dest will be filled with blanks.

Attention: dest[n-1] must be within the char array provided by dest. This cannot and will not be checked!

Hint: Contrary to strncpy there's no padding with 0. If you want dest to end after the insertion use strLappend().

Parameters

dest	the pointer to / into the destination sequence where src is to be copied to. If NULL nothing happens.
src	the sequence to be copied. If NULL or empty fill is used from start
n	the number of characters to be copied from src.

5.42.2.2 strLappend()

```
void strLappend (
            char * dest,
```

```
            char const * src,
            int n )
```

Append one char sequence left justified at another one.

This function copies n characters from src to dest and lets dest then end with 0 (end of string). If n is negativ, -n characters will be copied and dest will end with new line and 0;

Attention: dest[n] respectively dest [-n + 1] must be within the char array provided by dest. This cannot and will not be checked!

Parameters

dest	the pointer to / into the destination sequence where src is to be copied to. If Null nothing happens.
src	the sequence to be copied. If Null or empty fill is used from start
n	the absolute value is the number of characters to be copied from src. If this number exceeds 300 it will be taken as 0. If n is negative a line feed will be appended, too.

5.42.2.3 strRinto()

```
void strRinto (
            char * dest,
            char const * src,
            size_t n )
```

Set one char sequence right justified into another one.

This function copies n characters from src to dest right justified. If the length of src is less than n the remaining length on left in dest will be filled with blanks.

Attention: dest[n-1] must be within the char array provided by dest. This cannot and will not be checked!

Hint to append instead of insert: If this operation shall be at the end of the changed char sequence do
dest[n] = 0;
Then, of course, dest[n] must be within the char array provided by dest.

Parameters

dest	the pointer to / into the destination sequence where src is to be copied to. If NULL nothing happens.
src	the sequence to be copied. If NULL or empty fill is used from start
n	the number of characters to be copied from src.

5.42.2.4 formFixed16()

```
char * formFixed16 (
            char * target,
            uint8_t targetLen,
```

```
            uint16_t value,
            uint8_t dotPos )
```

Format 16 bit unsigned fixed point, right aligned.

formFixed16(target, 6, 1234, 2), e.g., will yield " 12.34".
formFixed16(target, 6, 4, 2), e.g., will yield " 0.04".

If the value would not fit within targetLen characters leading digits will be truncated.

Parameters

target	pointer to first of targLen characters changed
targetLen	field length 2..16; number of characters changed
value	the fixed point value
dotPos	where the fixed point is 0..6 < targetLen

Returns

points to the most significant digit set or NULL on error / no formatting

5.42.2.5 formFixed32()

```
char * formFixed32 (
            char * target,
            uint8_t targetLen,
            uint32_t value,
            uint8_t dotPos )
```

Format 32 bit unsigned fixed point, right aligned.

This function behaves like formFixed16() except for handling 32 bit values. formFixed16() should be preferred, when feasible.

Parameters

target	pointer to first of targLen characters changed
targetLen	field length 2..16; number of characters changed
value	the fixed point value
dotPos	where the fixed point is 0..6 < targetLen

Returns

points to the most significant digit set or NULL on error / no formatting

5.42.2.6 formEpocTime()

```
char * formEpocTime (
            char * target,
            uint32_t valueS )
```

Format 32 bit unsigned epoch time as d.hh:mm:ss relative to today.

The output format ddhh:mm:ss means:
d.: '<<' '<-' ' ' '->' '>>' mean day before yesterday, yesterday, today, tomorrow, day after tomorrow ...
hh:mm:ss is, of course, the time in that day.

For days further in past or future the epoch seconds (ten digits incomprehensible to humans) are output, see formFixed32().

Parameters

target	pointer to first of 10 characters changed
valueS	the fixed point value (epoch seconds)

Returns

points to the most significant digit set or NULL on error / no formatting

sprintf(target, "%3dd%5ds", relNoDay, secInDay);

5.42.2.7 formUnsByte()

```
char * formUnsByte (
            char * target,
            uint8_t value )
```

Format 8 bit unsigned fixed point, right aligned.

Parameters

target	pointer to first of targLen characters changed
value	the unsigned 8 bit value (0..255)

Returns

points behind the number i.e. target + 3; null on error

5.42.2.8 isValidIp4()

```
int isValidIp4 (
            char const * str )
```

Check if a string is a valid IPv4 address.

Syntactically valid IPv4 addresses are: 0.0.0.0 .. 255.255.255.255

Parameters

str	The string containing the address, only; 0-terminated

Returns

0: no syntactically valid IPv4 address; 1: OK

5.42.2.9 char2hexDig()

```
int char2hexDig (
            char c )
```

Character to hexadecimal.

Parameter values '0'..'9' return 0..9. Parameter values 'A'..'F' and 'a'..'f' return 10..15. Other values return -1.

5.42.2.10 parsInt()

```
int parsInt (
            const char * str,
            const int lower,
            const int upper,
            const int def )
```

Parse int with checks.

This function expects parameter str to point to a null-terminated string. If not def is returned. If lower > upper def is returned. If the string str contains a decimal integer number n, fulfilling lower <= n <= upper n is returned, or def otherwise.

If the string str starts with [+|-][min|med|max] ignoring case lower respectively ((lower + upper) / 2) respectively upper is returned. A leading sign (+|-) as well as any trailing characters are ignored.

Parameters

str	0-terminated string containing a decimal integer number, or one of the keywords described above
lower	lower limit
upper	upper limit
def	default value, to be returned when str is not a pure decimal number one of the keyword starts or when the result violates the limits

5.42.2.11 parse2Long()

```
unsigned int parse2Long (
```

```
            char *const optArg,
            long int * parsResult )
```

Parse a string of integer numbers.

The string optArg will be tokenised taking any occurrences of the characters " +,;" (blank, plus, comma, semicolon) as border. "Any occurrences" means two commas ",,", e.g., acting as one separator and not denoting an empty number.
N.b.: The string optArg will be modified (by replacing the first character of the token separators found by zero ('\0').

The number format accepted and parsed is decimal and hexadecimal. Hexadecimal starts with 0x or 0X. Leading zeros have no significance (in C stone age sense of being octal).

Parameters

optArg	the string to be passed to a number of integer numbers, passed as program parameter, e.g.
parsResult	pointer to an array of long int, minimal length 14 (!)

Returns

the number of integer numbers parsed ab put into parsResult[], 0..14

5.42.2.12 timeAdd()

```
timespec timeAdd (
            timespec const t1,
            timespec const t2 )
```

Add two times as new structure.

Parameters

t1	summand as time structure (not NULL!, will be left unchanged)
t2	the second summand (dto.)

Returns

the sum (probably passed as hidden parameter by the way)

5.42.2.13 timeAddTo()

```
void timeAddTo (
            timespec * t1,
            timespec const t2 )
```

Add two times overwriting the first operand.

Parameters

t1	the time structure to add to (not NULL!, will be modified)
t2	the summand (not NULL!, will be left unchanged)

5.42.2.14 timeCmp()

```
int timeCmp (
            timespec const t1,
            timespec const t2 )
```

Compare two times.

Parameters

t1	the time structure to compare to t2 (not NULL!)
t2	the time structure to compare t1 with (not NULL!)

Returns

0: equal; +: t1 is greater (2 by s, 1 by ns); -: t1 is smaller

5.42.2.15 monoTimeResol()

```
void monoTimeResol (
            timespec * timeRes )
```

Absolute time (source) resolution.

This function sets the time structure provided to the absolute time's (ABS_MONOTIME default: CLOCK_↩ MONOTONIC) resolution.

Raspian Jessie on a Raspberry Pi 3 always yielded 1ns, which one may believe or not. We took it as "sufficient for accurate 1ms cycles".

Parameters

timeRes	the time structure to be used (never NULL!)

5.42.2.16 timeSleep()

```
int timeSleep (
            unsigned int micros )
```

Relative delay for the specified number of s.

This is local sleep. It should not be used in combination with absolute times and cyclic threads. It is just an utility for test or very short delays (as a better replacement for spinning).

Parameters

micros	sleep time in s; allowed 30 .. 63000

Returns

sleep's return value if of interest (0: uninterrupted)

5.42.2.17 initStartRTime()

```
void initStartRTime ( )
```

Initialise start (real) time.

This will be done in theCyclistStart(int). Hence, this function is for "non-cyclic" applications, mainly. Nevertheless it can be called before theCyclistStart(int) and won't be repeated therein.

5.42.2.18 advanceTmTim()

```
int advanceTmTim (
            struct tm * rTm,
            char * rTmTxt,
            uint8_t sec )
```

Advance broken down real time by seconds.

This function just advances the broken down (local) time structure rTm and the fitting text rTmTxt by 1 to 40s. All fields not affected by adding to the seconds part, won't be touched.

This function won't care about leap seconds nor handle DST rules. If this is to be kept up to date, it is recommended to refresh it on every hour change (return >=3) by
clock_gettime(CLOCK_REALTIME,..) and localtime_r(..).
Depending on OS, that might be an expensive operation with extra locks.

With wrong parameter values this function does nothing (returns 0).

Parameters

rTm	pointer to broken down real time
rTmTxt	date text, length 32, format Fr 2017-10-20 13:55:12.987 UTC+20 NULL is substituted by actRTmTxt
sec	1..40 will be added; else: error

Returns

0: error (rTm NULL e.g.); 1: seconds changed; 2: minute; 3: hour; 4: day; 5: month ; 6: year; 7: zone offset

5.42.2.19 ioSetClrSelect()

```
uint32_t ioSetClrSelect (
            uint8_t pin )
```

Fetch a clear and set select bit for a GPIO pin.

For the masks to set or clear GPIO bits each bit 0..31 selects the GPIO pin 0..31 respectively 32..53.

Parameters

pin	GPIO pin number (only 5 bits relevant here)

Returns

the the function select bit (a value with one bit set)

5.42.2.20 logErrWithText()

```
void logErrWithText (
            char const * txt )
```

Log error text (on errLog) with system error text appended.

Gives a (English) clear text translation of the latest system stored error. If txt is not null it will be prepended. This function appends a linefeed and flushes errLog.

Parameters

txt	text to be prepended (should nod be longer than 58 characters)

5.42.2.21 genErrWithText()

```
int genErrWithText (
            char const * txt )
```

Generate error text (errorText) with system error text appended.

Gives a (English) clear text translation of the latest system stored error. If txt is not null it will be prepended. Date and time will be prepended anyway.

Parameters

txt	text to be prepended (should nod be longer than 58 characters)

Returns

0: no error; else mutex error (time and date may be spoiled)

5.42.2.22 logErrorText()

```
void logErrorText (
            void  )
```

Log the (last) common error text generated.

This function outputs the last generated errorText (by genErrWithText() e.g.) to errLog. It appends a linefeed and flushes errLog.

5.42.2.23 logErrText()

```
void logErrText (
            char const * txt )
```

Log an error text on errLog.

If txt is not null it will be output to errLog and errLog will be flushed.

Parameters

txt	text to be output; n.b not LF appended

5.42.2.24 logStampedText()

```
void logStampedText (
            char const * txt )
```

Log an event or a message on outLog as line with time stamp.

If txt is not null it will be output to outLog. A time stamp is prepended and a line feed is appended. txt will be shortened to 50 characters if longer.

Parameters

txt	the text to be output

5.42.2.25 onSignalExit()

```
void onSignalExit (
            int s )
```

On signal exit.

This function is intended as signal hook; see signal(s, hook). When called, this function calls exit(s) and never returns.

Parameters

s	the signal forwarded to exit

5.42.2.26 onSignalExit0()

```
void onSignalExit0 (
            int s )
```

On signal exit 0.

This function is intended as signal hook; see signal(s, hook).
When called this function calls exit(0) and never returns.
This may be used as hook for s==SIGIN, to provide a normal return on cntl-C.

Parameters

s	ignored

5.42.2.27 onSignalStop()

```
void onSignalStop (
            int s )
```

On signal stop.

This function is a prepared signal hook. When called it sets sigRec by s and clears commonRun.

5.42.2.28 cycTaskInit()

```
int cycTaskInit (
            cycTask_t * cykTask )
```

Initialise a cyclic task / threads structure.

This function initialises a cyclic or non cyclic (asynchronous random event driven) task (thread) structure. Common mutex and an own condition are initialised, the event counter (.count) is set to 0.

Note: For the standard cycles provided here, 1ms, 100ms .., this initialisation is done in theCyclistStart() and the destruction (by cycTaskDestroy()) in endCyclist().

Parameters

cykTask	the task structure to initialise (not NULL!)

Returns

0: success, else: one of the error codes occurred

5.42.2.29 cycTaskDestroy()

```
int cycTaskDestroy (
            cycTask_t * cykTask )
```

Destroy a cyclic task / threads structure.

Parameters

cykTask	the task structure to destroy (not NULL!)

Returns

0: success, else: one of the error codes occurred

5.42.2.30 cycTaskEvent()

```
int cycTaskEvent (
            cycTask_t * cycTask,
            uint8_t noEvents,
            timespec stamp,
            cycTaskEventData_t cycTaskEventData )
```

Handle and signal events.

This is a helper function for the controller / manager to be called when having determined, that one or more events happened.

Parameters

cycTask	the task structure (not NULL!)
noEvents	number of events (usually 1); summand to cykTask.count
stamp	absolute monotonic time of the event; sets sykTask.stamp
cycTaskEventData	actual cyclic event data

Returns

0: success, else: one of the error codes occurred

5.42.2.31 cycTaskWaitEvent()

```
int cycTaskWaitEvent (
            cycTask_t * cycTask,
            uint32_t eventsThreshold,
            cycTask_t * cycTaskSnap )
```

Wait on signalled event.

This is a helper function for a worker thread. It will return on reaching the signalled event(s) or on ! commonRun. If cykTaskSnap is not NULL cycTask will be assigned to it under mutex lock before returning. This is helpful if cykTask's events are broadcast to multiple handlers.

Parameters

cycTask	the task structure (not NULL!)
eventsThreshold	threshold for cykTask.count (update for every round)
cycTaskSnap	copy of cykTask under mutex lock before returning

Returns

0: success, else: one of the error codes occurred

5.42.2.32 getCykTaskCount()

```
uint32_t getCykTaskCount (
            cycTask_t const *const cycTask )
```

Get a cycle's/task's current event counter.

This is done under (cyclist's) mutex lock.

Parameters

cycTask	the task structure

Returns

cycTask's event counter value (.count) got under lock; 0x7FffFFffFFf7 on any error (null, lock error) situation

5.42.2.33 stopMSwatch()

```
uint16_t stopMSwatch ( )
```

Get a (stop-watch) ms reading.

This function provides an 16 bit reading of the cyclist's (64 bit) milliseconds. It is intended for measuring short (<= 1min) durations.

Hint: This functions thread safety stems from the hope of 16 bit increments being atomic. Even if no problems in this respect were observed on Raspberry Pi 3s, it may be just hope in the end. Thread-safe values are, of course, provided in the cycTaskEventData_t structure. But those are frozen within one cycle task step, and, hence, not usable as stop-watch readings within such step.

5.42.2.34 getMSinS()

```
uint16_t getMSinS ( )
```

Get a ms in s reading.

This function provides the cyclist's ms in sec as 16 bit unsigned reading. It is intended for measuring and testing durations.

Hint: This functions does nothing for thread safety. It hopes 16 bit accesses being atomic. Even if no problems in this respect were observed on Raspberry Pi 3s, it may be just hope in the end. Thread-safe values are, of course, provided in the cycTaskEventData_t structure. But those are frozen within one cycle task step, and, hence, not usable as stop-watch readings within such step.

5.42.2.35 get10inS()

```
uint8_t get10inS ( )
```

Get a 10th of second in s reading.

This function provides the cyclist's tenth in seconds reading (0..9). It is intended for cyclic tasks with times greater than 100 ms or asynchronous tasks to get a coarse second sub-division.

Hint: Cyclic tasks get this value in their task date valid at start. This function provides an actual value for tasks running longer than 100ms.

5.42.2.36 getAbsS()

```
uint32_t getAbsS ( )
```

Get the absolute s reading.

This function provides a 32 bit monotonic seconds value.
Base of this 32 bit value is the cyclist's 64 bit epoch time in seconds, 0 being 1.1.1970 00:00:00 UTC on almost all Linuxes and C libraries.

This unsigned 32 bit holds until 7. February 2106, which is far longer than the projected lifetime age of this library and of Raspberry Pi3s. (But who knows?) The value may be used for seconds-resolution, absolute (i.e. zone and DST independent) time-stamps and interval calculations (which will be incorrect with leap seconds).

Hint: Cyclic tasks get this value (.realSec) in their task date valid at tick start. Hence, this function is intended for asynchronous tasks or cyclic tasks with periods $>$ 1s.

Since version R.110 we dare to fetch this value without lock, assuming ARMv7 32 bit load and stores being atomic.

5.42.2.37 theCyclistStart()

```
int theCyclistStart (
            int startMsDelay )
```

Start the cycles handler.

This function initialises and then runs the predefined cycles cycles (as of Sept. 2020: 1ms, 10ms, 20ms, 100ms and 1s; see have1msCyc) when enabled.

Besides the absolute / monotonic times for the cycles it also initialises real time and timers handling.

Timers and cycles are run in an extra thread made by this function. And to be precise, the cycles are not run here; instead, cyclic events are generated and broadcast.

As the thread started by this function also provides monotonic and civil times and stamps it should be started with the program (i.e. earliest in main()). Preparation time before the cycles should start can be handled by the delay parameter.

As of September 2020 five cycles (see above) are defined and handled. It is strongly recommended not to use more than two of them and implement other cycles with multiple periods by sub-division. That means, e.g., do not enable the 20ms cycle when having the 10ms one.

Parameters

startMsDelay	number of ms before generating the first cyclic event; allowed range 12 .. 1200; default 1

Returns

0: after having initialised all and having made and started the cyclist thread; other values signal errors

5.42.2.38 theCyclistWaitEnd()

```
int theCyclistWaitEnd ( )
```

Wait for the end of the cycles thread.

This function does so by unconditionally joining the cyclist thread.

Returns

the return value of thread join; 0: join OK

5.42.2.39 endCyclist()

```
int endCyclist (
            void  )
```

The cycles handler arrived.

This function cleans up after theCyclist. It should be called after theCyclist() ending successfully on commonRun false. The controller thread shall call this function after having joined and cleaned up all of its threads. It may also be put in an exit hook.

Returns

0: OK; else: a cycTaskDestroy() error

5.42.3 Variable Documentation

5.42.3.1 parsResult

```
long int parsResult[]  [extern]
```

Long array of length 14.

Prepared for non thread safe use with parse2Long()

5.42.3.2 startRTime

```
timespec startRTime  [extern]
```

Start time (structure, monotonic real time clock).

By initStartRTime() or by theCyclistStart() actRTime and this startRTime will initially be set. actRTime may be updated on demand, but startRTime should be left unchanged.

5.42.3.3 actRTmTxt

```
char actRTmTxt[]  [extern]
```

Actual broken down time (text).

```
            |-3|-  10  -|1|- 12     -|
```

The format is: Fr 2017-10-20 13:55:12.987 UTC+20 .....0123456789x123456789v123456789t1234 was Fr 2017-10-20 13:55:12 UTC+20 The length is 32.

5.42.3.4 stmp23

```
char const* const stmp23  [extern]
```

The current time as text.

/code The format is: 2017-10-20 13:55:12.987 UTC+20 .....0123456789x123456789v123456789 /endcode The length is 30.
Do NOT change the value provided by this pointer.

5.42.3.5 stmpSec

```
uint32_t const* const stmpSec  [extern]
```

The real time epoch seconds.

Do NOT change the value provided by this pointer.

5.42.3.6 errorText

```
char errorText[182]  [extern]
```

Common error text.

This text is set by genErrWithText() and hence indirectly by (many) other functions optionally generating error texts.

5.42.3.7 commonRun

```
volatile uint8_t commonRun  [extern]
```

Common boolean run flag for all threads.

When set false, all threads must exit as soon as possible. On any case, a thread has to exit and clean up on next signal. Setting commonRun false implies the end of the application/program and all of its threads as soon as possible.

Initialised as 1 (true) Set 0 by onSignalStop() (or application program)

5.42.3.8 sigRec

```
volatile int sigRec  [extern]
```

Storage for the signal (number) requesting exit.

Set by: onSignalStop()
See also: retCode

5.42.3.9 allCycStart

```
timespec allCycStart  [extern]
```

Common absolute / monotonic start time of all cycles.

May be considered as program's start time when cycles are started early by theCyclist. Normally not to be modified.

5.42.3.10 have1msCyc

```
uint8_t have1msCyc  [extern]
```

Flag to enable the 1ms cycle.

As a rule no more than two oft the cycles offered — cyc1ms, cyc10ms, cyc20ms, cyc100ms, cyc1sec — shall be enabled. This is no restriction as a faster cycle can easily (and often should) implement slower cycles by subdivision.

The default setting is 1ms and 100ms ON and all others OFF.
If other settings are used the flags should be set at the program's early initialisation phase and afterwards left untouched.

default: ON

See also

cycTask_t cyc1ms

5.42.3.11 have10msCyc

```
uint8_t have10msCyc  [extern]
```

Flag to enable the 10ms cycle.

default: OFF

See also

have1msCyc cycTask_t cyc10ms

5.42.3.12 have20msCyc

```
uint8_t have20msCyc  [extern]
```

Flag to enable the 20ms cycle.

default: OFF

See also

have1msCyc cycTask_t cyc20ms

5.42.3.13 have100msCyc

```
uint8_t have100msCyc  [extern]
```

Flag to enable the 100ms cycle.

default: ON

See also

have1msCyc cycTask_t cyc100ms

5.42.3.14 have1secCyc

```
uint8_t have1secCyc  [extern]
```

Flag to enable the 1s cycle.

default: OFF

See also

have1msCyc cycTask_t cyc1s

5.43 main_page.dox File Reference

This file is for extra Doxygen documentation texts, only.

5.43.1 Detailed Description

This file is for extra Doxygen documentation texts, only.

It contains no software. Copyright (c) 2018 2020 2025 Albrecht Weinert, Bochum

Revision history
```
Rev.  77 7.03.2025
Rev.  108 13.02.2018 :  new, modified from weAutSys (2014)
Rev.  109 15.02.2018 :  directory descriptions included (trial)
Rev.  209 21.07.2019 :  more links
Rev.  233 20.10.2020 :  minor corrections and updates
Rev.    77 27.02.2025 :  raspberry4distributedControl.pdf
```

5.44 meteRead.c File Reference

A CGI program to co-operate with hometerControl.

```
#include "sysBasic.h"
#include "sweetHome.h"
#include "weCGIajax.h"
#include "weShareMem.h"
```

Functions

- int main (int argc, char **argv)

  The program.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.44.1 Detailed Description

A CGI program to co-operate with hometerControl.
```
Copyright  (c)  2018 - 2025  Albrecht Weinert
weinert-automation.de        a-weinert.de
    /         /      /\
   /         /___   /  \      |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history
```
Rev.  94 2.10.2025
Rev.  76+ 06.12.2017 :  new; derived from hometersConsol.c
Rev.  115 22.02.2018 :  larger data structures
Rev.  125 23.03.2018 :  power factor (all meters and phases) added
Rev.  132 28.04.2018 :  batModU added
Rev.  149 17.06.2010 :  pps value added
```

```
Rev.  165 12.07.2018 :  temperature & batt values, pps power
Rev.  166 14.07.2018 :  more pps commands, more  help texts (title) in JSON
Rev.  170 24.07.2018 :  real temperature names; Umlauts got working
Rev.  187 14.10.2018 :  JSON sequences:    P in front, T resorted
Rev.  220 09.11.2019 :  Growatt values added to valFilVal_t
Rev.  251 11.07.2023 :  update for 2nd heater element and prep.  car load
Rev.  257 13.07.2024 :  surplus power, html update (title's UTF8 problems)
Rev.    81 26.03.2025 :  comments on web upload updated
Rev.    90 06.08.2025 :  battery state of charge (SOC)/%; soc(Ubat)
```

Client functions

This program gets values from hometersControl via shared memory synchronised with a set of semaphores:
sem # 0: exclusive lock of shared memory (for the shortest time possible !)
sem # 1: signal from from hometersControl to other program
sem # 2: signal from from hometersControl to this program (meteRead)

Under the same semaphore (#0) lock it may set command codes in the shared memory according to the query string. A query will usually be part of the request when buttons were pressed in the web page.

GCI server functions

This program's output (i.e. AJAX answer) are physical readings, status values and times as JSON object, leaving selection of values and their display to the HTML page respectively its Javascript code.

In the JSON object's text delivered all numerical values (int, float) are put as strings in appropriate form and precision. The rationale is to avoid auto parsing of data, all or most of which will probably be formatted (back to text) to be put in the web page. And, alas, formatting is not Javascript's strong point, while parsing a string to a number would not be a problem, if a number is needed.

GCI back-link – command by query

This program evaluates a query string parameter command=command. command (2nd) = startPump | stopPump etc. see sweetHome.h and cmdLookUp.

Library usage

The program uses the library (lib...): pthread

```
Build the program
```

cross-compile by:

```
make PROGRAM=meteRead TARGET=meterPi clean all
```

program by:

```
make PROGRAM=meteRead TARGET=meterPi FTPuser=sweet:1234 progapp
```

due to bugs in c make use winscp directly by entering the command displayed

```
  winscp.com /script=progTransWin /parameter sweet:0123 meterPi var/www/cgi meteRead
load the matching html page by:  \code
  make PROGRAM=meteReadHTML TARGET=meterPi progapp
```

or update all web files by:

```
make PROGRAM=www TARGET=meterPi progapp
```

The "due to bugs in c make" remark above applies to all winscp commandlines displayed.

5.44.2 Function Documentation

5.44.2.1 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

Run by (Apache) web server as (cgi) script with optional (query string) parameters.

5.44.3 Variable Documentation

5.44.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.44.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.44.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.45 meterModbusTest.c File Reference

```
#include <basicTyCo.h>
#include <time.h>
#include <stdio.h>
#include <string.h>
#include <errno.h>
#include <getopt.h>
#include "arch/config.h"
#include "sysBasic.h"
#include "weUtil.h"
#include "weGPIOd.h"
```

Functions

- int main (int argc, char **argv)

  The program.

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.45.1 Detailed Description

```
Copyright  (c)     2024  Albrecht Weinert
weinert-automation.de        a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history
```
Rev.  73 18.12.2024
Rev.   270 05.11.2024 :  develop reliable Modbus communication to smart meters
```

Just read a set of input registers of an eastron smart meter, SDM630 e.g.

NOT ready!!! playground to get rid of Stepane's overhead.

Library usage

Build the program

cross-compile by:
```
make PROGRAM=meterModbusTest TARGET=meterPi clean all
```

program by:
```
make PROGRAM=meterModbusTest TARGET=meterPi FTPuser=sweet:0123 progapp
```

or due to some bugs in make use winscp and IP directly by:
```
winscp.com /script=progTransWin /parameter sweet:0123  meterPi bin meterModbusTest
```

5.45.2 Function Documentation

5.45.2.1 main()

```
int main (
            int argc,
            char ** argv )
```

The program.

run by: meterModBusRest [options

For options see longOptions and :: optHlpTxt.

5.45.3 Variable Documentation

5.45.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.45.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.45.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.46 minTerm.c File Reference

A console program for a RS232 UART on the Pi.

```
#include "weSerial.h"
#include <errno.h>
#include <getopt.h>
#include <pthread.h>
#include <modbus-private.h>
#include <modbus.h>
#include "weUtil.h"
#include <weModbus.h>
#include <dirent.h>
```

Functions

- void progPrepare ()

Variables

- char const prgNamPure [ ]
  The pure program name.
- char const prgSVNdat [ ]
  The complete SVN date string.
- char const prgSVNrev [ ]
  The complete SVN revision string.

5.46.1 Detailed Description

A console program for a RS232 UART on the Pi.

```
Copyright (c) 2019 2025 Albrecht Weinert
weinert-automation.de a-weinert.de
```

Revision history

```
Rev.  83 15.05.2025
Rev.  204 28.06.2019 :  new; first step just for testing UART
Rev.  270 07.11.2024 :  the old include before meterpi crash ("BC")
Rev.    76 21.02.2024 :  sched_yield() instead of pthread_yield()
```

Program functions

This program offers very basic communication and Modbus usage with Raspberry's serial interface for testing and developing.

Library usage

This program uses libmodbus.

Build

```
make PROGRAM=minTerm TARGET=growPi clean all
make PROGRAM=minTerm TARGET=growPi progapp
make PROGRAM=minTerm clean
winscp.com /script=progTransWin /parameter sweet:0123 meterPi bin minTerm
```

5.46.2 Function Documentation

5.46.2.1 progPrepare()

```
void progPrepare ( )
```

20.0220.25

5.46.3 Variable Documentation

5.46.3.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.46.3.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.46.3.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.47 mosquiSub.c File Reference

A very simple MQTT subsciber.

```
#include <signal.h>
#include <stdio.h>
#include <stdint.h>
#include <string.h>
#include <unistd.h>
#include <mosquitto.h>
#include <getopt.h>
```

Variables

- char clientId [30]

  Id of this MQTT subscriber.
- char mqttHost [68]

  The MQTT broker URL or name.
- int **mqttPort**

  MQTT port 1883.
- char **topicS** [60]

  Root of topics to log.

5.47.1 Detailed Description

A very simple MQTT subsciber.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \     /      \|   |
     \/  \/   \__/         \__/|_
```

cross-compile by:

```
make PROGRAM=mosquiSub TARGET=meterPi clean all
```

program respectively transfer to target machine by:

```
make PROGRAM=mosquiSub TARGET=meterPi FTPuser=sweet:0123 progapp
```

respectively by the displayed

```
winscp.com /script=progTransWin /parameter sweet:0123 192.168.178.87 bin mosquiSub
```

The building of the application is governed by the make include makeProg_mosquiSub_settings.mk:

```
# A makefile include for raspberry projects
# program include for one program
# makeProg_mosquiSub_settings.mk
# Copyright  2017  Albrecht Weinert    < a-weinert.de >
MAKE_INCLUDE_PROGRAM  = mosquiSub
MAKE_PROGRAM_LAST_CHANGE = '$Date:  2021-02-02 18:11:02 +0100 (Di, 02 Feb 2021) $ '
MAKE_PROGRAM_REVISION = '$Revision:  38 $ '
ifndef COPYRIGHT_YEAR
$(error includefile $(MAKE_INCLUDE_PROGRAM) used directly.)
endif
# PROGRAM or MAIN_F might have been given in wrong case (at least on Windows)
override MAIN_F = $(MAKE_INCLUDE_PROGRAM)
# An optional short multiline description of this program's specifica.
# May be empty.  But, do not change the three lines define endef and export.
define PROG_DES_TEXTT
Program mosquiSub
This program is a first example of a MQTT subscriber as well as a minimal
test program to see whats going on with subjects labExp/sweetHome/#.
endef
export PROG_DES_TEXT
extraLDFLAGS = -lmosquitto
# extraSOURCES = weRasp/weUtil.c weRasp/weShareMem.c weRasp/weCGIajax.c
# FTPdir = var/www/cgi
```

5.47.2 Variable Documentation

5.47.2.1 mqttHost

```
char mqttHost[68]
```

The MQTT broker URL or name.

May be set by option –mqttHost meterPi or –mqttBroker 192.168.178.87

default: localhost MQTTBroker (currently localhost !)

5.47.2.2 clientId

```
char clientId[30]
```

Id of this MQTT subscriber.

MQTT client ID.

5.48 rdGnBlink.c File Reference

A simple output program for Raspberry's GPIO pins 75 (19.02.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

```
#include "arch/config.h"
#include <stdlib.h>
#include <stdio.h>
#include <pigpio.h>
#include <pigpiod_if2.h>
#include <unistd.h>
#include <signal.h>
#include "weGPIOd.h"
#include "weLockWatch.h"
```

Variables

- char const prgNamPure [ ]

  The pure program name.
- char const prgSVNdat [ ]

  The complete SVN date string.
- char const prgSVNrev [ ]

  The complete SVN revision string.

5.48.1 Detailed Description

A simple output program for Raspberry's GPIO pins 75 (19.02.2025) Copyright (c) 2024 Albrecht Weinert weinert-automation.de a-weinert.de.

This is a second simple GPIO pin output program using pigpio(d), as does gnBlinkSimple.c. Additionally, it has features qualifying it as a process control service. It locks gpio, it can run endlessly and it cleans up when ended. Hence, it may be the germ cell of of simple real time control applications.

Compile on Pi by: gcc -lpigpiod_if2 -I./include -o rdGnBlink rdGnBlink.c gcc -lpigpiod_if2 -I./include -c -o weRasp/weLockWatch.o weRasp/weLockWatch.c gcc -lpigpiod_if2 -I./include -c -o weRasp/sysBasic.↩ o weRasp/sysBasic.c

Compile on Windows by:

```
arm-linux-gnueabihf-gcc -DF_CPU=1200000000 -DPLATFORM=raspberry_03 -DMCU=BCM2837  -DTARGET=Pi4all
      -I./include    -c -o rdGnBlink.o rdGnBlink.c
arm-linux-gnueabihf-gcc -DF_CPU=1200000000 -DPLATFORM=raspberry_03 -DMCU=BCM2837  -DTARGET=Pi4all
      -I./include    -c -o weRasp/weLockWatch.o weRasp/weLockWatch.c
arm-linux-gnueabihf-gcc -DF_CPU=1200000000 -DPLATFORM=raspberry_03 -DMCU=BCM2837  -DTARGET=Pi4all
      -I./include    -c -o weRasp/sysBasic.o weRasp/sysBasic.c
cp  rdGnBlink.elf rdGnBlink
winscp.com /script=progTransWin /parameter sweet:0123  targetPi bin  gnBlinkSimple
```

or better by

```
make PROGRAM=rdGnBlink TARGET=pi4play clean all
make PROGRAM=rdGnBlink TARGET=pi4play FTPuser=sweet:0123 progapp
```

5.48.2 Variable Documentation

5.48.2.1 prgNamPure

```
char const prgNamPure[]
```

The pure program name.

To be provided in the application's / program's source.

See also

progNam() progNamB()

5.48.2.2 prgSVNrev

```
char const prgSVNrev[]
```

The complete SVN revision string.

To be provided in the application's / program's source.

See also

progRev()

5.48.2.3 prgSVNdat

```
char const prgSVNdat[]
```

The complete SVN date string.

To be provided in the application's / program's source.

See also

progDat()

5.49 weRasp/sweetHome.c File Reference

Common values for an experimental smart home (lab) project.

```
#include "sweetHome.h"
#include "weBatt.h"
#include <stdio.h>
```

Variables

- cmdLookUp_t cmdLookUp [ ]

  The common command look up table.
- volatile float fLine

  last valid power line frequency
- volatile int invHasUnloadPow

  The miniJoule inverter has battery unload power.
- float const **phPckSwPow** [101]

  First (or only) phase packet switching device power look up.
- phPckSwSet_t const phPckSwSets [101]

  The packet switch control values.
- smdX30modbus_t smdX30modbus [ANZmodSLAVES]

  Descriptive and state array for smart meters on Modbus.
- volatile int tempTankWater

  Last value of tank water temperature.
- volatile uint8_t tempWaterBadCnt

  Tank water temperature bad read count.
- valFilVal_t **valFilVal**

  All process values relevant for log files and HMI.

5.49.1 Detailed Description

Common values for an experimental smart home (lab) project.

```
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    /         /      /\
   /         /___    /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \     /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  94 2.10.2025
Rev.    99 29.01.2018 :  load module voltage handling added
Rev.  217 05.09.2019 :  phase packet switch ballast three 100% values
Rev.  229 23.07.2020 :  valFil (CSV) removed
Rev.  245 27.02.2023 :  pps 100% power raised to 1983 W due panel reorg.
Rev.  268 15.10.2024 :  float lookup Uload(pwm) range 0..141 now float
Rev.    75 09.02.2025 :  remove old tables
Rev.    90 30.07.2025 :  new Uload(pwm) table (pwm range 0..254)
Rev.    90 06.08.2025 :  battery state of charge (SOC)/% <-> Ubat
Rev.    92 15.08.2025 :  load unload values and SFCs
Rev.    94 24.09.2025 :  charge module settings changed, hence loadModUlookup &c
```

5.49.2 Variable Documentation

5.49.2.1 cmdLookUp

```
cmdLookUp_t cmdLookUp[ ]
```

The common command look up table.

It must end with an entry {"", 0}.

The current (CGI) program uses linear search for the command mnemonic. Hence, and cause of structure, alphabetic sorting is of no avail.

5.49.2.2 fLine

```
volatile float fLine
```

last valid power line frequency

Last valid power line frequency.

5.49.2.3 phPckSwSets

```
phPckSwSet_t const phPckSwSets[101]
```

The packet switch control values.

The array holds the number of on and off phases (i.e. 20 ms periods at 50 Hz line frequency) for each percentage of full power. The array length is 101; the index [0..100] is, hence, directly the percentage wanted.

To avoid too visible flicker, for no set (phPckSwSets[i].onPhases, phPckSwSets[i].offPhases) the smaller of the two values would be greater than 4 (80 ms); in most cases it is 1 or 2 (40 ms).

5.49.2.4 smdX30modbus

```
smdX30modbus_t smdX30modbus[ANZmodSLAVES]
```

Descriptive and state array for smart meters on Modbus.

The number of meters is ANZmodSLAVES.

5.49.2.5 tempTankWater

```
volatile int tempTankWater
```

Last value of tank water temperature.

This value will be the last good .tempTankTop (see valFilVal_t) or the last good .tempPipe. If neither is good for 251 measurements BAD_TEMP_READ (an incredibly high value) will be set.
This last tank water temperature will be checked against a safety limit to allow electric heating as ballast.
The value is in units of 1/1000 grdC.

5.49.2.6 tempWaterBadCnt

```
volatile uint8_t tempWaterBadCnt
```

Tank water temperature bad read count.

This last tank water temperature will be checked against a safety limit to allow electric heating as ballast.

In case of too many bad reads the value must be fixed at 253

5.49.2.7 invHasUnloadPow

```
volatile int invHasUnloadPow
```

The miniJoule inverter has battery unload power.

Or at least may still have due to step up converter capacitors.

5.50 weRasp/sweetHome2.c File Reference

Common values for an experimental smart home (lab) project.

```
#include "sweetHome2.h"
#include "weBatt.h"
#include "sweetHomeLocal.h"
```

Functions

- void batKeepInhTimChg (state_t ∗const me)

  Inhibit battery keep alive loading timer state change function.
- void befRiseTimChg (state_t ∗const me)

  Before sunrise timer state change callback.
- void changeBatLoadPWM (int pwmChg)

  Change battery loader module PWM.
- void dawnTimChg (state_t ∗const me)

  Dawn timer state change callback.
- void duskTimChg (state_t ∗const me)

  Dusk timer state change callback.
- void genSunStateText (char ∗stateText, state_t const ∗const me, char const ∗stamp)

  Generate the sun's status text.
- void logBatteryState ()

  Log battery state on outLog as line with time stamp.
- void **mqttClean** ()

  End as MQTT client.
- int mqttInit ()

  Initialise as MQTT client.
- void mqttPlg01Set (uint8_t const on)

  Switch the plug Plug01.
- void mqttPlg02Set (uint8_t const on)

  Switch the plug PLG2.
- void mqttPlg03Set (uint8_t const on)

  Switch the plug PLG3.
- void mqttPlg04Set (uint8_t const on)

  Switch the plug PLG4.
- uint8_t pckSwPec (float power)

  Set and get package switch percentage by power.
- void setBatLoadPWM (int const pwm)

  Set battery loader module PWM.

- void setConsGiv (state_t *const me)

  Power consumer / producer (give away) SFC transition.
- uint8_t setPckSwPerc (uint8_t perc)

  Set package switch percentage.
- float setPhPckLimit (float powerLimit)

  Set and get package switch power limit.
- void solPowStateText (char *stateText, state_t const *const me, char const *stamp)

  Generate solar power status text.
- void sunriseTimChg (state_t *const me)

  Sunrise timer state change callback.
- void sunsetTimChg (state_t *const me)

  Sunset timer state change callback.
- void surplStateText (char *stateText, state_t const *const me, char const *stamp)

  Generate surplus power status text.
- void switchBatToStepUp (uint8_t const on)

  Switch battery to step up converter.
- void switchConsGiv (state_t *const me)

  Power consumer / producer (give away) transition.
- void switchHotWpump (uint8_t const on)

  Hot water comfort pump turn on/off.
- void switchSolPow (state_t *const me)

  Solar power producer transition.
- void switchWouldGiv250W (state_t *const me)

  Would give 250W or more away, the transition.
- void switchWouldGivAway (state_t *const me)

  Would give away transition.

Variables

- state_t batKeepInh

  Inhibit battery keep alive loading.
- int batLoadAllowed

  Battery loading allowed.
- volatile uint8_t batLodTst

  Battery loader test modus.
- volatile int batModPWM

  The actual battery load module's PWM input.
- int batUnloadAllowed

  Battery unload allowed.
- uint8_t batVoltValid

  The measured battery voltage is valid.
- state_t befRiseTimer

  Before sunrise timer.
- char clientId [38]

  MQTT client ID.
- state_t consumeGiveHyst

  Give away hysteresis.
- state_t consumeGiveSFC

  Give away state machine / SFC.
- state_t dawnTimer

Dawn timer.

- state_t duskTimer

  Dusk timer.

- uint8_t **heaterAllowed**

  phase packet load enabled (always)

- int hippoSwitchMode

  Hippogreiff on/off times.

- uint16_t hundredsV

  The battery voltage in 0.01V units.

- char mqttHost [68]

  The MQTT broker URL or name.

- int **mqttPort**

  MQTT port 1883.

- volatile uint8_t **phPckCnt**

  current switch state duration counter

- volatile uint8_t **phPckOff**

  current phase packet switch OFF duration

- volatile uint8_t **phPckOn**

  current phase packet switch ON duration

- volatile uint8_t **phPckRelOffDelay**

  PPS relay off delay.

- volatile uint8_t **phPckS2**

  heater 2 pps switch state: 0 off; 1 on

- volatile uint8_t **phPckSw**

  phase packet switch state: 0 off; 1 on

- volatile uint8_t phPckSwIndex

  Actual index (0..200%) determining power.

- volatile uint8_t **phPpow2**

  heater 2 power ∗ 50% (0:0% .. 2:100%)

- oneWireDevice_t **sensors** [NUM1W_SENSORS]

  The 1-wire sensors used.

- state_t solarPowerHyst

  Solar power producer hysteresis.

- char subTopStPlg01 [14]

  State sub topic of S20 plug Number 01 to 09.

- state_t sunriseTimer

  Sunrise timer.

- state_t sunsetTimer

  Sunset timer.

- state_t wouldGive250WHyst

  Would give away 250W hysteresis.

- state_t wouldGiveAwayHyst

  Would give away hysteresis.

5.50.1 Detailed Description

Common values for an experimental smart home (lab) project.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  95 9.10.2025
Rev.    85 09.01.2018 :  new
Rev.    99 29.01.2018 :  load module voltage handling added
Rev.  148 16.06.2018 :  time handling improved, Hippogreiff relay
Rev.  187 14.10.2018 :  Hippogreiff off 2h before sunrise
Rev.  189 06.12.2018 :  Hippo and (in between optional) Plug 3/4 back to rise
Rev.  197 03.03.2019 :  Plug 2 hippo; Plug04 surplus power
Rev.  199 02.04.2019 :  allow battery unload before sunrise as default
Rev.  200 16.04.2019 :  battery keep inhibit until low stress
Rev.  203 30.04.2019 :  timer macro change, sun times & surplus log enhanced
Rev.  205 19.05.2019 :  log battery stress (%) repaired
Rev.  206 27.05.2019 :  PPS pre relay off delay 5 minutes (en lieu de 3s)
Rev.  209 22.07.2019 :  work around a Doxygen bug
Rev.  222 18.03.2020 :  noUnloadBat as default
Rev.  232 13.12.2022 :  off Hippogreiff 2h earlier
Rev.  248 29.06.2023 :  relays reorg.  (1.  defect & prep.  extra heater)
Rev.  252 17.08.2023 :  ECar loading ++
Rev.  256 15.12.2023 :  Hippogreiff sunset to sunrise (again) in winter
                     make:  implement automatic summer winter change   !!
                     check:  dif./semantics/use dawn vs.  beforeSunRise !!
Rev.  256 17.03.2024 :  flexible /ref Hippogreiff switching times
Rev.  260 06.08.2024 :  force battery loading pwm <= BAT_LDMX_PWM
Rev.    84 04.06.2025 :  solPowerProd:  display OFF corr.; miniJoule->Envertech
Rev.    85 14.06.2025 :  miniJoule inverter replaced - cleanup
Rev.    87 03.07.2025 :  solarPowerHyst values
Rev.    90 06.08.2025 :  battery SOC/% <-> Ubat; load test prep.
```

This file is the addendum to sweetHome.c and sweetHome.h containing process IO related issues, not necessary for pure HMI or logging related programs.

5.50.2 Function Documentation

5.50.2.1 switchHotWpump()

```
void switchHotWpump (
             uint8_t const on )
```

Hot water comfort pump turn on/off.

It turns the hot water comfort circulation pump on respectively off.

Parameters

on	!= 0 : on; else, ==0 : off

5.50.2.2 setPhPckLimit()

```
float setPhPckLimit (
            float powerLimit )
```

Set and get package switch power limit.

This function sets the PPS power limit in the range 0.0 ... PCK_POWER_LIM_MAX.

Parameters

powerLimit	PPS power limit in W

Returns

the (new) power limit

5.50.2.3 pckSwPec()

```
uint8_t pckSwPec (
            float power )
```

Set and get package switch percentage by power.

Besides determining an returning the percentage(power), this function sets the process control values via setPckSwPerc() returns its value.

Parameters

power	in W

Returns

the phase packet percentage 0..100

5.50.2.4 setPckSwPerc()

```
uint8_t setPckSwPerc (
            uint8_t perc )
```

Set package switch percentage.

This function sets phPckSwIndex by the parameter value in the range 0..200; respectively PCK_POWER_IND_MAX. Additionally it adjusts the current phPckCnt should its value be higher than by the new setting.

On transitions from respectively to 0 the control relay (PCK_POWER_REL) is actuated before respectively after actuating the electronic switch.

This function also sets .phPckpower in valFilVal according to the values in table (array) phPckSwPow.

Parameters

perc	0..200; values above PCK_POWER_IND_MAX will have no effect and return the current setting un-altered

Returns

the actual (new) phase packet percentage 0..200

5.50.2.5 logBatteryState()

```
void logBatteryState ( )
```

Log battery state on outLog as line with time stamp.

Logs the battery voltage in the format
```
/0123456789x123456789v123456789t123456789q123456789c123456789s123456789S1234567
/ 2019-05-01 11:58:16.600 # battery 1?.05 V, pwmL 000:  13.08V;  1234.6W       .
/linefeed
```

5.50.2.6 switchBatToStepUp()

```
void switchBatToStepUp (
            uint8_t on )
```

Switch battery to step up converter.

When the parameter is !=0 respectively ON, this function switches the battery to the step up converter.

When the parameter is off, this function switches the battery to the (max. 20 A) battery loader / keep alive module .

Parameters

on	true: switch battery to step up converter; 0, false: switch battery to load modul.

5.50.2.7 batKeepInhTimChg()

```
void batKeepInhTimChg (
            state_t *const me )
```

Inhibit battery keep alive loading timer state change function.

It turns the battery keep alive loading on when ending, see BAT_KEEP_PWM.

Parameters

me	pointer to the inhibit battery keep alive loading timer

5.50.2.8 setBatLoadPWM()

```
void setBatLoadPWM (
            int pwm )
```

Set battery loader module PWM.

This function sets the battery load module power PWM signal and hence its output voltage. 0 is the lowest and 255 the highest possible setting. While this function allows setting to 0, the highest value is limited to BAT_LDMX_PWM.

Parameters

pwm	the pwm ratio 0: 0%; 255: 100%

5.50.2.9 changeBatLoadPWM()

```
void changeBatLoadPWM (
            int pwmChg )
```

Change battery loader module PWM.

This function adds the parameter pwmChg's value to the current one limits the result to BAT_NOLD_PWM ... BAT_LDMX_PWM and sets it (see setBatLoadPWM).

Parameters

pwmChg	the change of the pwm value

5.50.2.10 befRiseTimChg()

```
void befRiseTimChg (
            state_t *const me )
```

Before sunrise timer state change callback.

On timer end .....

Parameters

me	pointer to the sunset timer

5.50.2.11 dawnTimChg()

```
void dawnTimChg (
             state_t *const me )
```

Dawn timer state change callback.

On timer end .....

Parameters

me	pointer to the dawn timer

5.50.2.12 sunriseTimChg()

```
void sunriseTimChg (
             state_t *const me )
```

Sunrise timer state change callback.

On timer end turn off Hippogreiff (again) and mqttPlg02.
No more turning off battery unload due to replacing the one input miniJoule inverter by a two input Enversys. One input is for the PV panels and one for the battery discharge step up converter. Hence, solar power and battery discharging can be used simultaneously and do not have to be guarded against each other.

Parameters

me	pointer to the sunrise timer

5.50.2.13 sunsetTimChg()

```
void sunsetTimChg (
             state_t *const me )
```

Sunset timer state change callback.

On timer end .....

Parameters

me	pointer to the sunset timer

5.50.2.14 duskTimChg()

```
void duskTimChg (
            state_t *const me )
```

Dusk timer state change callback.

On timer end .....

Parameters

me	pointer to the sunset timer

5.50.2.15 genSunStateText()

```
void genSunStateText (
            char * stateText,
            state_t const *const me,
            char const * stamp )
```

Generate the sun's status text.

This function makes the special log text for sun's times: set, rise etc..

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.50.2.16 switchSolPow()

```
void switchSolPow (
            state_t *const me )
```

Solar power producer transition.

At the moment just switch the relays and set a flag.
Note 1: trigger with pSolar

Note 2: Used for state_t solarPowerHyst only.
state_t solarPowerHyst = newFloatHyst("solPowerProd", switchSolPow, ...

Parameters

me	pointer to the give away hysteresis

5.50.2.17 solPowStateText()

```
void solPowStateText (
            char * stateText,
            state_t const *const me,
            char const * stamp )
```

Generate solar power status text.

This function generates the log text for the solar power on/off discriminator.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.50.2.18 switchWouldGivAway()

```
void switchWouldGivAway (
            state_t *const me )
```

Would give away transition.

At the moment just switch the relays and set a flag. Note: trigger wouldGiveAwayHyst with pGiveAway

Parameters

me	pointer to the give away hysteresis

5.50.2.19 switchWouldGiv250W()

```
void switchWouldGiv250W (
            state_t *const me )
```

Would give 250W or more away, the transition.

At the moment just switch the relays and set a flag. Note: trigger with pGiveAway

Parameters

me	pointer to the give away hysteresis

5.50.2.20 switchConsGiv()

```
void switchConsGiv (
            state_t *const me )
```

Power consumer / producer (give away) transition.

Triggered with pHome, at transitions relay and plug are switched for signalling via the switchConsGiv() SFC to have minimal on and off times.

At transitions to OFF, i.e. producer role imminent, battery ballast loading will be started (if not yet ON).

Parameters

me	pointer to the give away hysteresis

5.50.2.21 setConsGiv()

```
void setConsGiv (
            state_t *const me )
```

Power consumer / producer (give away) SFC transition.

At the moment just switch the relays and set a flag. Note: trigger with pHome (hyst)

Parameters

me	pointer to consumeGiveSFC

5.50.2.22 surplStateText()

```
void surplStateText (
            char * stateText,
            state_t const *const me,
            char const * stamp )
```

Generate surplus power status text.

This function generates the log text for the surplus power status machine.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.50.2.23 mqttInit()

```
int mqttInit ( )
```

Initialise as MQTT client.

On success only: subscribe, loop and publish.

Returns

0: success the common mosq is set and usable; else: errno

5.50.2.24 mqttPlg01Set()

```
void mqttPlg01Set (
            uint8_t const on )
```

Switch the plug Plug01.

This function publishes the switch command via MQTT to the relay device Plug01, usually a Sonoff S20 with Tasmota.

Parameters

on	switch on when true, else off

5.50.2.25 mqttPlg02Set()

```
void mqttPlg02Set (
            uint8_t const on )
```

Switch the plug PLG2.

See mqttPlg01Set

5.50.2.26 mqttPlg03Set()

```
void mqttPlg03Set (
            uint8_t const on )
```

Switch the plug PLG3.

See mqttPlg01Set

5.50.2.27 mqttPlg04Set()

```
void mqttPlg04Set (
            uint8_t const on )
```

Switch the plug PLG4.

See mqttPlg01Set

5.50.3 Variable Documentation

5.50.3.1 phPckSwIndex

```
volatile uint8_t phPckSwIndex
```

Actual index (0..200%) determining power.

This is the control variable for the electric heater elements in the hot water tank. Until June 2023 there was one such element of PCK100PERC_POWER W and this variable had a range of 0..100%. Since July 2023 there are two heater elements of equal power. The range of this control variable was extended to 0..200%. The power distribution between the two heater elements is done by software; see setPckSwPerc(uint8_t const perc) and PCK_POWER_IND_MAX

5.50.3.2 batVoltValid

```
uint8_t batVoltValid
```

The measured battery voltage is valid.

When not 0 the last MQTT battery voltage measurement respectively message is not older than 2.4s and hence considered the actual valid value.

5.50.3.3 batUnloadAllowed

```
int batUnloadAllowed
```

Battery unload allowed.

Bit 0 (1): allow after sunset
Bit 1 (2): allow before sunrise
Bit 3 (4): allow when Pimp > 400W, i.e. allow also at daylight.
Bit 4 (8): default (usually 2 in winter and 3 in summer)
Start value: 8 = default
Note: Must be a standard integer (no uint_8 e.g.) for use in getopt_long.

See also

BAT_UNL_SUMM

BAT_UNL_WINT

5.50.3.4 batLoadAllowed

```
int batLoadAllowed
```

Battery loading allowed.

Bit 0 (1): allow ballast loading
Bit 1 (2): allow automatic / controlled loading
start value: 3 = all allowed
Note: Must be a standard integer (no uint_8 e.g.) for use in getopt_long.

See also

batUnloadAllowed

BAT_LOAD_FORBID

5.50.3.5 hippoSwitchMode

```
int hippoSwitchMode
```

Hippogreiff on/off times.

Bit 0,1 (3): switch at sunset resp. sunrise (winter)
Bit 2,3 (12): switch at dusk resp. dawn (summer)
start value: 12 (/ref Hippogreiff summer)

5.50.3.6 hundredsV

```
uint16_t hundredsV
```

The battery voltage in 0.01V units.

This is just an integer value consistent to the last valid battery voltage measurement valFilVal.batVolt. Contrary to valFilVal.batVolt which is set to -0.9 to indicate invalidity after 2.4s without new (MQTT) measurements, this value will be kept (forever).
It is preset with 1289 (12.89 V) lest have battery low before the first valid MQTT measurement / message.
Receiving a good MQTT message from the battery voltmeter will set valFilVal.batVolt, batVoltValid and this value.
Use formFixed16(&textStart, hundredsV, 2) to format as "12.89" without trailing zero.

See also

formFixed16 valFilVal batVoltValid

5.50.3.7 batModPWM

```
volatile int batModPWM
```

The actual battery load module's PWM input.

The range of the Pi's pwm output control register 0 for 0 % or permanent off to 255 for 100% respectively permanent on. The eight bit register, hence, is to be fed with an unsigned 8 bit value which was for many years the type of this variable.
A new loader module since August 2025 uses the full range 0..255. This variable was made a standard int to simplify underflow and overflow detection.
Note: Keeping this variable's value in the range 0 .. +255 is essential!

5.50.3.8 batLodTst

```
volatile uint8_t batLodTst
```

Battery loader test modus.

A value 0 means normal loading, keeping or idle mode.
Other values mean test modus, i.e. have stable PWM values to allow test measurements. These PWM values are usually set manually.

See also BAT_LDTEST_MAX_PWM, BAT_LDTEST_MIN_PWM, BAT_LDTEST_UPS_PWM, BAT_LDTEST_↩ DWN_PWM, setBatLoadPWM

5.50.3.9 batKeepInh

```
state_t batKeepInh
```

Inhibit battery keep alive loading.

This timer will be started after battery loading and unloading for a specific time BATkeepInhContLoad, BATkeepInhUnload or BATkeepInhByCmd. This timer is initially OFF and will be stopped in advance by battery keep command via HMI/GUI.
It will be started after battery unload, after battery ballast load and by battery off command via GUI.
When running out it will start battery keep alive with BAT_KEEP_PWM.

Note: The feature seems/is unnecessarily complicated due to its lead acid battery past

5.50.3.10 sunriseTimer

```
state_t sunriseTimer
```

Sunrise timer.

This timer will run out every day at (approximated) sunrise. For the "every day" behaviour, its state change function will — after all due actions — restart this timer for the next 24h to hit (very approximately) the next sunrise. This acceptable guess will be adjusted at day change or at program start.

5.50.3.11 sunsetTimer

```
state_t sunsetTimer
```

Sunset timer.

This timer will run out every day at (approximated) sunset. See also sunriseTimer

5.50.3.12 befRiseTimer

```
state_t befRiseTimer
```

Before sunrise timer.

This timer will run out every day at about 180 min before (approximated) sunrise. The offset must be sufficient time to unload the battery before sunrise.
See also: sunriseTimer BEFORE_RISE

5.50.3.13 dawnTimer

```
state_t dawnTimer
```

Dawn timer.

This timer will run out every day at (approximated) dawn, meaning the beginning of civil twilight. See also sunriseTimer and duskTimer

5.50.3.14 duskTimer

```
state_t duskTimer
```

Dusk timer.

This timer will run out every day at (approximated) dusk, meaning the end of civil twilight. About this time street lamps and position lights may be lit. See also sunriseTimer

5.50.3.15 solarPowerHyst

```
state_t solarPowerHyst
```

Solar power producer hysteresis.

The limits of the power of the biggest (or all) PV panels to recognise the availability / generation of solar power.
Current limits 7.9W (off), 40.0 W (on); since 03.07.2025
Former values 4.8, 12.02

5.50.3.16 wouldGiveAwayHyst

```
state_t wouldGiveAwayHyst
```

Would give away hysteresis.

thresholds (04.03.18): -/+ 7W

5.50.3.17 wouldGive250WHyst

```
state_t wouldGive250WHyst
```

Would give away 250W hysteresis.

thresholds (04.03.18): -250 / -178W

5.50.3.18 consumeGiveHyst

```
state_t consumeGiveHyst
```

Give away hysteresis.

thresholds: PDEL_SGGIVE, PDEL_SGCONS

5.50.3.19 consumeGiveSFC

```
state_t consumeGiveSFC
```

Give away state machine / SFC.

Status ON means consumer: OK.
Status OFF means very low power consumption: Inhibit power delivery.

5.50.3.20 mqttHost

```
char mqttHost[68]
```

The MQTT broker URL or name.

May be set by option –mqttHost meterPi or –mqttBroker 192.168.178.87

default: localhost MQTTBroker (currently localhost !)

5.50.3.21 subTopStPlg01

```
char subTopStPlg01[14]
```

State sub topic of S20 plug Number 01 to 09.

It's preset as plug01/POWER for 01, but the digit at index [5] will be set before each use accordingly.

5.50.3.22 clientId

```
char clientId[38]
```

MQTT client ID.

default value: sweetHomeControl; length: 15; max. length: 36
May be changed before mqttInit().

MQTT client ID.

5.51 weRasp/sysBasic.c File Reference

Some system related basic functions for Raspberry Pis.

```
#include "sysBasic.h"
```

Functions

- uint8_t **errLogIsStd** (void)
  Error log (errLog) is standard stream or outLog.
- int formatDec2Digs (char *targTxt, uint32_t value)
  Format number as two digit decimal number with leading zeroes.
- int formatDec3Digs (char *targTxt, uint32_t value)
  Format number as three digit decimal number with leading zeroes.
- int formatTmTim (char *rTmTxt, struct tm *rTm)
  Format broken down real time and date as standard text.
- int formatTmTiMs (char *rTmTxt, struct tm *rTm, int millis)
  Format broken down real time clock+ms as standard text.
- uint8_t isFNaN (float const val)
  Floating point NaN.
- uint8_t littleEndian ()
  Actual runtime / architecture is little endian.
- void logEventText (char const *txt)
  Log an event/log message on outLog.
- void monoTimeInit (timespec *timer)
  Absolute timer initialisation.
- uint8_t **outLogIsStd** (void)
  Event log (outLog) is standard stream.
- void printNamRevDat (void)

Print the program name, SVN revision and date.

- void printRevDat (void)

  Print the program SVN revision and date.
- char const * progDat ()

  The program date.
- char const * progNam ()

  The program name.
- char const * progNamB ()

  The program name with blank.
- uint8_t progNameLen ()

  The program's name length.
- uint8_t progNameOutp ()

  The program's name was output.
- char const * progRev ()

  The program revision.
- size_t strlcat (char *dest, char const *src, size_t num)

  String concatenation with limit.
- size_t strlcpy (char *dest, char const *src, size_t const num)

  String copy with limit.
- int switchErrorLog (char const *const errFilNam)

  Switch errlog to other file.
- int switchEventLog (char const *const logFilNam)

  Switch outLog to other file.
- void timeAddNs (timespec *t1, long ns)

  Add a ns increment to a time overwriting it.
- int timeStep (timespec *timeSp, unsigned int micros)

  A delay to an absolute step specified in number of s to a given time.
- void updateReaLocalTime (void)

  Update local real time.

Variables

- timespec **actRTime**

  Actual time (structure, real time clock).
- struct tm actRTm

  Actual time (broken down structure / local).
- float const cosDiY [192]

  Cosine of day in year, look up.
- int16_t const cosDiY60 [192]

  *Cosine of day in year * 60.*
- char const dec2digs [128][2]

  Format two digit decimal, leading zero, by lookup.
- char const dec3digs [1024][4]

  Format three digit decimal, leading zero, 0-terminated, by lookup.
- char const dow [9][4]

  English weekdays, two letter abbreviation.
- FILE * errLog

  Error log output.
- char const fType [16][8]

  Translation of directory entry typed to 8 char text.

- char const *const lckPiGpioPth

  Common path to a lock file for GpIO use.
- __time_t localMidnight

  Actual local midnight.
- uint32_t noLgdEvnt

  Number of events logged.
- FILE * outLog

  Event log output.
- uint8_t **progNamLen**

  char progNamPure[] = PROGNAME;
- int retCode

  Basic start-up function failure.
- int todayInYear

  Today's day in year.
- int useErrLogFiles

  Log on files.
- uint8_t useOutLog4errLog

  Use outLog for errors too.
- __time_t utcMidnight

  Actual (local) UTC midnight.
- char const zif2charMod10 [44]

  The digits 0..9 repeated as 44 characters.

5.51.1 Detailed Description

Some system related basic functions for Raspberry Pis.

```
Copyright  (c)  2020   Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  83 15.05.2025
Rev.    105 06.02.2018 :  new (transfered parts from sysutil.c)
Rev.    108 12.02.2018 :  parts moved out, one event file; Started to get
                    Doxygen usable.  Note:  Not yet done.
Rev.  147 16.06.2018 :  time handling enhanced improved
Rev.  155 27.06.2018 :  time handling debugged
Rev.  164 11.07.2018 :  sunset/sunrise location parameters; string functions
Rev.  229 23.07.2020 :  UTF 8 BOM for log and error file
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DMCU=BCM2837 -I./include -c -o weRasp/sysBasic.o weRasp/sysBasic.c
```

For documentation see the include file sysBasic.h

5.51.2 Function Documentation

5.51.2.1 progNameOutp()

```
uint8_t progNameOutp ( )
```

The program's name was output.

This function returns a value not 0 if the programs name etc. was probably logged or output.

Returns

the programs name's length if output, 0 else

5.51.2.2 progNameLen()

```
uint8_t progNameLen ( )
```

The program's name length.

This function determines the programs name's length and prepares the program strings if not yet done.

See also

progNam() progNamB() progRev() progDat()

Returns

the programs name's length

5.51.2.3 progNam()

```
char const * progNam ( )
```

The program name.

Returns

the program's name as pure text, "homeDoorPhone", e.g.

5.51.2.4 progNamB()

```
char const * progNamB ( )
```

The program name with blank.

Same as progNam but with at least one trailing blank or so many blanks to get a minimal length of 17, , "home↩ DoorPhone ", e.g.

Returns

the program's name with trailing blank(s)

5.51.2.5 progRev()

```
char const * progRev ( )
```

The program revision.

Returns

the program's SVN revision as pure text, "0", "341" e.g.

5.51.2.6 progDat()

```
char const * progDat ( )
```

The program date.

Returns

the program's SVN date "2020-07-23" e.g., length 10

5.51.2.7 printRevDat()

```
void printRevDat (
            void  )
```

Print the program SVN revision and date.

This function prints a line in the form (4 leading blanks)
`Revision  229 (2020-07-23)`

to outLog

5.51.2.8 printNamRevDat()

```
void printNamRevDat (
            void  )
```

Print the program name, SVN revision and date.

This function prints a line in the form (4 leading blanks)
`theLittleProg    R.  229 (2020-07-23)`

to outLog

5.51.2.9 isFNaN()

```
uint8_t isFNaN (
            float const val )
```

Floating point NaN.

Parameters

val	the floating point value to be checked for IEEE754 NaN

Returns

0xFF (true) when not a number, else 0

5.51.2.10 littleEndian()

```
uint8_t littleEndian ( )
```

Actual runtime / architecture is little endian.

This boolean function is evaluated by char* to int comparison.

To save runtime resources use the marco PLATFlittlE instead, which would fall back to littleEndian() (this function) when no target platform informations on endianness are available.

Returns

true when platform is little endian (evaluated at run time)

5.51.2.11 switchErrorLog()

```
int switchErrorLog (
            char const *const errFilNam )
```

Switch errlog to other file.

Parameters

errFilNam	the name of the file to switch to; NULL or empty: switch (back) to stderr

Returns

96 : file name can't be opened for append, old state kept; 97 : useOutLog4errLog is ON, nothing done 0 : OK

5.51.2.12 switchEventLog()

```
int switchEventLog (
            char const *const logFilNam )
```

Switch outLog to other file.

If useOutLog4errLog is ON the errLog file will point to the same named file on success.

Parameters

logFilNam	the name of the file to switch to; NULL or empty: switch (back) to stdout

Returns

96 : file name can't be opened for append; old state kept.

5.51.2.13 logEventText()

```
void logEventText (
            char const * txt )
```

Log an event/log message on outLog.

If txt is not null it will be output to outLog and outLog will be flushed. No line feed will be appended; the text is put as is.

Parameters

txt	text to be output; n.b not LF appended and not counted as line

5.51.2.14 monoTimeInit()

```
void monoTimeInit (
            timespec * timer )
```

Absolute timer initialisation.

This function sets the time structure provided to the current absolute monotonic ABS_MONOTIME (default↩ : CLOCK_MONOTONIC).

Note: Error returns, suppressed here, cannot occur, as long as the time library functions and used clock IDs are implemented. Otherwise all else timing done here would fail completely.

Parameters

timer	the time structure to be used (never NULL!)

5.51.2.15 timeStep()

```
int timeStep (
            timespec * timeSp,
            unsigned int micros )
```

A delay to an absolute step specified in number of s to a given time.

This function does an absolute monotonic real time delay until timer += micros;

Chaining this calls can give absolute triggers relative to a given start. One must initialise the time structure timespec before every start of a new cycle chain. Afterwards the structure time must not be written to. See timeAddNs, ABS_MONOTIME and monoTimeInit (or clock_gettime).

Chaining absolute delays accomplishes long term exact periods respectively cycles. See also explanations in ABS_MONOTIME (default: CLOCK_MONOTONIC).

Parameters

timeSp	the time structure to be used (never NULL!)
micros	delay in s (recommended 100s .. 1h)

Returns

sleep's return value if of interest (0: uninterrupted)

5.51.2.16 timeAddNs()

```
void timeAddNs (
            timespec * t1,
            long ns )
```

Add a ns increment to a time overwriting it.

Parameters

t1	the time structure to add to (not NULL!, will be modified)
ns	the increment in nanoseconds

5.51.2.17 updateReaLocalTime()

```
void updateReaLocalTime (
            void  )
```

Update local real time.

This function initialises / updates both actRTime and actRTm.

5.51.2.18 strlcpy()

```
size_t strlcpy (
            char * dest,
            char const * src,
            size_t const num )
```

String copy with limit.

This function copies at most num - 1 characters from src to dst. If not terminated by a 0 from src, dest[num-1] will be set 0. Hence, except for num == 0, dest will be 0-terminated.

The value returned is the length of string src; if this value is not less than num truncation occurred.

Hint: This function resembles the one from bsd/string.h usually not available with standard Linuxes and Raspbians .

Parameters

dest	the character array to copy to; must not be shorter than num
src	the string to copy from
num	the maximum allowed string length of dest

Returns

the length of src

5.51.2.19 strlcat()

```
size_t strlcat (
            char * dest,
```

```
            char const * src,
            size_t num )
```

String concatenation with limit.

This function appends at most num - 1 characters from src to the end of dest. If not terminated by a 0 from src, dest[num-1] will be set 0. Hence, except for num == 0, dest will be 0-terminated.

The value returned is the length of string src (if no truncation occurred).

Hint: This function resembles the one from bsd/string.h usually not available with standard Linuxes and Raspbians .

Parameters

dest	the character array to copy to; must not be shorter than num
src	the string to copy from
num	the maximum allowed string length of dest

Returns

the length of src

5.51.2.20 formatDec2Digs()

```
int formatDec2Digs (
            char * targTxt,
            uint32_t value )
```

Format number as two digit decimal number with leading zeroes.

The format is: 00 to 99

The length is always 2. There is no trailing character zero appended.
returned is the number of leading zeroes in the range 0 o 1. N.B. the value 0 yielding "00" is considered to have one leading zero.

See also

dec2digs formatDec3Digs

Parameters

targTxt	pointer to the target text buffer, must have place for 3 characters (!)
value	the value to be formatted; values outside 0 .. 999 will yield incorrect results

Returns

the number of leading zeroes (0 or 1)

5.51.2.21 formatDec3Digs()

```
int formatDec3Digs (
            char * targTxt,
            uint32_t value )
```

Format number as three digit decimal number with leading zeroes.

The format is: 000 to 999

The length is always 3. There is no trailing character zero appended.
returned is the number of leading zeroes in the range 0 to 2. N.B. the value 0 yielding "000" is considered to have 2 leading zeroes.

See also

dec3digs formatDec2Digs

Parameters

targTxt	pointer to the target text buffer, must have place for 3 characters (!)
value	the value to be formatted; values outside 0 .. 999 will yield incorrect results

Returns

the number of leading zeroes (0..2)

5.51.2.22 formatTmTim()

```
int formatTmTim (
            char * rTmTxt,
            struct tm * rTm )
```

Format broken down real time and date as standard text.

The format is: Fr 2017-10-20 13:55:12 UTC+20 .....0123456789x123456789v123456789t The length is 29. See formatTmTiMs() for a longer format with 3 digit ms.

Parameters

rTmTxt	pointer to the target text buffer, must have place for 30 characters (!)
rTm	pointer to broken down real time; NULL will take actRTm

Returns

the number of characters put (should be 28) or 0: error (rTmTxT NULL)

5.51.2.23 formatTmTiMs()

```
int formatTmTiMs (
            char * rTmTxt,
            struct tm * rTm,
            int millis )
```

Format broken down real time clock+ms as standard text.

/code The format is: Fr 2017-10-20 13:55:12.987 UTC+20 .....0123456789x123456789v123456789t123 +3 .....0123456789x123456789v123456789t /endcode The length is 33. See formatTmTim() for a shorter format without ms.

Parameters

rTmTxt	pointer to the target text buffer, must have place for 34 characters (!)
rTm	pointer to broken down real time; NULL will take actRTm
millis	milliseconds 0..999 supplement to rTm

Returns

the number of characters put (should be 32) or 0: error (rTmTxT NULL)

5.51.3 Variable Documentation

5.51.3.1 retCode

```
int retCode
```

Basic start-up function failure.

Allows for compact code without saving the (error) return:
if (openLock(lckPiGpioPth, ON)) return retCode;

Storage for return/error codes. Used by: openLock(char const ∗, uint8_t) theCyclistStart(int) theCyclistWaitEnd()

Value: 0: OK, else: error

5.51.3.2 lckPiGpioPth

```
char const* const lckPiGpioPth
```

Common path to a lock file for GpIO use.

Programs using GPIO in any form usually (and forced by some libraries) have to do this exclusively. This is implemented here by locking a file named ∼/bin/.lockPiGpio
Make the lock file by: touch /home/[user]/bin/.lockPiGpio or by touch ∼/bin/.lockPiGpio

Without locking this file those programs must not start.
So, deleting this file inhibits the start even by cron etc.

5.51.3.3 useErrLogFiles

```
int useErrLogFiles
```

Log on files.

If true (default) logging and errors go to files or one file, otherwise to console

5.51.3.4 outLog

```
FILE* outLog
```

Event log output.

default: standard output; may be put to a file.

5.51.3.5 noLgdEvnt

```
uint32_t noLgdEvnt
```

Number of events logged.

Counter for lines put to or events logged on outLog.

5.51.3.6 useOutLog4errLog

```
uint8_t useOutLog4errLog
```

Use outLog for errors too.

When set true errLog will be set to outLog when using files. In this case there is just one event log file. Hence, doubling the same entry to both errLog and outLog should be avoided.

5.51.3.7 errLog

```
FILE* errLog
```

Error log output.

default: standard error; may be put to a file.

5.51.3.8 actRTm

```
struct tm actRTm
```

Actual time (broken down structure / local).

This structure is initialised may be updated by some timing and cyclic functions. See initStartRTime() and others.

5.51.3.9 todayInYear

```
int todayInYear
```

Today's day in year.

The value should be set at start (will be by updateReaLocalTime()) and updated at midnight.

5.51.3.10 utcMidnight

```
__time_t utcMidnight
```

Actual (local) UTC midnight.

This is the actual "local" UTC midnight. "Local" means that on early hours, i.e. those within zone offset, UTC midnight will be corrected to the next (east of Greenwich) respectively previous day (west). The rationale is to point to the same day or date at day time (around Europe).
Or, to put it simple, utcMidnight is to be set so, that the equation
local Midnight = utcMidnight - UTCoffset
holds.

The value will will be set correctly by updateReaLocalTime(). It should be updated at day change (if used).

5.51.3.11 localMidnight

```
__time_t localMidnight
```

Actual local midnight.

This is the UTC Linux time stamp of the actual day's / time's local midnight. See also utcMidnight for explanations.

Note: On days with DST changes this value will shift within the day. It's mostly better to make calculations relative to day start — sunrise and sunset e.g. — relative to UTC midnight.

5.51.3.12 cosDiY

```
float const cosDiY[192]
```

Cosine of day in year, look up.

This lookup table provides the cosine by the day of the year without resource eating floating point arithmetic or math.h. The rationale is the approximate calculation of sunrise and sunset times based on earliest, latest and delta for any given location within the arctic circles.

The length of the look up table is abundant 192. According to cosine's periodic properties it shall be used in the range 0..183 by applying the following operations to the day in year value
absolute when $<$ 0,
modulo FOURYEARS when $>=$ FOURYEARS,
modulo 365 when $>=$ 365 and
x = 365 - x when $>$ 190.

Note: These rules are implemented in the function cosDay() and in the function cosDay60() using the look up table cosDiY60

5.51.3.13 cosDiY60

```
int16_t const cosDiY60[192]
```

Cosine of day in year ∗ 60.

This look up table is the same as cosDiY, except the values being multiplied by 60 which includes minutes to seconds conversion, avoiding a multiplication and all floating point operations for some applications.

lenght: 192

5.51.3.14 dow

```
char const dow[9][4]
```

English weekdays, two letter abbreviation.

Monday (Mo) is 1; Sunday (Su) is 7 or, also, 0.

5.51.3.15 dec2digs

```
char const dec2digs[128][2]
```

Format two digit decimal, leading zero, by lookup.

"00" .. "99" + "00", "_1" .. "_7"

5.51.3.16 dec3digs

```
char const dec3digs[1024][4]
```

Format three digit decimal, leading zero, 0-terminated, by lookup.

"000" .. "999" + "000" .. "023"

5.51.3.17 zif2charMod10

```
char const zif2charMod10[44]
```

The digits 0..9 repeated as 44 characters.

By using a number 0..43 as index this will give modulo 10 respectively the last decimal digit as character.

5.51.3.18 fType

```
char const fType[16][8]
```

Translation of directory entry typed to 8 char text.

direntry.d_type as index in the range 0..15 gives an 8 character short type text. Note: Only 0, 1, 2, 4, 6, 8, 10, 12 and 14 are defined d_type values. The undefined ones give undef3 .. undefF

5.52 weRasp/we1wire.c File Reference

Functions for 1-wire sensors.

```
#include "we1wire.h"
#include <sys/file.h>
```

Functions

- int getTemp (oneWireDevice_t *const tempSensor)

  Get temperature.
- void initTempSensor (oneWireDevice_t *const tempSensor, char const *const name, char const *const valueFile)

  Initialise a 1-wire sensor structure.

5.52.1 Detailed Description

Functions for 1-wire sensors.

```
Copyright (c) 2018 Albrecht Weinert
weinert-automation.de      a-weinert.de
    /         /      /\
   /         /___   /  \      |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  72 12.11.2024
Rev.  168 21.07.2018 :  new
```

See file include/we1wire.h

5.52.2 Function Documentation

5.52.2.1 getTemp()

```
int getTemp (
            oneWireDevice_t *const tempSensor )
```

Get temperature.

This function tries a new measurement on the 1-wire temperature sensor provided. On success the new value is returned. On failure the last good value is returned, but at most 7 times after 7 good readings before. On total failure -99900 (-99.9 °C, 0 K, BAD_TEMP_READ) is returned.

Additionally on temperature changes, the integer reading (.value) and the floating point string (valueGrdC[]) will be set in the structure.

Parameters

tempSensor	pointer to the sensor's structure

Returns

the actual or last reading or -2721500 if no good / not enough past good readings

5.52.2.2 initTempSensor()

```
void initTempSensor (
            oneWireDevice_t *const tempSensor,
            char const *const name,
            char const *const valueFile )
```

Initialise a 1-wire sensor structure.

This function does basic initial settings for a 1-wire temperature sensor. tempSensor.name and tempSensor.value↩File are set by the respective parameters.
The temperature values are set to bad value; see BAD_TEMP_READ and BAD_TEMP_FLOAT

Parameters

tempSensor	pointer to the sensor's structure (never NULL!)
name	the sensor's short name or its directory name; NULL / empty: no change
valueFile	the canonical absolute path to its value file; NULL / empty: no change

5.53 weRasp/weAR_N4105.c File Reference

support for VDE-AR-N 4105

```
#include "weAR_N4105.h"
#include "weStateM.h"
#include "weUtil.h"
```

Functions

- void arn4105TimChg (state_t *const me)

  AR-N 4105 control timer state change function.
- void setARN4105state (uint8_t const state, uint8_t const select)

  Set AR-N 4105 frequency and voltage states.

Variables

- uint8_t arn4105state

  AR-N 4105 frequency and voltage states.
- state_t arn4105Timer

  AR-N 4105 control timer.
- state_t checkL1_U

  The (one) five band checker for line L1 voltage.
- state_t checkL2_U

  The (one) five band checker for line L2 voltage.
- state_t checkL3_U

  The (one) five band checker for line L3 voltage.
- state_t checkLineFrq

  The (one) five band checker for line frequency.

5.53.1 Detailed Description

support for VDE-AR-N 4105

```
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```

Revision history

```
Rev.  36 20.01.2021
Rev.  195 01.03.2019 :  new
Rev.  202 28.04.2019 :  minor (timer macro change)
```

5.53.2 Function Documentation

5.53.2.1 setARN4105state()

```
void setARN4105state (
             uint8_t const state,
             uint8_t const select )
```

Set AR-N 4105 frequency and voltage states.

This function is called internally by the respective five band checker's state_t.onStateChange function.

Parameter selection mask must be one of LfMsk, L1Msk - L3Msk.

Parameters

state	state_t.status of the five band checker in question
select	selection mask

5.53.2.2 arn4105TimChg()

```
void arn4105TimChg (
            state_t *const me )
```

AR-N 4105 control timer state change function.

It signals the timer state to the function arn4105TimChg.

Parameters

me	pointer to the AR-N 4105 control timer

5.53.3 Variable Documentation

5.53.3.1 checkLineFrq

```
state_t checkLineFrq
```

The (one) five band checker for line frequency.

See newLineFcheck

5.53.3.2 checkL1_U

```
state_t checkL1_U
```

The (one) five band checker for line L1 voltage.

In a one phase system this will be the only one fed with values by fiveBandTick.

See newLineUcheck

5.53.3.3 checkL2_U

```
state_t checkL2_U
```

The (one) five band checker for line L2 voltage.

See newLineUcheck

5.53.3.4 checkL3_U

```
state_t checkL3_U
```

The (one) five band checker for line L3 voltage.

See newLineUcheck

5.53.3.5 arn4105state

```
uint8_t arn4105state
```

AR-N 4105 frequency and voltage states.

If all is OK this status byte is 0. The meaning of bits set is

```
|   7    |   6    |   5    |   4    ||   3    |   2    |   1    |   0    |
|   L3   |   L2   |   L1   |   f    ||   L3   |   L2   |   L1   |   f    |
|       voltage error       |  error ||      voltage warning     | warning|
```

If any error bit is set the respective generators has to be cut off.
Ten minutes after the last warning bit is gone the respective generators may be put back to power line.
The timer arn4105Timer will be handled accordingly.

User software should not touch this variable (except when knowing the consequences.

5.53.3.6 arn4105Timer

```
state_t arn4105Timer
```

AR-N 4105 control timer.

When this timer is running distributed small generators must be cut off. When this timer stops the respective generators may be put back to power line.

User software must provide a function switchARN4105 doing the cutoff and switch back plus optionally logging. It will be called by this timer and, hence, in the end by the frequency and voltage checkers.

The user/application software must check (timerTickCheck) regularly to enable switch back.

5.54 weRasp/weCGIajax.c File Reference

Functions and values for Web interfaces with AJAX, CGI etc.

```
#include "weCGIajax.h"
```

Functions

- int getQSparam (char const ∗const name, char ∗const value, int const vLen)

  Get the query string parameter value for a unique and known key.
- int getQueryString ()

  Fetch and store the query string.
- int jsonBinForm (uint8_t const indent, char const ∗const name, uint8_t const value, char ∗end)

  Output an eight bit value binary formated as JSON name:value.
- int jsonBreading (uint8_t const indent, char const ∗const name, uint8_t const value, char ∗end)

  Output a boolean value as JSON name:value.
- int jsonFPreadingT (uint8_t const indent, char const ∗const name, uint16_t const valueLo, uint16_t const valueHi, uint8_t dotPos, char const ∗const unit, char ∗end, char ∗title)

  Output a physical value as JSON {object} with name, 32 bit FP value and unit.
- int jsonFreading (uint8_t const indent, char const ∗const name, float const value, char const ∗const unit, uint8_t const fractional, char ∗end)

  Output a float (physical value as JSON {object} with name, value and unit.
- int jsonFreadingT (uint8_t const indent, char const ∗const name, float const value, char const ∗const unit, uint8_t const fractional, char ∗end, char ∗title)

  Output a float value as JSON {object} with name, value, unit and help text.
- int jsonIreading (uint8_t const indent, char const ∗const name, int const value, char ∗end)

  Output an int value as JSON name:value.
- int jsonSreadingT (uint8_t const indent, char const ∗const name, char ∗const value, char const ∗const unit, char ∗end, char ∗title)

  Output a physical value as JSON {object} with name, value as String and unit.

Variables

- char **actQSPvalue** [QS_MAX_VAL_LEN]

  to be used for actual parameter
- char **queryString** [QS_MAX_STRING_LEN]

  holding the query string
- char const ∗ **requestMethod**

  to hold (environment's) REQUEST_METHOD

5.54.1 Detailed Description

Functions and values for Web interfaces with AJAX, CGI etc.

```
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   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  59 14.07.2024
Rev.    82  14.12.2017 :  new
Rev.  187  14.10.2018 :  minor typos
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DMCU=BCM2837 -I./include -c -o weRasp/weCGIajax.o weRasp/weCGIajax.c
```

This is a (basic) library to support CGI programs written in C to be used under a web sever – as e.g. an Apache 2.4 on a Pi for hometersControl.

For documentation see the include file weCGIajax.h

5.54.2 Function Documentation

5.54.2.1 getQueryString()

```
int getQueryString ( )
```

Fetch and store the query string.

This function gets the raw query string storing it (on success) in queryString. Raw means, all the ugly '+' and 'AB' things are still there.

Returns

0: from get; 1: from get, truncated; 2: from post; 3: from get, truncated; -1: program probably not run as CGI, no query string

5.54.2.2 getQSparam()

```
int getQSparam (
            char const * name,
            char *const value,
            int const vLen )
```

Get the query string parameter value for a unique and known key.

This simple method would fetch the value to a known query string parameter.

Warning: Longer names/keys with the same prefix must come first. When having "carlength=91&length=300", this (simple) function will get "91" for "length".

Parameters

name	the parameter's name or key
value	character array (string) to store the value to, the result may be empty (on name\0, name=\0 or name&)
vLen	value's length including the terminating 0

Returns

0: OK, got value; -1: got no value (no name, no value, ...) 1: got value truncated to vLen -1 characters

5.54.2.3 jsonIreading()

```
int jsonIreading (
            uint8_t const indent,
```

```
            char const *const name,
            int const value,
            char * end )
```

Output an int value as JSON name:value.

This function puts an integer value as "name": "999" respectively "name": "-1" to the standard output.

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	the property's name
value	the integer value (put as string)
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.54.2.4 jsonBreading()

```
int jsonBreading (
            uint8_t const indent,
            char const *const name,
            uint8_t const value,
            char * end )
```

Output a boolean value as JSON name:value.

This function puts a boolean value as "name": true or as "name": false to the standard output.

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	the property's name
value	0: false; else: true
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.54.2.5 jsonBinForm()

```
int jsonBinForm (
             uint8_t const indent,
             char const *const name,
             uint8_t const value,
             char * end )
```

Output an eight bit value binary formated as JSON name:value.

This function puts a boolean value as "name": "1001_1100" to the standard output.

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	the property's name
value	0..255 i.e 0000_0000 .. 1111_1111
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.54.2.6 jsonFreading()

```
int jsonFreading (
             uint8_t const indent,
             char const *const name,
             float const value,
             char const *const unit,
             uint8_t const fractional,
             char * end )
```

Output a float (physical value as JSON {object} with name, value and unit.

This function puts a float value as e.g. {"name": "Wimp", "value": "15.22", "unit": "kWh"}

The text by parameter end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
value	the float value
unit	0-terminated string being the value's physical unit
fractional	0..9 number of fractional digits 0: value will be taken as int
end	0-terminated string to put at the end

Returns

>=0: OK; <0: error

5.54.2.7 jsonFreadingT()

```
int jsonFreadingT (
            uint8_t const indent,
            char const *const name,
            float const value,
            char const *const unit,
            uint8_t const fractional,
            char * end,
            char * title )
```

Output a float value as JSON {object} with name, value, unit and help text.

This function puts a float value as e.g. {"name": "Wimp", "value": "15.22", "unit": "kWh"}

The text by parameter end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

The text by parameter title will be used as such, acting as hover help text (not title) by html tradition. This text must not be NULL nor empty. When wanting no help text use jsonFreading() instead.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
value	the float value
unit	0-terminated string being the value's physical unit
fractional	0..9 number of fractional digits 0: value will be taken as int
end	0-terminated string to put at the end
title	0-terminated string as help text

Returns

>=0: OK; <0: error

5.54.2.8 jsonSreadingT()

```
int jsonSreadingT (
            uint8_t const indent,
            char const *const name,
            char *const value,
            char const *const unit,
```

```
            char * end,
            char * title )
```

Output a physical value as JSON {object} with name, value as String and unit.

This function puts a value given as String "15.22" e.g. in the form {"name": "Wimp", "value": "15.22", "unit": "kWh"}

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
value	the float value
unit	0-terminated string being the value's physical unit
end	0-terminated string to put at the end
title	0-terminated string as help text (NULL no title)

Returns

>=0: OK; <0: error

5.54.2.9 jsonFPreadingT()

```
int jsonFPreadingT (
            uint8_t const indent,
            char const *const name,
            uint16_t const valueLo,
            uint16_t const valueHi,
            uint8_t dotPos,
            char const *const unit,
            char * end,
            char * title )
```

Output a physical value as JSON {object} with name, 32 bit FP value and unit.

This function puts a value given as 32 bit fixed point value in two 16 bit parts in the form {"name": "Wimp", "value": "15.22", "unit": "kWh"}. Accepting the vale as two parts solves problems with 32 bit integers or fixed point values delivered as two 16 bit Modbus registers in arbitrary order. The value is specified by the parameters valueLo, valueHi and dotPos.
With valueHi == 0 valueLo is considered as 16 bit value

The text end is appended. According to JSON syntax rules it must contain a comma (,) if and only if other elements follow. Besides that white space (", " " " ",\n" "\n") may enhance human readability.

Parameters

indent	0..36 number of spaces to put before
name	0-terminated string naming the reading (measured value e.g.)
valueLo	the least significant 16 bits of the fixed point value
valueHi	the most significant 16 bits of the fixed point value
dotPos	position where the fixed point is 0..6; 0 means integer
unit	0-terminated string being the value's physical unit
end	0-terminated string to put at the end
title	0-terminated string as help text (NULL no title)

Returns

>=0: OK; <0: error

5.55 weRasp/weDCF77.c File Reference

DCF77 decoder on Raspberry Pi.

```
#include "weDCF77.h"
```

Functions

- void dcf77receiveRec (int pi, unsigned gpio, unsigned level, uint32_t tick)
  DCF77 receive recorder.
- int dcf77receiveRecDeregister (void)
  DCF77 receive function de-registration.
- int dcf77receiveRecRegister (void)
  DCF77 receive recorder registration.
- durDiscrPointData_t * disc5 (durDiscrPointData_t table[ ], uint32_t const value)
  Discriminating a value.
- uint32_t initDCF77io ()
  Initialise the DCF77 signal input GPIO / pin.
- void setReceiver (int const level)
  Set receiver On control.

Variables

- unsigned curBCDnum
  Number decoded from period sequence parts.
- int **dcf77callbackID**
  PiGpioD's call back ID for receiver function.
- unsigned dcf77glitch
  DCF77 input's glitch filter time setting.
- unsigned dcf77inp
  Input GPIO for the DCF77 receiver's AM signal.
- unsigned dcf77invInp
  Inverted DCF77 receiver's signal.
- unsigned dcf77lastLevel
  Last DCF77 modulation level.
- unsigned dcf77PUD
  DCF77 input's pull resistor setting.
- unsigned dcf77recCnt
  Control output GPIO of the DCF77 receiver's control.
- unsigned dcf77recCntInv
  Receiver On control inverted.
- dcf77recPerData_t **dfc77actRecPer**
  The actual respectively last modulation period data received.
- dcf77recPerData_t **dfc77ringBrecPer** [DCF77RINGbufWRAP+1]

Ring buffer of modulation period data received.

- uint8_t **dfc77ringBrecWInd**

  Modulation period data received ring buffer write index.

- char lastSysClk [14]

  The system time for low AM as text hh:mm:ss.

- unsigned const **num02st** [ ]

  see numBCDinit, values 0 2

- unsigned const **num04st** [ ]

  see numBCDinit, values 0 4

- unsigned const **num08st** [ ]

  see numBCDinit, values 0 8

- unsigned const **num10st** [ ]

  see numBCDinit, values 0 10

- unsigned const **num20st** [ ]

  see numBCDinit, values 0 20

- unsigned const **num40st** [ ]

  see numBCDinit, values 0 40

- unsigned const **num80st** [ ]

  see numBCDinit, values 0 80

- unsigned const numBCDinit [ ]

  Initialisation or least significant BDC digit for modulation time.

- durDiscrPointData_t perDiscH [5]

  Discrimination values for the modulation period.

- durDiscrPointData_t perDiscP [5]

  Discrimination values for the modulation period.

- durDiscrPointData_t * perDiscUsed

  Discrimination values for the modulation period used.

- durDiscrPointData_t timDiscH [5]

  Discrimination values for the 15% modulation time.

- durDiscrPointData_t timDiscHs [5]

  Discrimination values for the 15% modulation time.

- durDiscrPointData_t timDiscP [5]

  Discrimination values for the 15% modulation time.

- durDiscrPointData_t * timDiscUsed

  Discrimination values for the 15% modulation time.

5.55.1 Detailed Description

DCF77 decoder on Raspberry Pi.

```
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    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  42 10.04.2021
Rev.  233 17.10.2020 :  new
Rev.  234 31.12.2020 :  HQ DCF77 timing set modified
Rev.  239 02.03.2021 :  functions from dcf77onPi.c ported here
```

This is a supplementary basic library to handle the signal of a DCF77 receiver. In the case of AM (amplitude) modulation a 1 (high) at the signal input means 15% amplitude and a 0 (low) 100% respectively full amplitude. The other way round is marked as dcf77invInp.

5.55.2 Function Documentation

5.55.2.1 setReceiver()

```
void setReceiver (
            int const level )
```

Set receiver On control.

Parameters

level	set receiver ON or OFF

See also

dcf77recCnt, dcf77recCntInv

5.55.2.2 initDCF77io()

```
uint32_t initDCF77io ( )
```

Initialise the DCF77 signal input GPIO / pin.

The signal input dcf77inp and control output dcf77recCnt are initialised.

Returns

the bank mask of the output dcf77recCnt if given, 0 if PINig

5.55.2.3 dcf77receiveRec()

```
void dcf77receiveRec (
            int pi,
            unsigned gpio,
            unsigned level,
            uint32_t tick )
```

DCF77 receive recorder.

This is a pigpiod callback function for an AM DCF77 receiver. It does no filtering nor decoding. It just fills dfc77actRecPer for the current modulation period and stores it in dfc77ringBrecPer when the next period begins.

5.55.2.4 dcf77receiveRecRegister()

```
int dcf77receiveRecRegister (
            void  )
```

DCF77 receive recorder registration.

This function registers the call back function dcf77receiveRec with the PiGpioDaemon.

Returns

register or error number; also stored in dcf77callbackID

5.55.2.5 dcf77receiveRecDeregister()

```
int dcf77receiveRecDeregister (
            void  )
```

DCF77 receive function de-registration.

This function de-registers the call back registered under dcf77callbackID.

Returns

0: OK, pigif_callback_not_found: otherwise

5.55.2.6 disc5()

```
durDiscrPointData_t * disc5 (
            durDiscrPointData_t table[],
            uint32_t const value )
```

Discriminating a value.

In a discrimination table / array of length 5 this function returns a pointer to the highest table entry with value >= table[i].v
The entry returned must be treated as const.

Parameters

table	discrimination table of length 5. With other lengths the function will fail. Must not be null.
value	the number to be discriminated

Returns

the lowest table entry with value < table[i].v

5.55.3 Variable Documentation

5.55.3.1 dcf77recCnt

```
unsigned dcf77recCnt
```

Control output GPIO of the DCF77 receiver's control.

This output, if used and connected, controls the amplitude modulation (AM) receiver's control (On/Off) signal. If there is no such output (PINig) The receiver either has no such control input or it is tight to On.

default PINig; see also dcf77recCntInv, setReceiver()

5.55.3.2 dcf77recCntInv

```
unsigned dcf77recCntInv
```

Receiver On control inverted.

The receiver control output (dcf77recCnt), when used, would be set to ON (Hi, 3V) to enable the receiver. And it would be set OFF for a short time to reset a panicing or inactive receiver.
If dcf77recCntInv is true it is the other way round. The common receiver chips control input is low active, hence inverted and dcf77recCntInv should be true. As an open collector stage near the Pi for this output is highly recommended, nevertheless the default value is FALSE.

default FALSE; see also dcf77recCnt, setReceiver()

5.55.3.3 dcf77inp

```
unsigned dcf77inp
```

Input GPIO for the DCF77 receiver's AM signal.

This is the amplitude modulation (AM) level signal; the level is either 100% or 15% (for 100 or 200ms).

default PIN08; see also dcf77invInp, dcf77PUD, dcf77glitch

5.55.3.4 dcf77invInp

```
unsigned dcf77invInp
```

Inverted DCF77 receiver's signal.

In the case of AM (amplitude) modulation a 1 (high) at the signal input dcf77inp means 15% amplitude and a 0 (low) 100% respectively full amplitude, when dcf77invInp is OFF. ON, obviously, means other way round.

default: OFF; see also dcf77inp

5.55.3.5 dcf77PUD

```
unsigned dcf77PUD
```

DCF77 input's pull resistor setting.

default: PI_PUD_KEEP; see also dcf77inp

5.55.3.6 dcf77glitch

```
unsigned dcf77glitch
```

DCF77 input's glitch filter time setting.

The value for pigpiod's input filter time in μs. The allowed range is 0 ... 30000. The filtering only works for pins sampled by a callback function (like dcf77receiveRec()).

default: 0; glitch filter off; see also dcf77inp

5.55.3.7 dcf77lastLevel

```
unsigned dcf77lastLevel
```

Last DCF77 modulation level.

ON means 15% modulation amplitude; i.e. the signal.
OFF means 100% amplitude; i.e. just the 77,5 kHz carrier.

This variable is set by the receiver (callback) function and must not be modified by user software.

5.55.3.8 lastSysClk

```
char lastSysClk[14]
```

The system time for low AM as text hh:mm:ss.

This textual time stamp is taken at the start of the AM (15%) tick respectively when the callback function is executed for this event.

5.55.3.9 timDiscP

```
durDiscrPointData_t timDiscP[5]
```

Discrimination values for the 15% modulation time.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::tim values.
The only good outcomes of discrimination are indices (durDiscrPointData_t::i) 1 and 3 meaning a recognisable bit 0 respectively 1.
Hint: index bit 0 set means no error.
Hint2: Name ending with P means designed for low grade AM receiver modules. The criteria values are extended quite far for guessing the meaning in the presence of timing faults. Spikes would have to be filtered in a next stage by combining two to four faulty periods in one. Low grade receivers would be not usable without such (complex) filter algorithms.

5.55.3.10 perDiscP

```
durDiscrPointData_t perDiscP[5]
```

Discrimination values for the modulation period.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::per values.
The only good outcomes of discrimination are indices (durDiscrPointData_t::i) 1 and 3 meaning an acceptable 1s respectively 2s period.
Hint: See hints at timDiscP.

5.55.3.11 timDiscH

```
durDiscrPointData_t timDiscH[5]
```

Discrimination values for the 15% modulation time.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::tim values.
The good outcomes have indices (durDiscrPointData_t::i) 1 and 3 meaning a recognisable bit 0 (FALSE) respectively 1 (TRUE).
Hint: index bit 0 set means no error.

Hint2: Name ending with H means designed for high grade AM receiver modules with virtually no timing faults or spikes. Hence, the criteria values are relatively tight, to recognise EMI or short outages as such. Trying to interpret those with filter algorithms may not be worth the effort with good receivers.

Hint3: Some lower grade AM receiver modules were enhanced with an inverting NPN transistor stage with a low capacity collector to ground capacitor implemented by three meter shielded signal and supply cable. This adding of a simple inverter stage is recommended for all receiver modules not equipped with an open collector (OC) output stage. And for some of them its a necessary filter stage.

5.55.3.12 timDiscHs

```
durDiscrPointData_t timDiscHs[5]
```

Discrimination values for the 15% modulation time.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::tim values.
It is the same as timDiscH except for the extra note/hint 4.

Hint 4: The price for turning bad to good receivers by the circuit of Hint 3 was good pulses shortened well below 100 respectively 200 ms. Therefore this table allows for such shortened pulses noting it by the name's suffix s.

5.55.3.13 perDiscH

```
durDiscrPointData_t perDiscH[5]
```

Discrimination values for the modulation period.

This is an array of fixed length 5 to discriminate dcf77recPerData_t::per values.
The only good outcomes of discrimination are indices (durDiscrPointData_t::i) 1 and 3 meaning an acceptable 1s respectively 2s period.
Hint: See hints at timDiscHs.

5.55.3.14 perDiscUsed

```
durDiscrPointData_t* perDiscUsed
```

Discrimination values for the modulation period used.

This is a pointer to an array of fixed length 5 to discriminate dcf77recPerData_t::per values. The purpose is to hold the current filter values.
default: perDiscP

5.55.3.15 timDiscUsed

```
durDiscrPointData_t* timDiscUsed
```

Discrimination values for the 15% modulation time.

This is a pointer to an array of fixed length 5 to discriminate dcf77recPerData_t::per values. The purpose is to hold the current filter values.
default: timDiscP

5.55.3.16 curBCDnum

```
unsigned curBCDnum
```

Number decoded from period sequence parts.

This variable holds the (current) number evaluated by considering the sequence of disc5(timDiscUsed, modulation↩ Time) in question. Here, with number sequences a false (level 1, 'F') means 0 and a true (level 3, 'T') means 1, 2, 4, 8, 10, 20, 40 or 80 depending on the place within the BCD coded number. Any other level (0 spike, 3 undef, 4 error) invalidates the whole number.
Values 0..99 (max year) are OK, a value above means an error in the sequence.

See also

disc5 timDiscUsed timDiscHs

5.55.3.17 numBCDinit

```
unsigned const numBCDinit[]
```

Initialisation or least significant BDC digit for modulation time.

For the durDiscrPointData_t i value as index this constant array yields 0 or 1 — or respectively 2, 4 , 8, 10, 20, 40, 60 and 80 — for valid times and a high error value else.
The rationale is just adding up yields a correct value in the BCD range of 0 .. 99 while any higher value means error.

See also

timDiscUsed timDiscHs disc5() curBCDnum

5.56 weRasp/weEcarLd.c File Reference

Some functions for E-Car loading on a Raspberry Pi using pigpiod.

```
#include "weEcarLd.h"
#include "sweetHome.h"
```

Macros

- #define **CHS_CP_OFF_LEV**

  loading off CP state (1: +12V, 0: -12V)

Functions

- int chsItoDutyC (float const ldCurrLim)

  Calculate CP dutycycle for current limit per phase.
- void initAsCPilot (int const thePi, unsigned const gpio, uint8_t init)

  Initialise a GPIO pin as pilot drive.
- void setChStControl (float const ldCurrLim)

  Control E-Car charging current limit per phase by PWM.
- float setChStLimit (float ldCurrLim)

  Set and get E-Car charging current limit per phase.
- uint8_t setChStNoPhases (uint8_t assumedNofPhases)

  Set and get charging E-Car's actual number of phases.
- void setCPilot (uint8_t set)

  Set CP signal to constant ON or OFF.
- void setCPilotPWM (int duty)

  Set CP signal PWM.

5.56.1 Detailed Description

Some functions for E-Car loading on a Raspberry Pi using pigpiod.

```
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weinert-automation.de          a-weinert.de
    /          /      /\
   /          /___   /  \       |
   \         /____\ /____\ |  _|__
    \  /\  / \     /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  253 7.10.2023
Rev.  253 07.18.2023 :  new
Rev.    89 22.07.2025 :  return duCyc; // has been missing until ..
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DF_CPU=1500000000 -DPLATFORM=raspberry_04
      -DMCU=BCM2711 -I./include     -c -o weRasp/weGPIOd.o weRasp/weEcarLd.c
```

This is a supplementary library basic library to be used in conjunction with the pigpio library (link: -lpigpiod_if2 -lrt). For documentation see the include file weEcarLd.h and also http://abyz.me.↩uk/rpi/pigpio/pdif2.html by Joan NN.

5.56.2 Function Documentation

5.56.2.1 initAsCPilot()

```
void initAsCPilot (
            int thePi,
            unsigned gpio,
            uint8_t init )
```

Initialise a GPIO pin as pilot drive.

This function initialises the GPIO pin like initAsHiDrive() and (additionally) sets the PWM frequency to 1kHz and the duty cyle range to 0..1000. The parameter init when 0 (FALSE) sets the CP output to -12V signalling EVSE being not ready. init when 1 (TRUE) sets the CP output to +12V signalling EVSE ready.

This function must be called before all other CP control functions, as it sets the CP's GPIO henceforth.

A value outside this range will turn the 1kHz CP signal off; see CHS_CP_OFF_LEV.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)
init	0: off (-12V) 1: on (+12V)

5.56.2.2 setCPilot()

```
void setCPilot (
            uint8_t set )
```

Set CP signal to constant ON or OFF.

This function sets the CP either constant ON (+12V) or OFF (-12V). It will stop any 1kHz square wave.

Parameters

set	0: off (-12V) 1: on (+12V)

5.56.2.3 setCPilotPWM()

```
void setCPilotPWM (
            int duty )
```

Set CP signal PWM.

This function sets the CP duty cycle in the range 0..1000‰ applying offset (CHS_CP_OFFSET) and inversion (CHS_CP_INVERTED) if applicable.

Note: 50‰ (5%) signals the of a digital protocol (not implemented here).
The range for signalling current limit per phase is 10..970‰; see chsItoDutyC(float).

Parameters

duty	dutycycle in ‰ (parts per mille)

5.56.2.4 setChStLimit()

```
float setChStLimit (
            float ldCurrLim )
```

Set and get E-Car charging current limit per phase.

This function sets the charging stations current limit in the range 6.0 ... CHS_CURRENT_LIM_MAX.

Note: This function just sets/changes the internal limit value. It will not influence any signal (CP) to the EVSE.

Parameters

ldCurrLim	load current in A (per phase)

Returns

the (new) current limit

5.56.2.5 chsItoDutyC()

```
int chsItoDutyC (
            float ldCurrLim )
```

Calculate CP dutycycle for current limit per phase.

The IEC CP dutycycle(current) curve will be applied and the outcome limited to 100..970‰ resp. 6..80A per phase.

This function just implements the standard and its limits, that is without offsets or inversion in the CP signal handling. Those, if applicable will be handled by setCPilotPWM(int) and setChStControl(float).

Parameters

ldCurrLim	the current limit

Returns

dutycycle in ‰ (per mille)

5.56.2.6 setChStControl()

```
void setChStControl (
            float ldCurrLim )
```

Control E-Car charging current limit per phase by PWM.

This function sets the the control pilot (CP) PWM signal to the charging station.

This function should only be called with a current value within actual limits (6...32A, e.g.). It only limits the CP duty cycle to the range 10..97% corresponding to 6..80A.

Parameters

ldCurrLim	current limit in A per phase

5.56.2.7 setChStNoPhases()

```
uint8_t setChStNoPhases (
            uint8_t assumedNofPhases )
```

Set and get charging E-Car's actual number of phases.

This function sets the (assumed) number of phases for E-Car AC charging in the range 1..CHS_MAX_PHASES. The default is CHS_BEG_PHASES.

The value set will be used to calculate and eventually limit the maximum loading power. The real number of phases depends on the car(s) connected.

Warning: There exist E-car types using only one phase even when offered three!

Parameters

assumedNofPhases	number of phases 1.. CHS_MAX_PHASES

Returns

the (new) number of phases

5.57 weRasp/weGPIOd.c File Reference

Some IO functions for Raspberry Pi using pigpiod.

```
#include "weGPIOd.h"
```

Functions

- uint8_t gpio4pin (int const pin)

  Pin number to GPIO number lookup.
- void initAsDrive (int thePi, unsigned gpio, unsigned init)

  Initialise a GPIO pin as output.
- void initAsHiDrive (int const thePi, unsigned gpio, unsigned init)

  Initialise a GPIO pin as high drive.
- void initAsHiInput (int thePi, unsigned gpio)

  Initialise a GPIO pin as input with pull down.
- void initAsInput (int thePi, unsigned gpio)

  Initialise a GPIO pin as input.
- void initAsInputs (unsigned const lesGPIOs[ ])

  Initialise one or more GPIO pin as input.
- void initAsLoInput (int thePi, unsigned gpio)

  Initialise a GPIO pin as input with pull up.
- uint32_t initAsOutput (int thePi, unsigned gpio)

  Initialise a GPIO pin as output.
- uint32_t initAsOutputs (unsigned const lesGPIOs[ ])

  Make one or more GPIO pins output.
- uint8_t pin4GPIO (int const gpio)

  GPIO number to pin number lookup.
- uint32_t releaseOutputs (int const thePi)

  Release all GPIO pins set as output.
- uint32_t releaseOutputsReport (int const thePi)

  Release all GPIO pins set as output with report.
- void reportPinOp (char const ∗op, unsigned const lesGpio[ ])

  Report an arbitrary operation on a list of GPIOs.
- void setOutput (unsigned const gpio, unsigned const level)

  Set a GPIO output pin.
- void setOutputs (uint32_t const lesOuts, unsigned const level)

  Set a list/mask of GPIO output pins.
- void setPadStrength (int thePi, unsigned mA)

  Set the output drive capacity of GPIO ports 0..27.

Variables

- uint32_t const gpio2bit [36]

  GPIO number to bank pin number lookup.
- uint8_t const gpio2pin [44]

  GPIO number to pin number lookup.
- uint8_t const pin2gpio [44]

  Pin number to GPIO number lookup.
- char const **pudTxt** [5][6]

  Names for input's pull resistor settings.
- int thePi

  The standard Pi for gpio(d) IO of the program.

5.57.1 Detailed Description

Some IO functions for Raspberry Pi using pigpiod.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  73 18.12.2024
Rev.  227 12.08.2020 :  common functions collected and consolidated
Rev.  233 12.10.2020 :  initAsHiInput() added
Rev.  237 01.03.2021 :  documentation (Doxygen) corrected/improved
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DF_CPU=1500000000 -DPLATFORM=raspberry_04
      -DMCU=BCM2711 -I./include    -c -o weRasp/weGPIOd.o weRasp/weGPIOd.c
```

This is a supplementary library basic library to be used in conjunction with the pigpio library (link: -lpigpiod_if2 -lrt). For documentation see the include file weGPIOd.h and also http://abyz.me.uk/rpi/pigpio/pdif2.html by Joan NN.

5.57.2 Function Documentation

5.57.2.1 pin4GPIO()

```
uint8_t pin4GPIO (
            int const gpio )
```

GPIO number to pin number lookup.

Parameters

gpio	a GPIO number (>= 0) available on the Pi's 40 respectively 26 pins IO connector

Returns

the GPIO's pin number (1..40 resp. 26) on the IO connector;
0 means not available in the Pi IO connector or even undefined

5.57.2.2 gpio4pin()

```
uint8_t gpio4pin (
            int const pin )
```

Pin number to GPIO number lookup.

Parameters

pin	1..40 (26) is the legal IO connector pin number

Returns

0..56 the GPIO number; 90: ground (0V);
93: 3.3V; 95: 5V; 99: undefined, i.e. illegal pin number

5.57.2.3 initAsInputs()

```
void initAsInputs (
            unsigned const lesGPIOs[] )
```

Initialise one or more GPIO pin as input.

This functions sets the pins listed as GPIOs to input mode. This is also used to release them from any output modes as input means hi impedandance.

The Pi for the IO operation is thePi.

Parameters

lesGPIOs	array of GPIO numbers (0..53); use 0x7F as end marker

5.57.2.4 initAsOutputs()

```
uint32_t initAsOutputs (
            unsigned const lesGPIOs[] )
```

Make one or more GPIO pins output.

This functions sets the pins listed as GPIOs to output mode.
Normally, at program end, the same list of outputs should be released to high impedance by initAsInputs().

The Pi for the IO operations is thePi.

Parameters

lesGPIOs	array of GPIO numbers (0..53); use 0x7F as end marker

Returns

the bank mask of the outputs set so by this function; 0 means non set (complete failure)

5.57.2.5 setOutputs()

```
void setOutputs (
            uint32_t const lesOuts,
            unsigned const level )
```

Set a list/mask of GPIO output pins.

This functions sets the (output) pins set in the bank mask ON or OFF.

The Pi for the IO operations is thePi.

Parameters

lesOuts	bank mask of outputs to be set
level	OFF or ON (0 or 1)

5.57.2.6 setOutput()

```
void setOutput (
            unsigned const gpio,
            unsigned const level )
```

Set a GPIO output pin.

This functions sets an output pin gpio ON or OFF.
If gpio is $>$ 31 nothing is done. That handles the meaning of gpio 33 (within a bank) as unused.

The Pi for the IO operations is thePi.

Parameters

gpio	an output pin (that should have been set as such!)
level	OFF or ON (0 or 1)

5.57.2.7 reportPinOp()

```
void reportPinOp (
            char const * op,
            unsigned const lesGpio[] )
```

Report an arbitrary operation on a list of GPIOs.

The report lines on outLog will be
```
progNam   ___operation GPIO: 13 pin:  27
```

Parameters

op	the operation displayed as 12 characters right justified.
lesGpio	a GPIO list (terminated by a value > 56)

5.57.2.8 initAsOutput()

```
uint32_t initAsOutput (
            int thePi,
            unsigned gpio )
```

Initialise a GPIO pin as output.

This sets a GPIO as output and puts it in the list of GPIOs used as outputs by the program if in the range of 0..31 (resp. 2..27).

All functions setting setting as output should use this function.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..31); PINig means no action

Returns

the bank mask of this output if set (0 no action or error)

5.57.2.9 releaseOutputs()

```
uint32_t releaseOutputs (
            int const thePi )
```

Release all GPIO pins set as output.

This releases all GPIO in the range 0..27 that this program has set as outputs (by setting those as inputs).
The order of this operation is by increasing GPIO number. If another order or extra actions are required this must be done before or afterwards.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)

Returns

the bank mask of the previous resp. released outputs

5.57.2.10 releaseOutputsReport()

```
uint32_t releaseOutputsReport (
             int const thePi )
```

Release all GPIO pins set as output with report.

Same as releaseOutputs() plus a "releaseToIn" for every output released.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)

Returns

the bank mask of the previous resp. released outputs

5.57.2.11 initAsInput()

```
void initAsInput (
             int thePi,
             unsigned gpio )
```

Initialise a GPIO pin as input.

This sets a GPIO as input and removes it form the list of GPIOs set as output if in the range of 0..31 (resp. 2..27).

All functions setting as input should use this function.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)

5.57.2.12 initAsLoInput()

```
void initAsLoInput (
             int thePi,
             unsigned gpio )
```

Initialise a GPIO pin as input with pull up.

This initialisation is for an input sensing a switch (button) or transistor (optocoupler) connected to ground (gnd, 0V). This is the normal configuration instead of switching to Hi (3.3V).
In most of the cases the Pi's internal pull up resistor (about 50 kOhm) is sufficient for Lo-switches and should then be used.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)

5.57.2.13 initAsHiInput()

```
void initAsHiInput (
            int thePi,
            unsigned gpio )
```

Initialise a GPIO pin as input with pull down.

This initialisation is for an input sensing an electronic device delivering a voltage about 3 V when active respectively ON. Some of those devices require a pull down to deliver clean signals.
The Pi's internal pull down resistor (about 50 kOhm) may be sufficient for Hi-switches and should then be used.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)

5.57.2.14 initAsHiDrive()

```
void initAsHiDrive (
            int thePi,
            unsigned gpio,
            unsigned init )
```

Initialise a GPIO pin as high drive.

Of course, Raspberry's (BCM2837's) GPIO pins are high and low drivers as output. Hi-drive is provided by turning on pull-up as to allow broken wire diagnosis when shortly switching to input.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)
init	0 or 1: the initial output value; else: leave unchanged

5.57.2.15 initAsDrive()

```
void initAsDrive (
            int thePi,
            unsigned gpio,
            unsigned init )
```

Initialise a GPIO pin as output.

This function sets the GPIO pi as output, optionally sets the drive capacity and leaves a pull resistor setting unchanged.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
gpio	the GPIO number (0..53)
init	0 or 1: the initial output value; else: leave unchanged

5.57.2.16 setPadStrength()

```
void setPadStrength (
            int thePi,
            unsigned mA )
```

Set the output drive capacity of GPIO ports 0..27.

For pins set as output (by initAsHiDrive() or initAsDrive() e.g.) this function sets the drive capacity in the range of 2..16 mA.
Note 1: All 27 pins get the same common value. Hence, one has to set the maximum needed for any pin.
Note 2: This value is no current limit nor pin overload protection. It is the maximum load current, which a valid 0 or 1 output voltage can be guaranteed under. Note 3: The BCM processor can set the strength in 2mA steps (2, 4.. 14, 16). Nevertheless, this function accepts all values 2..16 incrementing odd values.

Parameters

thePi	the Raspberry's identifier as got from initialising gpio(d)
mA	2..16: output drive capacity for providing legal low or high; else: leave drive capacity unchanged

5.57.3 Variable Documentation

5.57.3.1 gpio2pin

```
uint8_t const gpio2pin[44]
```

GPIO number to pin number lookup.

Index [0..39] is a GPIO number available on the Pi's 40 (26) pins connector. Result 1..40: The GPIO's pin number on the IO connector;
0: not available in the Pi IO connector or even undefined
Outside [0..39] index out of bound.
See also gpio2bit, pin2gpio

5.57.3.2 gpio2bit

```
uint32_t const gpio2bit[36]
```

GPIO number to bank pin number lookup.

Index [0..31] is a GPIO number partly (2..27) available on the Pi's 40 (26) pins connector. Result 0x00000001..0x80000000: a 32 bit with exactly one bit set corresponding to place in a 32 bit bank mask.
Outside [0..31] index out of bound.
See also gpio2pin, pin2gpio

5.57.3.3 pin2gpio

```
uint8_t const pin2gpio[44]
```

Pin number to GPIO number lookup.

Index [1..40 (26)] is the legal pin number.
Result 0..56: GPIO number; 90: ground (0V); 93: 3.3V; 95: 5V;
99: undefined (for pin 0 and 41 (27)..44).
Outside [0..43] index out of bound.
See also gpio2bit, gpio2pin

5.57.3.4 thePi

```
int thePi
```

The standard Pi for gpio(d) IO of the program.

This global variable is provided to hold the main pi used by a program doing process IO via piGpIO[d]. In most local use cases

```
thePi = pigpio_start(NULL, NULL);
```

it will be 0 = this local Pi. After usage don't forget to terminate the connection to the pigpio daemon by

```
pigpio_stop(thePi);
```

5.58 weRasp/weLockWatch.c File Reference

Process control helpers for Raspberry Pi: lock and watchdog.

```
#include "weLockWatch.h"
#include "unistd.h"
```

Functions

- void **closeLock** (void)

  Unlock the lock file

- int initWatchdog (void)

  Get and initialise or arm the watchdog.
- int justInitWatchdog (void)

  Get and initialise or arm the watchdog.
- int justLock (char const *lckPiGpioFil)

  Open and lock the lock file.
- int openLock (char const *lckPiGpioFil, uint8_t const perr)

  Open and lock the lock file.
- void stopWatchdog (void)

  Stop and disarm the watchdog.
- void triggerWatchdog (void)

  Trigger the watchdog.

Variables

- int lockFd

  Lock file handle.
- int useIOlock

  flag to use IO (singleton) lock; default on
- int useWatchdog

  flag to use watchdog; default on

5.58.1 Detailed Description

Process control helpers for Raspberry Pi: lock and watchdog.

```
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   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  76 26.02.2025
Rev.  227 12.08.2020 :  common functions collected and consolidated
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DF_CPU=1500000000 -DPLATFORM=raspberry_04
       -DMCU=BCM2711 -DTARGET=pi4you  -I./include
             -c -o weRasp/weLockWatch.o weRasp/weLockWatch.c
```

This is a supplementary library basic library to be used in conjunction with the pigpio library (link: -lpigpiod_if2 -lrt). For documentation see the include file weLOckWatch.h .

5.58.2 Function Documentation

5.58.2.1 justLock()

```
int justLock (
            char const * lckPiGpioFil )
```

Open and lock the lock file.

This function is the basic implementation of openLock. Applications not wanting its optional logging or doing their own should use this function directly.

Parameters

lckPiGpioFil	lock file name

Returns

0: OK, locked; 97: fd does not exist; 98: can't be locked

5.58.2.2 openLock()

```
int openLock (
            char const * lckPiGpioFil,
            uint8_t const perr )
```

Open and lock the lock file.

This function may use logging and streams not available on smaller applications. Those applications not wanting that optional logging or doing their own should use the function justLock().

Parameters

lckPiGpioFil	lock file path name
perr	make error message when lock file does not exist or can't be locked

Returns

0: OK, locked; 97: fd does not exist; 98: can't be locked

5.58.2.3 justInitWatchdog()

```
int justInitWatchdog (
            void  )
```

Get and initialise or arm the watchdog.

This function justInitWatchdog() is the basic implementation of initWatchdog() without logging failure.

Returns

0: watchdog OK or not to be used (useWatchdog OFF); 1: error while trying to get the watchdog

5.58.2.4 initWatchdog()

```
int initWatchdog (
             void  )
```

Get and initialise or arm the watchdog.

If the watchdog is to be used, i.e. useWatchdog is ON. this function tries to get it. Otherwise it does nothing but return 0 (success).

On no success 1 is returned and useWatchdog is set OFF and the misfortune is logged. Use justInitWatchdog() :: for silence.

Returns

0: watchdog OK or not to be used (useWatchdog OFF); 1: error while trying to get the watchdog

5.58.2.5 stopWatchdog()

```
void stopWatchdog (
             void  )
```

Stop and disarm the watchdog.

If the watchdog is to be used, i.e. useWatchdog is ON, this function stops and disarms it.
useWatchdog is then OFF .

5.58.2.6 triggerWatchdog()

```
void triggerWatchdog (
             void  )
```

Trigger the watchdog.

If the watchdog is to be used, i.e. useWatchdog is ON, this function triggers it.
If the watchdog is armed (by initWatchdog()) not triggering it at least once about every 15 s will lead to system reset.

5.58.3 Variable Documentation

5.58.3.1 useIOlock

```
int useIOlock
```

flag to use IO (singleton) lock; default on

Do use IO lock.

5.58.3.2 lockFd

```
int lockFd
```

Lock file handle.

Do not use directly.

5.58.3.3 useWatchdog

```
int useWatchdog
```

flag to use watchdog; default on

flag to use watchdog; default ON

5.59 weRasp/weModbus.c File Reference

Modbus functions for Raspberry Pis.

```
#include <weModbus.h>
```

Functions

- void modRSclose (modRS_t *modRS)

  Close a Modbus RS link and destroy the (libmodbus) structure.
- int modRSconnect (modRS_t *modRS, int currentSlave)

  Connect a the Modbus (libmodbus) structure for RS485 (RTU).
- int modRSctxNew (modRS_t *modRS, int currentSlave)

  Make a new Modbus (libmodbus) structure for RS485.
- int modRSswitchSlave (modRS_t *modRS, int currentSlave)

  Switch the slave on a connected Modbus (libmodbus) structure for RS485.
- void modTCPclose (modTCP_t *modTCP)

  Close a Modbus TCP and destroy the (libmodbus) structure.
- int modTCPconnect (modTCP_t *modTCP)

  Connect a the Modbus (libmodbus) structure for TCP.
- int modTCPctxNew (modTCP_t *modTCP)

  Make a new Modbus (libmodbus) structure for TCP.
- int modTCPlisten (modTCP_t *modTCP)

  Listen at the Modbus (libmodbus) structure for TCP.
- int parseModPort (const char *str)

  Parse a string as Modbus TCP port number with checks.
- void reg2val32 (dualReg_t *const dest, dualReg_t const *const source)

  Copy float (32 bit) Modbus input to correctly ordered value.
- uint16_t regs2string (char *dest, uint16_t *source, int n)

  Copy a sequence of character pairs from registers to a string.
- void regs2vals32 (float *const dest, dualReg_t const *const source, int const n)

  Copy n float (32 bit) Modbus input to correctly ordered values.
- int setIP4add (char *dest, const char *src)

  Set an IPv4 address as string with syntax checks.

5.59.1 Detailed Description

Modbus functions for Raspberry Pis.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  83 15.05.2025
Rev.    51  18.10.2017 A.W.:  more structures and functions, more comfort
Rev.  188  15.10.2018 :  minor typos
Rev.  212  04.08.2019 :  regs2string added
Rev.  216  31.08.2019 :  mod_bus close added
Rev.  270 07.11.2024 :  use old includes before meterpi crash ("BC")
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DMCU=BCM2837 -I./include -c -o weRasp/weModbus.o weRasp/weModbus.c
```

This is a supplementary (basic) library to be used in conjunction with the libmodbus library (link: -lmodbus). For documentation see the include file weModbus.h

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history
```
Rev.  83 15.05.2025
Rev.    51  18.10.2017 A.W.:  more structures and functions, more comfort
Rev.  188  15.10.2018 :  minor typos
Rev.  212  04.08.2019 :  regs2string added
Rev.  216  31.08.2019 :  mod_bus close added
```

cross-compile by:
```
arm-linux-gnueabihf-gcc -DMCU=BCM2837 -I./include -c -o weRasp/weModbus.o weRasp/weModbus.c
```

This is a supplementary (basic) library to be used in conjunction with the libmodbus library (link: -lmodbus). For documentation see the include file weModbus.h

5.59.2 Function Documentation

5.59.2.1 reg2val32()

```
void reg2val32 (
            dualReg_t *const dest,
            dualReg_t const *const source )
```

Copy float (32 bit) Modbus input to correctly ordered value.

This function copies a 32bit (e.g.) float value input from Modbus — with correct byte ordering at 16 bit level (!) — to a correctly ordered (32 bit) value.
Destination and source pointers may be the same, but not NULL.
The swap of the 16-bit parts only occurs, when the platform is little endian.
See also: PLATFlittlE and regs2vals32()

Parameters

dest	the dual registers to store the result in
source	the dual registers with the potentially wrong endianess

5.59.2.2 regs2vals32()

```
void regs2vals32 (
            float *const dest,
            dualReg_t const *const source,
            int const n )
```

Copy n float (32 bit) Modbus input to correctly ordered values.

This function copies n 32bit (e.g.) float values input from Modbus — with correct byte ordering at 16 bit level (!) — to correctly ordered (32 bit) values.
Destination and source pointers may be the same, but not NULL.
The swap of the 16-bit parts only occurs, when the platform is little endian.
See also: PLATFlittlE and reg2val32()

Parameters

dest	the array of dual registers to store the result in
source	the array of dual registers with potentially wrong endianess
n	the number of dual registers to treat

5.59.2.3 regs2string()

```
uint16_t regs2string (
            char * dest,
            uint16_t * source,
            int n )
```

Copy a sequence of character pairs from registers to a string.

Growatt inverter holding registers, for example, deliver strings as pairs of ASCII characters in consecutive registers. If the number of characters is odd the last register holds just one character. Some of those strings in registers are 0-terminated and some are not. In the first case the transfer stops at the 0, in the latter case a 0 is appended to the destination string as n+1st character.
The sequence of the two characters in each register is (as usual with Modbus) in wrong order. Hence, memcopy and consorts would fail.

Parameters

dest	the array of characters to store the result in
source	the array registers with wrong character sorting
n	the number of dual registers to treat

Returns

the number of characters transfered to dest including the terminating 0

5.59.2.4 modTCPctxNew()

```
int modTCPctxNew (
            modTCP_t * modTCP )
```

Make a new Modbus (libmodbus) structure for TCP.

This function makes a new modTCP.ctx according to .addr and .port; it does NOT check NOR change .mlStat.

Parameters

modTCP	pointer to modTCP_t structure to be used

Returns

0 : OK; -1: error

5.59.2.5 modTCPconnect()

```
int modTCPconnect (
            modTCP_t * modTCP )
```

Connect a the Modbus (libmodbus) structure for TCP.

This function makes a new modTCP.ctx according to .addr and .port, if not yet made. Then it "connects" it. On success 0 is returned. On failure -1 is returned and modTCP.ctx will be destroyed.

This function does NOT check NOR change .mlStat.

Parameters

modTCP	pointer to modTCP_t structure to be used

Returns

0 : OK; -1: error

5.59.2.6 modTCPlisten()

```
int modTCPlisten (
            modTCP_t * modTCP )
```

Listen at the Modbus (libmodbus) structure for TCP.

This function makes a new modTCP.ctx according to .addr and .port, if not yet made. Then it "listens" on it. On success .s >= 0, that is the socket, is returned. On failure -1 is returned and modTCP.ctx will be destroyed. The number of connections is limited to one, here.

This function does NOT check NOR change .mlStat.

Parameters

modTCP	pointer to modTCP_t structure to be used

Returns

>=0 : OK, i.e the socket andmodTCP.s; -1: error

5.59.2.7 modTCPclose()

```
void modTCPclose (
            modTCP_t * modTCP )
```

Close a Modbus TCP and destroy the (libmodbus) structure.

This function closes the connection (if on) and destroys modTCP.ctx (if existing) .mlStat will be set to ML_OFF.

Parameters

modTCP	pointer to modTCP_t structure to be used

5.59.2.8 setIP4add()

```
int setIP4add (
            char * dest,
            const char * src )
```

Set an IPv4 address as string with syntax checks.

This function sets the parameter dest with src, doing syntactic checks to assure a valid IPv4 address being set.

Parameters

dest	the strtring to copy the IP address to
src	the IP string to copy to dest; NULL acts as "0.0.0.0"

Returns

0: syntax error or dest is NULL, dest unchanged; 1: OK

5.59.2.9 parseModPort()

```
int parseModPort (
            const char * str )
```

Parse a string as Modbus TCP port number with checks.

Parse string as Modbus port with checks.

This function parses the string src as Modbus port number, doing validity checks: src must be a decimal number 502 or 1024..65535.

Parameters

str	the string to parse as (decimal) modPort; NULL acts as 502

Returns

0: syntax error, else valid Modbus port number (see above)

5.59.2.10 modRSctxNew()

```
int modRSctxNew (
            modRS_t * modRS,
            int currentSlave )
```

Make a new Modbus (libmodbus) structure for RS485.

This function makes a new modTCP.ctx according to .addr and .port; it does NOT check NOR change .rsState.

Parameters

modRS	pointer to modRS_t structure to be used
currentSlave	1..247 sets the slave number; sets .currentSlave

Returns

0 : OK; else: error: -1: modRS null; -2: slave number: -3: no ctx

5.59.2.11 modRSconnect()

```
int modRSconnect (
            modRS_t * modRS,
            int currentSlave )
```

Connect a the Modbus (libmodbus) structure for RS485 (RTU).

This function makes a new modRS.ctx according to .device and else. Then it "connects" it. On success 0 is returned. On failure -1 is returned and modTCP.ctx will be destroyed.

This function does NOT check NOR change .rsState.

Parameters

modRS	pointer to modRS_t structure to be used
currentSlave	if 1..247; sets the slave number to be used next and changes .currentSlave

5.59.2.12 modRSswitchSlave()

```
int modRSswitchSlave (
            modRS_t * modRS,
            int currentSlave )
```

Switch the slave on a connected Modbus (libmodbus) structure for RS485.

This function changes nothing on a functional and connected modRS.ctx setting than the slave number.

Modbus RS485 (RTU) can handle multiple slaves on the same serial interface. This has to be one at a time in a pure sequential matter: hence this slave switching.
With RS232 the one slave's number once correctly established would stay fixed.

Unfortunately (by a libmodbus deficiency) a communication error of one slave would require a total new connect (modRSconnect()) for all slaves; switching to a "good slave" won't help.

Parameters

modRS	pointer to modRS_t structure to be used
currentSlave	if 1..247; sets .currentSlave

Returns

-1: error wrong parameter or no modRS; 0: no change or no ctx; 1..247: changed currentSlave; OK

5.59.2.13 modRSclose()

```
void modRSclose (
            modRS_t * modRS )
```

Close a Modbus RS link and destroy the (libmodbus) structure.

This function destroys modRS.ctx (if existing). .rsState will not be changed.

Parameters

modRS	pointer to modRS_t structure to be used

5.60 weRasp/weSerial.c File Reference

Functions for Raspberry Pi's serial communication.

```
#include "weSerial.h"
```

Functions

- tcflag_t baudFlag (unsigned int const speed)

  Baud flags by baud rate.
- unsigned int baudRate (tcflag_t baudFlag)

  Baud rate by baud flags.
- void closeUART ()

  Close the UART.
- int openUART ()

  Open the UART with given settings.

Variables

- tcflag_t **baud**

  The UART's baud rate as flag bits.
- struct termios **options**

  The UART's setting structure.
- unsigned int **speed**

  The UART's baud rate as value.
- timespec **startReceive**

  Time used for receive timing.
- int uartFilestream

  The UART as file (stream).
- char * uartPath

  The UART's path name.

5.60.1 Detailed Description

Functions for Raspberry Pi's serial communication.

```
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    /          /       /\
   /          /___    /  \       |
   \         /____\  /____\  |  _|__
    \  /\  / \     /        \|   |
     \/  \/   \__/          \__/|_
```

Revision history

```
Rev.  36 20.01.2021
Rev.  209 09.07.2019 :  new
```

This is a (basic) library for serial communications. As far as Modbus is or can be supported this is independent of Stéphane Raimbault's Modbus library libmodbus; weModbus.c on the other hand is.
For documentation see the include file weSerial.h

5.60.2 Function Documentation

5.60.2.1 baudFlag()

```
tcflag_t baudFlag (
            unsigned int const speed )
```

Baud flags by baud rate.

Parameters

speed	a legal baudrate 300 9600 19200 and so on

Returns

the corresponding flag bits if rate is available; otherwise 0 (error). This should be defaulted to a standard rate like 9600 e.g.

5.60.2.2 baudRate()

```
unsigned int baudRate (
            tcflag_t baudFlag )
```

Baud rate by baud flags.

The speed bits of the parameter baudFlag will be evaluated and the corresponding baud rate will be returned. In vase of no valid speed flag value 0 will be returned. 0 may be considered as error and should be defaulted to 9600.

Parameters

baudFlag	the speed bits of the flags parameter will be evaluated

Returns

the corresponding baud rate 300, 9600, 19200 or other standard rate

5.60.2.3 openUART()

```
int openUART ( )
```

Open the UART with given settings.

Returns

uartFilestream; -1 means open error

5.60.2.4 closeUART()

```
void closeUART ( )
```

Close the UART.

uartFilestream will be set to -1.

5.60.3 Variable Documentation

5.60.3.1 uartFilestream

```
int uartFilestream
```

The UART as file (stream).

It is $>$ 0 ($>$2) when open and -1 when closed.

5.60.3.2 uartPath

```
char* uartPath
```

The UART's path name.

It will be preset with the architecture's standard UART path.

5.61 weRasp/weShareMem.c File Reference

One chunk of shared memory on a Raspberry Pi.

```
#include "weShareMem.h"
```

Functions

- int deleteSemas ()
  Delete the one semaphore set.
- int deleteSharedMem ()
  Delete and detach the shared memory.
- int **detachSharedMem** ()
  Detach the shared memory.
- int getSemas ()
  Get the one semaphore set.
- int initialiseSemas ()
  Initialise the one semaphore set.
- void * initialiseSharedMem ()
  Initialise shared memory.
- int semaphoreClt (int const semNum, int const op, semCtlPar_t par)
  Control semaphores of the set.
- int semaphoreLock (int const semNum, int const ms)
  Lock one semaphore of the set.
- int semaphoreOperation (int const semNum, int op, int const ms)
  Operation on one semaphore of the set.
- int semaphoreUnlock (int const semNum)
  Unlock one semaphore of the set.

Variables

- int semLckErrCnt

  Semaphore lock error count.
- int **shMemErrno**

  Last error number of (some) semaphore operations.
- int shMemSem

  Semaphore set identifier.
- const semCtlPar_t **VAL0**

  value 0 for SETVAL
- const semCtlPar_t **VAL1**

  value 1 for SETVAL
- const semCtlPar_t **VAL9**

  value 9 for SETVAL

5.61.1 Detailed Description

One chunk of shared memory on a Raspberry Pi.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  79  23.03.2025
Rev.    73+ 16.11.2017 :  new
Rev.    75  30.11.2017 :  signal semaphore initialised to 0
Rev.  188  15.10.2018 :  minor typos
Rev.    76  24.02.2025 :  clarification of 64 bit OS malfunction
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DMCU=BCM2837 -I./include -c -o weRasp/weShareMem.o weRasp/weShareMem.c
```

For documentation see also the include file weShareMem.h

5.61.2 Function Documentation

5.61.2.1 getSemas()

```
int getSemas ( )
```

Get the one semaphore set.

The one semaphore set, if existing, will be registered and used as is.

Returns

0: OK found existing semaphore set; -1: error (errno set and errorText generated)

5.61.2.2 initialiseSemas()

```
int initialiseSemas ( )
```

Initialise the one semaphore set.

The number of semaphores in the set is ANZ_SEMAS (default three). The one semaphore set, if existing, will be registered and used as is. If this is not possible it will be made and initialised.

Hint: This function has two OK return values!

Returns

1: OK semaphore set made new; 0: OK found existing semaphore set; -1: error (errno set and errorText generated)

5.61.2.3 deleteSemas()

```
int deleteSemas ( )
```

Delete the one semaphore set.

Server operation only.

Returns

0: OK; -1: error (errno set and errorText generated)

5.61.2.4 semaphoreOperation()

```
int semaphoreOperation (
            int const semNum,
            int const op,
            int ms )
```

Operation on one semaphore of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)
op	the semaphore operation
ms	if 2..20000 a timeout in ms

Returns

0: OK; -1: error (errno set and errorText generated)

5.61.2.5 semaphoreLock()

```
int semaphoreLock (
            int const semNum,
            int ms )
```

Lock one semaphore of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)
ms	if 2..20000 a timeout in ms

Returns

0: OK; -1: error (errno set and errorText generated)

5.61.2.6 semaphoreUnlock()

```
int semaphoreUnlock (
            int const semNum )
```

Unlock one semaphore of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)

Returns

0: OK; -1: error (errno set and errorText generated)

5.61.2.7 semaphoreClt()

```
int semaphoreClt (
            int const semNum,
            int const op,
            semCtlPar_t par )
```

Control semaphores of the set.

Parameters

semNum	the semaphore number in the set (0..ANZ_SEMAS -1)
op	the semaphore operation, like e.g. SETVAL
par	op's parameter if any

Returns

0: OK; -1: error (errno set and errorText generated)

5.61.2.8 initialiseSharedMem()

```
void * initialiseSharedMem ( )
```

Initialise shared memory.

Make or get and attach. return pointer to attached shared memory or (void *)-1

5.61.2.9 deleteSharedMem()

```
int deleteSharedMem ( )
```

Delete and detach the shared memory.

Server operation only.

5.61.3 Variable Documentation

5.61.3.1 shMemSem

```
int shMemSem
```

Semaphore set identifier.

The value returned by e.g. semget() (within getSemas() etc.) On success, semget() returns the semaphore set identifier (a nonnegative integer). On failure, -1 is returned, and errno is set to indicate the error.

5.61.3.2 semLckErrCnt

```
int semLckErrCnt
```

Semaphore lock error count.

Reset to 0 on success.

5.62 weRasp/weStateM.c File Reference

States and state machine support.

```
#include "weStateM.h"
#include "weUtil.h"
```

Functions

- void endStateTextTims (char *stateText, state_t const *const me)
  Generate status text standard end with two times.
- uint8_t fiveBandDoEnter (state_t *const me, float analogueVal)
  Five band checker turn / force ON.
- uint8_t fiveBandDoLeave (state_t *const me, float analogueVal)
  Five band checker turn / force OFF.
- uint8_t fiveBandTick (state_t *const me, float controlV)
  Five band checker trigger.
- uint8_t floatHystDoEnter (state_t *const me, float analogueVal)
  Float value hysteresis turn / force ON.
- uint8_t floatHystDoLeave (state_t *const me, float analogueVal)
  Float value hysteresis turn / force OFF.
- uint8_t floatHystTick (state_t *const me, float const controlV)
  Float value hysteresis trigger.
- void genStateText (char *stateText, state_t const *const me, char const *stamp)
  Generate text for state machine status.
- void logStateReason (state_t const *const me, char const *stamp, char const *cause)
  Log status text with cause and info.
- void logStateText (state_t const *const me, char const *stamp)
  Log status text.
- uint8_t seqContDoEnter (state_t *const me, char const *startCommand)
  Sequential control entry.
- uint8_t seqContDoLeave (state_t *const me, char const *const stopCommand)
  Sequential control leave.
- uint8_t seqContTick (state_t *const me)
  Sequential control tick or check.
- void startStateText (char *stateText, state_t const *const me, char const *stamp)
  Generate status text standard start.
- uint8_t switchDebDoEnter (state_t *const me, uint32_t controlV)
  Switch de-bounce turn / force ON.
- uint8_t switchDebDoLeave (state_t *const me, uint32_t controlV)
  Switch de-bounce turn / force OFF.
- uint8_t switchDebTick (state_t *const me, uint32_t controlV)
  Switch de-bounce trigger.
- uint8_t switchDebTickAC (state_t *const me, uint32_t controlV)
  Switch de-bounce trigger AC.
- uint8_t timerDoEnter (state_t *const me, uint32_t secFromNow)
  Timer entry.
- uint8_t timerDoLeave (state_t *const me, uint32_t ignored)
  Timer leave, that is stop timer.

- uint8_t timerDoStart (state_t *const me, uint32_t secFromNow)

  Timer unconditional entry and set.
- uint8_t timerDoStart4ever (state_t *const me)

  Timer unconditional entry and set forever or stop it.
- uint8_t timerDoTrigger (state_t *const me, uint32_t secFromNow)

  Timer entry or (pro-longing) re-trigger.
- uint8_t timerEndTrigger (state_t *const me, uint32_t const secUTCend)

  Timer entry or (pro-longing) re-trigger to absolute UTC end.
- uint8_t timerTickCheck (state_t *const me, uint32_t controlV)

  Timer trigger.

5.62.1 Detailed Description

States and state machine support.

```
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    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /      \|   |
     \/  \/   \__/        \__/|_
```

Revision history

```
Rev.  95 9.10.2025
Rev.  104 05.02.2018 :  new
Rev.  108 02.12.2018 :  parts moved out, one event file
Rev.  193 25.02.2019 :  fifeBandCheck implemented
Rev.  195 01.03.2019 :  switch de-bounce debugged
Rev.  198 04.03.2019 :  justLogStateChg added
Rev.  200 16.04.2019 :  state expanded, logging improved
Rev.  223 23.06.2020 :  switchDebTickAC added
Rev.  263 08.09.2024 :  formEpocTime added (to make logged timers readable)
Rev.    82 23.04.2025 :  typos, comments        (svn://DS1010/rasProject_01)
Rev.    86 22.06.2025 :  state machine less unions, more state
Rev.    92 20.08.2025 :  SFC revision
```

State machines are implemented in an object oriented way although C is in no way supporting objects. We do this by defining the state in a structure and the behaviour in a set of functions, regarding a defined structure variable plus the functions as an object modelling the state machine in question.
Of course, in C we don't have the object orientation principles, especially no encapsulation. There is no binding of behaviour (functions) to the state (structure variable), which leads to a structure pointer as first parameter of every related function. The only substitute for OO language features is discipline.

As of Revision 193 (2019) there are five types of state machines:

1. Timer, seconds resolution, UTC stamp (type 0xAD)
2. switch de-bounce (type 0xDB)
3. Float value hysteresis (0xFF)
4. 5 band check ...badLO | critLo | OK | critHi | badHi... (0x5B)
5. sequential Control in Sequential Function Chart (SFC) mannor (0xFC)

   cross-compile by:
   ```
   arm-linux-gnueabihf-gcc -DMCU=BCM2837 -I./include -c -o weRasp/weStateM.o weRasp/weStateM.c
   ```

5.62.2 Function Documentation

5.62.2.1 startStateText()

```
void startStateText (
            char * stateText,
            state_t const *const me,
            char const * stamp )
```

Generate status text standard start.

This sets the common standard start of a status text in state text, like:
```
//0123456789x123456789v123456789t123456789q1
 " 2019-04-26 03:08:26.278 # befRiseTimer:  "
```

It ends with a blank at [40] after the colon at [39]. State machine type or instance specific text may be added from [40] or [41] up to (recommended) [76] followed by a terminating 0.

Hint: This function sets a 0 at [41] for robustness, i.e. having stateText always as string.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.62.2.2 endStateTextTims()

```
void endStateTextTims (
            char * stateText,
            state_t const *const me )
```

Generate status text standard end with two times.

This sets a common standard end of a status text consisting of the two times me->realSecOn and me->realSecOff or me->endTime separated by a slash (~) and terminated with (char) 0. ~~~~ /code //0123456789x123456789v1 "1234567890/1234567890" 14:51:12~ 15:37:04 ~~~~ /endcode The standard start of this would be at stateText + 56. endTime is used when realSecOff < realSecOn.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null

5.62.2.3 genStateText()

```
void genStateText (
            char * stateText,
```

```
            state_t const *const me,
            char const * stamp )
```

Generate text for state machine status.

This is the minimal common standard for all status machines.

Parameters

stateText	a character array supplied to hold the state text to be generated; minimal length 80.
me	pointer to own state; never null!
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.62.2.4 logStateText()

```
void logStateText (
            state_t const *const me,
            char const * stamp )
```

Log status text.

The status as text will be generated in and then be output to outLog. outLog will be flushed.

Parameters

me	pointer to own state; not null
stamp	(time) stamp to be prepended (max. length 23); default " - "

5.62.2.5 logStateReason()

```
void logStateReason (
            state_t const *const me,
            char const * stamp,
            char const * cause )
```

Log status text with cause and info.

The status as text will be generated and then be output to outLog. outLog will be flushed.
The text will be:
stamp # state machine name: cause me->infoTxt
me->infoTxt has to be set/ provided by application software and will be output to a maximum / recommended length of 29. A standard format is one field of 7 and two fields of ten characters separated by spaces.

Parameters

me	pointer to own state; not null
stamp	(time) stamp to be prepended (max. length 23); default " - "
cause	the cause of the state change (max. length 6); default me->controlVS

was -29 check for homeDoor

5.62.2.6 timerTickCheck()

```
uint8_t timerTickCheck (
            state_t *const me,
            uint32_t controlV )
```

Timer trigger.

Parameters

me	pointer to own state; not null
controlV	current time stamp; mostly cycTaskEventData_t.realSec resp. getAbsS()

Returns

0: state changed, i.e. timer ended; 2: still running; 4: inactive

5.62.2.7 timerDoEnter()

```
uint8_t timerDoEnter (
            state_t *const me,
            uint32_t secFromNow )
```

Timer entry.

This function starts an inactive timer to end secFromNow s. It does nothing on a timer already active resp. running, especially, it does not re-trigger / prolong the timer's time.

This is the function set as (default) state_t.doEnter and not timerDoStart.

Parameters

me	pointer to own state; not null
secFromNow	time to run on from now (s)

Returns

0: OK, timer no or already ON

5.62.2.8 timerDoStart()

```
uint8_t timerDoStart (
            state_t *const me,
            uint32_t secFromNow )
```

Timer unconditional entry and set.

This function starts an inactive timer. The timer's end time will be set to (now + secFromNow s) no matter the timers previous state. This unconditional changing the end time of a timer already running is the difference to timerDoEnter.

This is not the function set as (default) state_t.doEnter; it is timerDoEnter.

Parameters

me	pointer to own state; not null
secFromNow	time to run on from now (s)

Returns

0: now started; 1: was running, probably end time changed

5.62.2.9 timerDoStart4ever()

```
uint8_t timerDoStart4ever (
            state_t *const me )
```

Timer unconditional entry and set forever or stop it.

This function starts an inactive timer. The timer's end time will be set to 2.2.2106 no matter the timers previous state. This date is considered as for ever in our 21st century. This does effectively stop the timer.

This function is intended to start or keep running a timer not to end before its time is to be set (by timerDoStart) to a sensible end time.
One use case is: A timer running forever is in error state.

This function is, of course, faster than timerDoEnter and timerDoStart.

Parameters

me	pointer to own state; not null

Returns

0: now started; 1: was running, probably end time changed

5.62.2.10 timerDoTrigger()

```
uint8_t timerDoTrigger (
            state_t *const me,
            uint32_t secFromNow )
```

Timer entry or (pro-longing) re-trigger.

This function starts an inactive timer to end secFromNow s. IF the timer is active and if (now + secFromNow) is later than the current end, the timer me's runtime will be prolonged accordingly (timer re-trigger).

Parameters

me	pointer to own state; not null
secFromNow	time to run on from now (s)

Returns

0: OK, timer starter or prolonged to new (later) time 1: running timer not prolonged

5.62.2.11 timerEndTrigger()

```
uint8_t timerEndTrigger (
            state_t *const me,
            uint32_t const secUTCend )
```

Timer entry or (pro-longing) re-trigger to absolute UTC end.

If secUTCend is now or in the past or if it is equal the the end of the already active timer, nothing will be done (returns 1).

This function starts an inactive timer to end at secUTCend. If the timer is active already secUTCend will be taken as new end time.

Parameters

me	pointer to own state; not null
secUTCend	end time

Returns

0: OK (started or re-triggered); 1: no state change (on and no prolonging, or secUTCend in past)

5.62.2.12 timerDoLeave()

```
uint8_t timerDoLeave (
            state_t *const me,
            uint32_t ignored )
```

Timer leave, that is stop timer.

Note: This function is usable for other state machine types, too, if appropriate.

Parameters

me	pointer to own state; not null
ignored	as the name says

Returns

0: state changed, 1: state hold

5.62.2.13 switchDebTick()

```
uint8_t switchDebTick (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce trigger.

Parameters

me	pointer to own state; not null
controlV	0: input OFF else: input ON

Returns

0: state changed, 1: state hold

See also

newSwitchDeb

5.62.2.14 switchDebTickAC()

```
uint8_t switchDebTickAC (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce trigger AC.

This function does essentially the same as switchDebTick, except for On ticks being counted twice. This is meant for half wave rectified AC signals sampled at multiples of their frequency. Obviously, half or 1/2 + 1 of the samples will always be Off. And, of course, the state machine has to be made with a on chain length being by the number of samples per period higher than the normal switch de-bounce filter time, to avoid spiky ON results.

Parameters

me	pointer to own state; not null
controlV	0: input OFF else: input ON

Returns

0: OFF, 1: ON

See also

newSwitchDeb

5.62.2.15 switchDebDoEnter()

```
uint8_t switchDebDoEnter (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce turn / force ON.

Parameters

me	pointer to own state; not null
controlV	irrelevant but recorded on state change

Returns

0: state changed, 1: state hold

5.62.2.16 switchDebDoLeave()

```
uint8_t switchDebDoLeave (
            state_t *const me,
            uint32_t controlV )
```

Switch de-bounce turn / force OFF.

Note: this function is usable for other non timer stati, too;

Parameters

me	pointer to own state; not null
controlV	irrelevant but recorded on state change

Returns

0: state changed, 1: state hold

5.62.2.17 floatHystTick()

```
uint8_t floatHystTick (
            state_t *const me,
            float controlV )
```

Float value hysteresis trigger.

Parameters

me	pointer to own state; not null
controlV	the sampled analogue value

Returns

0: state change, 1: no change, 0xFF: fault i.e. controlV is NaN (no state change)

5.62.2.18 floatHystDoEnter()

```
uint8_t floatHystDoEnter (
            state_t *const me,
            float analogueVal )
```

Float value hysteresis turn / force ON.

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded

Returns

0: OK, state now ON; 0xFF: fault (me is NULL e.g.)

5.62.2.19 floatHystDoLeave()

```
uint8_t floatHystDoLeave (
            state_t *const me,
            float analogueVal )
```

Float value hysteresis turn / force OFF.

Note: this function is usable for other non timer stati, too;

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded; may take an (uint32_t) cast float

Returns

0: state change, 1: no change

5.62.2.20 fiveBandTick()

```
uint8_t fiveBandTick (
            state_t *const me,
            float controlV )
```

Five band checker trigger.

Parameters

me	pointer to own state; not null
controlV	the sampled analogue value

Returns

0: state change, 1: no change

5.62.2.21 fiveBandDoEnter()

```
uint8_t fiveBandDoEnter (
            state_t *const me,
            float analogueVal )
```

Five band checker turn / force ON.

This function puts the checker in state bad Hi (2) no matter the parameter value.

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded on state change

Returns

0: state change, 1: no change

5.62.2.22 fiveBandDoLeave()

```
uint8_t fiveBandDoLeave (
            state_t *const me,
            float analogueVal )
```

Five band checker turn / force OFF.

This function puts the checker in state OK (0) no matter the parameter value.

Parameters

me	pointer to own state; not null
analogueVal	irrelevant, but recorded on state change

Returns

0: state change, 1: no change

5.62.2.23 seqContDoEnter()

```
uint8_t seqContDoEnter (
            state_t *const me,
            char const * startCommand )
```

Sequential control entry.

This function starts the sequence from OFF to ON.

Parameters

me	pointer to own state; not null
startCommand	the cause of the state change; 6 characters (max.) to be recorded and else irrelevant for his function

Returns

0: OK state now ON or on its way there; 1: already ON

5.62.2.24 seqContDoLeave()

```
uint8_t seqContDoLeave (
            state_t *const me,
            char const * stopCommand )
```

Sequential control leave.

This function starts the sequence from ON to OFF.

Parameters

me	pointer to own state; not null
stopCommand	It is recorded on state changes and else irrelevant for this function; see description on seqContTick

Returns

0: OK state now OFF or on its way there; else: other inhibit condition

5.62.2.25 seqContTick()

```
uint8_t seqContTick (
            state_t *const me )
```

Sequential control tick or check.

If this sequential control (me) is not in a stable OFF or ON state, that is state_t.status is 0 or 1 and state_t.subStatus is 0, this function should be called at regular intervals or on relevant conditions state changes.

The function must keep or advance the state.

It must react on interrupts by seqContDoEnter or seqContDoLeave recognisable by state_t.status == 5 respectively 4. Note: This is just for the case, that the individual call back function state_t.onStateChange does not handle this "interrupts" — what it really should.

This (basic) implementation advances the sub state from 1 to n-1 respectively m-1. Interrupts by seqContDoEnter or seqContDoLeave are handled by changing to sub state 1 of the opposite leg.

When this basic implementation is not sufficient for a concrete SFC, the application may provide an own tick/check function. However, in most cases seemingly complicated cases — nonlinear chains, wait conditions etc. — the specialised behaviour can most often be implemented by an individual state_t.onStateChange call back function.

Parameters

me	pointer to own state; not null

Returns

0: state or sub-state changed 0xFF: fault status panic ... else: current state kept, of course

5.63 weRasp/weUSBscan.c File Reference

USB 1D / 2D scanners mimicking keyboards on Raspberry Pi.

```
#include "weUSBscan.h"
```

Variables

- char const deRawCoDisAltGrph [120]

  Key position number to character, AltGr, German keyboard.
- char const deRawCoDisNoShift [90]

  Key position number to character, no shift, German keyboard.
- char const deRawCoDisShifted [90]

  Key position number to character, shifted, German keyboard.
- wchar_t raw2wcharAltGrph [102]

  Key position number to character, with AltGR.
- wchar_t raw2wcharNoShift [60]

  Key position number to character, no shift.
- wchar_t raw2wcharShifted [60]

  Key position number to character, with shift.
- unsigned char scanKeyAction [32]

  The one keystroke read buffer.
- int scanKeybLang

  The keyboard language.
- wchar_t scanResult [162]

  The result of one scan.
- char const usRawCoDisNoShift [90]

  Key position number to character, no shift, US keyboard.
- char const usRawCoDisShifted [90]

  Key position number to character, shifted, US keyboard.

5.63.1 Detailed Description

USB 1D / 2D scanners mimicking keyboards on Raspberry Pi.

```
Copyright  (c)   2020     Albrecht Weinert
weinert-automation.de     a-weinert.de
    /         /      /\
   /         /___   /  \       |
   \        /____\ /____\ |  _|__
    \  /\  / \    /       \|   |
     \/  \/   \__/         \__/|_
```

Revision history

```
Rev.  36 20.01.2021
Rev.  232 03.09.2020 :  new (extracted from testOnPi.c)
```

This is a supplementary basic library to handle USB barcode and QR code scanners. By plug'n play such scanner would normally appear as device

```
/dev/hidraw0
```

. To make this usable for scanner application programs run without sudo apply

```
sudo chmod  664 /dev/hidraw0
```

before.

5.63.2 Variable Documentation

5.63.2.1 usRawCoDisNoShift

```
char const usRawCoDisNoShift[90]
```

Key position number to character, no shift, US keyboard.

This utf-8 or multibyte character array respectively string describes the translation of key number to character for a US keyboard.
It will have to be transfered as wide character array to raw2wcharNoShift.

5.63.2.2 usRawCoDisShifted

```
char const usRawCoDisShifted[90]
```

Key position number to character, shifted, US keyboard.

See the explanation at usRawCoDisNoShift.

See also

raw2wcharShifted

5.63.2.3 deRawCoDisNoShift

```
char const deRawCoDisNoShift[90]
```

Key position number to character, no shift, German keyboard.

This utf-8 or multibyte character array respectively string describes the translation of key number to character for a US keyboard.
It will have to be transfered as wide character array to raw2wcharNoShift.

Remarks on non US keyboard emulations by the "USB Wired 2D Barcode Scanner" <MJ-8200> and consorts:
We strongly recommend not to use them and refrain from applications using more than primitive USASCII. As "↩ German keyboard", e.g., the scanner does neither recognise nor send . Besides being called German without umlauts [sic!] the scanner is ignorant to some other characters on every German keyboard (which are probably there because of being used in Western Europe). Additionally the scanner when set to German inserts additional strings of characters with no obvious sense or system.
In the end we consider everything beyond factory reset (except low beeper volume) as not functional.
Without the hard bug of inventing characters and string not contained in the QR-code, the so called German keyboard would give us some extra characters — but not umlauts.

5.63.2.4 deRawCoDisShifted

```
char const deRawCoDisShifted[90]
```

Key position number to character, shifted, German keyboard.

See the explanation at usRawCoDisNoShift.

See also

raw2wcharShifted deRawCoDisNoShift

5.63.2.5 deRawCoDisAltGrph

```
char const deRawCoDisAltGrph[120]
```

Key position number to character, AltGr, German keyboard.

See the explanation at usRawCoDisNoShift.

See also

raw2wcharShifted deRawCoDisNoShift

5.63.2.6 raw2wcharNoShift

```
wchar_t raw2wcharNoShift[60]
```

Key position number to character, no shift.

The length is 60. Valid characters are in the 4..56 key number range; there may be gaps. 0..3 are errors.

See also

usRawCoDisNoShift

5.63.2.7 raw2wcharShifted

```
wchar_t raw2wcharShifted[60]
```

Key position number to character, with shift.

The length is 60. Valid characters are in the 4..56 key number range; there may be gaps. 0..3 are errors.

See also

usRawCoDisShifted

5.63.2.8 raw2wcharAltGrph

```
wchar_t raw2wcharAltGrph[102]
```

Key position number to character, with AltGR.

The length is 60. Valid characters are in the 4..56 key number range; there will be many gaps. 0..3 are errors.

See also

usRawCoDisShifted

5.63.2.9 scanKeybLang

```
int scanKeybLang
```

The keyboard language.

The language of the USB keyboard (see scanKeyAction) emulated by the scanner is stored here as: 0=US (default), 10=DE

5.63.2.10 scanResult

```
wchar_t scanResult[162]
```

The result of one scan.

The result of consecutive keystrokes (see scanKeyAction) is stored here as array respectively string of wide characters.

5.63.2.11 scanKeyAction

```
unsigned char scanKeyAction[32]
```

The one keystroke read buffer.

Keyboard input comes in blocks of 8 bytes each. Hence a length of 8 would be sufficient. Hence, 32 is a reserve for device errors or the driver not recognising the gap between blocks.

The 8 bytes are:

```
              Bit/Value:    0/1 1/2   2/4 3/8         4/16 5/32  6/64  7/128
[0]  Modifier keys Left:  cntl shift Alt Win  Right:  cntl shift AltGr Win
[1]  Reserved field                  always 0
[2]  Keypress 1                      in a funny code (4 is a)
[3]  2nd simultaneously pressed key
[4..7]  Keypress 3..6
```

As scanners won't "press" more than one key at a time only bytes [0] and [1] will contain information.
Byte[2] will be a crazy key code for a..z1..90... athwart to any utf or unicode. In the end the semantic of that "code" is a mixture of key value and key position on the keyboard. In the end few scanners get more than an American (and a Chinese?) keybord right. When setting the scanner to German keyboard you may miss one or two of .

On byte [0] one should see only three values: /code 0 : no modifier, no shift 2 : shift, that means a->A 64: altGr

5.64 weRasp/weUtil.c File Reference

Some system related time and utility functions for Raspberry Pi.

```
#include "weUtil.h"
#include <errno.h>
```

Functions

- int advanceTmTim (struct tm *rTm, char *rTmTxt, uint8_t sec)

  Advance broken down real time by seconds.
- int char2hexDig (char c)

  Character to hexadecimal.
- int cycTaskDestroy (cycTask_t *cykTask)

  Destroy a cyclic task / threads structure.
- int cycTaskEvent (cycTask_t *cycTask, uint8_t noEvents, timespec stamp, cycTaskEventData_t cycTaskEventData)

  Handle and signal events.
- int cycTaskInit (cycTask_t *cykTask)

  Initialise a cyclic task / threads structure.
- int cycTaskWaitEvent (cycTask_t *cycTask, uint32_t eventsThreshold, cycTask_t *cycTaskSnap)

  Wait on signalled event.
- int endCyclist (void)

  The cycles handler arrived.
- char * formEpocTime (char *target, uint32_t const valueS)

  Format 32 bit unsigned epoch time as d.hh:mm:ss relative to today.
- char * formFixed16 (char *target, uint8_t targetLen, uint16_t value, uint8_t dotPos)

  Format 16 bit unsigned fixed point, right aligned.
- char * formFixed32 (char *target, uint8_t targetLen, uint32_t value, uint8_t dotPos)

  Format 32 bit unsigned fixed point, right aligned.
- char * formUnsByte (char *target, uint8_t value)

  Format 8 bit unsigned fixed point, right aligned.
- int genErrWithText (char const *txt)

  Generate error text (errorText) with system error text appended.
- uint8_t get10inS ()

  Get a 10th of second in s reading.
- uint32_t getAbsS ()

  Get the absolute s reading.
- uint32_t getCykTaskCount (cycTask_t const *const cycTask)

  Get a cycle's/task's current event counter.
- uint16_t getMSinS ()

  Get a ms in s reading.
- void initStartRTime ()

  Initialise start (real) time.
- uint32_t ioSetClrSelect (uint8_t pin)

  Fetch a clear and set select bit for a GPIO pin.
- int isValidIp4 (char const *str)

  Check if a string is a valid IPv4 address.
- void logErrorText ()

  Log the (last) common error text generated.
- void logErrText (char const *txt)

  Log an error text on errLog.
- void logErrWithText (char const *txt)

  Log error text (on errLog) with system error text appended.
- void logStampedText (char const *txt)

  Log an event or a message on outLog as line with time stamp.
- void monoTimeResol (timespec *timeRes)

  Absolute time (source) resolution.

- void onSignalExit (int s)

  On signal exit.
- void onSignalExit0 (int s)

  On signal exit 0.
- void onSignalStop (int s)

  On signal stop.
- unsigned int parse2Long (char ∗const optArg, long int ∗parsResult)

  Parse a string of integer numbers.
- int parsInt (const char ∗str, const int lower, const int upper, const int def)

  Parse int with checks.
- uint16_t stopMSwatch ()

  Get a (stop-watch) ms reading.
- void strLappend (char ∗dest, char const ∗src, int n)

  Append one char sequence left justified at another one.
- void strLinto (char ∗dest, char const ∗src, size_t n)

  Set one char sequence left justified into another one.
- void strRinto (char ∗dest, char const ∗src, size_t n)

  Set one char sequence right justified into another one.
- int theCyclistStart (int startMsDelay)

  Start the cycles handler.
- int theCyclistWaitEnd ()

  Wait for the end of the cycles thread.
- timespec timeAdd (timespec const t1, timespec const t2)

  Add two times as new structure.
- void timeAddTo (timespec ∗t1, timespec const t2)

  Add two times overwriting the first operand.
- int timeCmp (timespec const t1, timespec const t2)

  Compare two times.
- int timeSleep (unsigned int micros)

  Relative delay for the specified number of s.

Variables

- char actRTmTxt [34]

  Actual broken down time (text).
- timespec allCycStart

  Common absolute / monotonic start time of all cycles.
- char const **bin8digs** [256][10]

  "0000_0000" .. "1111_1111"
- volatile uint8_t commonRun

  Common boolean run flag for all threads.
- const uint32_t **csBit** [32]

  single bit set. 1 2 4 8 ... 0x80000000
- cycTask_t **cyc100ms**

  100ms cycle (data structure)
- cycTask_t **cyc10ms**

  10ms cycle (data structure)
- cycTask_t **cyc1ms**

  1ms cycle (data structure)
- cycTask_t **cyc1sec**

1s cycle (data structure)

- cycTask_t **cyc20ms**

  20ms cycle (data structure)
- char const **dec8duns** [256][4]

  " 0" .. "255" byte to three char dec
- char errorText [182]

  Common error text.
- uint8_t have100msCyc

  Flag to enable the 100ms cycle.
- uint8_t have10msCyc

  Flag to enable the 10ms cycle.
- uint8_t have1msCyc

  Flag to enable the 1ms cycle.
- uint8_t have1secCyc

  Flag to enable the 1s cycle.
- uint8_t have20msCyc

  Flag to enable the 20ms cycle.
- long int parsResult [14]

  Long array of length 14.
- volatile int sigRec

  Storage for the signal (number) requesting exit.
- timespec startRTime

  Start time (structure, monotonic real time clock).
- char const ∗const stmp23

  The current time as text.
- uint32_t const ∗const stmpSec

  The real time epoch seconds.
- int8_t **vcoCorrNs**

  external for test/debug only (don't change)

5.64.1 Detailed Description

Some system related time and utility functions for Raspberry Pi.

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weinert-automation.de a-weinert.de

Revision history

```
Rev.  95 9.10.2025
Rev.  050+ 2017-10-16 :  cycTask_t->mutex now pointer (allows common mutex)
Rev.  054+ 2017-10-23 :  timing enhanced, common mutex forced/standard
Rev.  076  2017-12-01 :  advanceTim month change debug.; ret 7 for offs.  chg.
Rev.  128+ 2018-04-16 :  some cleaning on comments
Rev.  155  27.06.2018 :  time handling debugged
Rev.  161  09.07.2018 :  20ms thread is now scheduled on end, too (was not)
Rev.  187  14.10.2018 :  minor typos
Rev.  200  16.04.2019 :  logging improved; formatting enh.
Rev.  201  26.04.2019 :  renamed from sysUtil.c
Rev.  209  22.07.2019 :  formFixed..  not void
Rev.  233  26.09.2020 :  10 ms cycle added
Rev.  263  08.09.2024 :  formEpocTime added (to make logged timers readable)
```

cross-compile by:

```
arm-linux-gnueabihf-gcc -DMCU=BCM2837  -I./include  -c -o weRasp/weUtil.o weRasp/weUtil.c
```

cross -build as library by:

```
arm-linux-gnueabihf-gcc -Wall -DMCU=BCM2837  -I./include  -shared -o libweUtil.so -fPIC weRasp/weUtil.c
copy libweUtil.so C:\util\WinRaspi\arm-linux-gnueabihf\sysroot\usr\lib\
```

And finally (ftp) transfer libweUtil.so to Raspy's /usr/local/lib/ and run sudo ldconfig there. N.b.: In most cases, it brings no disadvantage and it is easier to link instead of building and using an own library.

For documentation see the include files weUtil.h and sysBasic.h

5.64.2 Function Documentation

5.64.2.1 timeAdd()

```
timespec timeAdd (
            timespec const t1,
            timespec const t2 )
```

Add two times as new structure.

Parameters

t1	summand as time structure (not NULL!, will be left unchanged)
t2	the second summand (dto.)

Returns

the sum (probably passed as hidden parameter by the way)

5.64.2.2 timeAddTo()

```
void timeAddTo (
            timespec * t1,
            timespec const t2 )
```

Add two times overwriting the first operand.

Parameters

t1	the time structure to add to (not NULL!, will be modified)
t2	the summand (not NULL!, will be left unchanged)

5.64.2.3 timeCmp()

```
int timeCmp (
            timespec const t1,
            timespec const t2 )
```

Compare two times.

Parameters

t1	the time structure to compare to t2 (not NULL!)
t2	the time structure to compare t1 with (not NULL!)

Returns

0: equal; +: t1 is greater (2 by s, 1 by ns); -: t1 is smaller

5.64.2.4 timeSleep()

```
int timeSleep (
            unsigned int micros )
```

Relative delay for the specified number of s.

This is local sleep. It should not be used in combination with absolute times and cyclic threads. It is just an utility for test or very short delays (as a better replacement for spinning).

Parameters

micros	sleep time in s; allowed 30 .. 63000

Returns

sleep's return value if of interest (0: uninterrupted)

5.64.2.5 monoTimeResol()

```
void monoTimeResol (
            timespec * timeRes )
```

Absolute time (source) resolution.

This function sets the time structure provided to the absolute time's (ABS_MONOTIME default: CLOCK_↩ MONOTONIC) resolution.

Raspian Jessie on a Raspberry Pi 3 always yielded 1ns, which one may believe or not. We took it as "sufficient for accurate 1ms cycles".

Parameters

timeRes	the time structure to be used (never NULL!)

5.64.2.6 strLinto()

```
void strLinto (
            char * dest,
            char const * src,
            size_t n )
```

Set one char sequence left justified into another one.

This function copies n characters from src to dest left justified. If the length of src is less than n the remaining length on right in dest will be filled with blanks.

Attention: dest[n-1] must be within the char array provided by dest. This cannot and will not be checked!

Hint: Contrary to strncpy there's no padding with 0. If you want dest to end after the insertion use strLappend().

Parameters

dest	the pointer to / into the destination sequence where src is to be copied to. If NULL nothing happens.
src	the sequence to be copied. If NULL or empty fill is used from start
n	the number of characters to be copied from src.

5.64.2.7 strLappend()

```
void strLappend (
            char * dest,
            char const * src,
            int n )
```

Append one char sequence left justified at another one.

This function copies n characters from src to dest and lets dest then end with 0 (end of string). If n is negativ, -n characters will be copied and dest will end with new line and 0;

Attention: dest[n] respectively dest [-n + 1] must be within the char array provided by dest. This cannot and will not be checked!

Parameters

dest	the pointer to / into the destination sequence where src is to be copied to. If Null nothing happens.
src	the sequence to be copied. If Null or empty fill is used from start
n	the absolute value is the number of characters to be copied from src. If this number exceeds 300 it will be taken as 0. If n is negative a line feed will be appended, too.

5.64.2.8 strRinto()

```
void strRinto (
            char * dest,
```

```
            char const * src,
            size_t n )
```

Set one char sequence right justified into another one.

This function copies n characters from src to dest right justified. If the length of src is less than n the remaining length on left in dest will be filled with blanks.

Attention: dest[n-1] must be within the char array provided by dest. This cannot and will not be checked!

Hint to append instead of insert: If this operation shall be at the end of the changed char sequence do
dest[n] = 0;
Then, of course, dest[n] must be within the char array provided by dest.

Parameters

dest	the pointer to / into the destination sequence where src is to be copied to. If NULL nothing happens.
src	the sequence to be copied. If NULL or empty fill is used from start
n	the number of characters to be copied from src.

5.64.2.9 formFixed16()

```
char * formFixed16 (
            char * target,
            uint8_t targetLen,
            uint16_t value,
            uint8_t dotPos )
```

Format 16 bit unsigned fixed point, right aligned.

formFixed16(target, 6, 1234, 2), e.g., will yield " 12.34".
formFixed16(target, 6, 4, 2), e.g., will yield " 0.04".

If the value would not fit within targetLen characters leading digits will be truncated.

Parameters

target	pointer to first of targLen characters changed
targetLen	field length 2..16; number of characters changed
value	the fixed point value
dotPos	where the fixed point is 0..6 $<$ targetLen

Returns

points to the most significant digit set or NULL on error / no formatting

5.64.2.10 formFixed32()

```
char * formFixed32 (
            char * target,
            uint8_t targetLen,
            uint32_t value,
            uint8_t dotPos )
```

Format 32 bit unsigned fixed point, right aligned.

This function behaves like formFixed16() except for handling 32 bit values. formFixed16() should be preferred, when feasible.

Parameters

target	pointer to first of targLen characters changed
targetLen	field length 2..16; number of characters changed
value	the fixed point value
dotPos	where the fixed point is 0..6 < targetLen

Returns

points to the most significant digit set or NULL on error / no formatting

5.64.2.11 formEpocTime()

```
char * formEpocTime (
            char * target,
            uint32_t valueS )
```

Format 32 bit unsigned epoch time as d.hh:mm:ss relative to today.

The output format ddhh:mm:ss means:
d.: '<<''<-'' ''->''>>' mean day before yesterday, yesterday, today, tomorrow, day after tomorrow ...
hh:mm:ss is, of course, the time in that day.

For days further in past or future the epoch seconds (ten digits incomprehensible to humans) are output, see formFixed32().

Parameters

target	pointer to first of 10 characters changed
valueS	the fixed point value (epoch seconds)

Returns

points to the most significant digit set or NULL on error / no formatting

sprintf(target, "%3dd%5ds", relNoDay, secInDay);

5.64.2.12 formUnsByte()

```
char * formUnsByte (
            char * target,
            uint8_t value )
```

Format 8 bit unsigned fixed point, right aligned.

Parameters

target	pointer to first of targLen characters changed
value	the unsigned 8 bit value (0..255)

Returns

points behind the number i.e. target + 3; null on error

5.64.2.13 ioSetClrSelect()

```
uint32_t ioSetClrSelect (
            uint8_t pin )
```

Fetch a clear and set select bit for a GPIO pin.

For the masks to set or clear GPIO bits each bit 0..31 selects the GPIO pin 0..31 respectively 32..53.

Parameters

pin	GPIO pin number (only 5 bits relevant here)

Returns

the the function select bit (a value with one bit set)

5.64.2.14 isValidIp4()

```
int isValidIp4 (
            char const * str )
```

Check if a string is a valid IPv4 address.

Syntactically valid IPv4 addresses are: 0.0.0.0 .. 255.255.255.255

Parameters

str	The string containing the address, only; 0-terminated

Returns

0: no syntactically valid IPv4 address; 1: OK

5.64.2.15 parsInt()

```
int parsInt (
            const char * str,
            const int lower,
            const int upper,
            const int def )
```

Parse int with checks.

This function expects parameter str to point to a null-terminated string. If not def is returned. If lower > upper def is returned. If the string str contains a decimal integer number n, fulfilling lower <= n <= upper n is returned, or def otherwise.

If the string str starts with [+|-][min|med|max] ignoring case lower respectively ((lower + upper) / 2) respectively upper is returned. A leading sign (+|-) as well as any trailing characters are ignored.

Parameters

str	0-terminated string containing a decimal integer number, or one of the keywords described above
lower	lower limit
upper	upper limit
def	default value, to be returned when str is not a pure decimal number one of the keyword starts or when the result violates the limits

5.64.2.16 char2hexDig()

```
int char2hexDig (
            char c )
```

Character to hexadecimal.

Parameter values '0'..'9' return 0..9. Parameter values 'A'..'F' and 'a'..'f' return 10..15. Other values return -1.

5.64.2.17 parse2Long()

```
unsigned int parse2Long (
            char *const optArg,
            long int * parsResult )
```

Parse a string of integer numbers.

The string optArg will be tokenised taking any occurrences of the characters " +,;" (blank, plus, comma, semicolon) as border. "Any occurrences" means two commas „,", e.g., acting as one separator and not denoting an empty number.
N.b.: The string optArg will be modified (by replacing the first character of the token separators found by zero ('\0').

The number format accepted and parsed is decimal and hexadecimal. Hexadecimal starts with 0x or 0X. Leading zeros have no significance (in C stone age sense of being octal).

Parameters

optArg	the string to be passed to a number of integer numbers, passed as program parameter, e.g.
parsResult	pointer to an array of long int, minimal length 14 (!)

Returns

the number of integer numbers parsed ab put into parsResult[], 0..14

5.64.2.18 logErrWithText()

```
void logErrWithText (
            char const * txt )
```

Log error text (on errLog) with system error text appended.

Gives a (English) clear text translation of the latest system stored error. If txt is not null it will be prepended. This function appends a linefeed and flushes errLog.

Parameters

txt	text to be prepended (should nod be longer than 58 characters)

5.64.2.19 logErrorText()

```
void logErrorText (
            void  )
```

Log the (last) common error text generated.

This function outputs the last generated errorText (by genErrWithText() e.g.) to errLog. It appends a linefeed and flushes errLog.

5.64.2.20 genErrWithText()

```
int genErrWithText (
            char const * txt )
```

Generate error text (errorText) with system error text appended.

Gives a (English) clear text translation of the latest system stored error. If txt is not null it will be prepended. Date and time will be prepended anyway.

Parameters

txt	text to be prepended (should nod be longer than 58 characters)

Returns

0: no error; else mutex error (time and date may be spoiled)

5.64.2.21 logErrText()

```
void logErrText (
            char const * txt )
```

Log an error text on errLog.

If txt is not null it will be output to errLog and errLog will be flushed.

Parameters

txt	text to be output; n.b not LF appended

5.64.2.22 logStampedText()

```
void logStampedText (
            char const * txt )
```

Log an event or a message on outLog as line with time stamp.

If txt is not null it will be output to outLog. A time stamp is prepended and a line feed is appended. txt will be shortened to 50 characters if longer.

Parameters

txt	the text to be output

5.64.2.23 onSignalExit()

```
void onSignalExit (
            int s )
```

On signal exit.

This function is intended as signal hook; see signal(s, hook). When called, this function calls exit(s) and never returns.

Parameters

s	the signal forwarded to exit

5.64.2.24 onSignalExit0()

```
void onSignalExit0 (
            int s )
```

On signal exit 0.

This function is intended as signal hook; see signal(s, hook).
When called this function calls exit(0) and never returns.
This may be used as hook for s==SIGIN, to provide a normal return on cntl-C.

Parameters

s	ignored

5.64.2.25 onSignalStop()

```
void onSignalStop (
            int s )
```

On signal stop.

This function is a prepared signal hook. When called it sets sigRec by s and clears commonRun.

5.64.2.26 cycTaskInit()

```
int cycTaskInit (
            cycTask_t * cykTask )
```

Initialise a cyclic task / threads structure.

This function initialises a cyclic or non cyclic (asynchronous random event driven) task (thread) structure. Common mutex and an own condition are initialised, the event counter (.count) is set to 0.

Note: For the standard cycles provided here, 1ms, 100ms .., this initialisation is done in theCyclistStart() and the destruction (by cycTaskDestroy()) in endCyclist().

Parameters

cykTask	the task structure to initialise (not NULL!)

Returns

0: success, else: one of the error codes occurred

5.64.2.27 cycTaskDestroy()

```
int cycTaskDestroy (
            cycTask_t * cykTask )
```

Destroy a cyclic task / threads structure.

Parameters

cykTask	the task structure to destroy (not NULL!)

Returns

0: success, else: one of the error codes occurred

5.64.2.28 cycTaskEvent()

```
int cycTaskEvent (
            cycTask_t * cycTask,
            uint8_t noEvents,
            timespec stamp,
            cycTaskEventData_t cycTaskEventData )
```

Handle and signal events.

This is a helper function for the controller / manager to be called when having determined, that one or more events happened.

Parameters

cycTask	the task structure (not NULL!)
noEvents	number of events (usually 1); summand to cykTask.count
stamp	absolute monotonic time of the event; sets sykTask.stamp
cycTaskEventData	actual cyclic event data

Returns

0: success, else: one of the error codes occurred

5.64.2.29 cycTaskWaitEvent()

```
int cycTaskWaitEvent (
            cycTask_t * cycTask,
            uint32_t eventsThreshold,
            cycTask_t * cycTaskSnap )
```

Wait on signalled event.

This is a helper function for a worker thread. It will return on reaching the signalled event(s) or on ! commonRun. If cykTaskSnap is not NULL cycTask will be assigned to it under mutex lock before returning. This is helpful if cykTask's events are broadcast to multiple handlers.

Parameters

cycTask	the task structure (not NULL!)
eventsThreshold	threshold for cykTask.count (update for every round)
cycTaskSnap	copy of cykTask under mutex lock before returning

Returns

0: success, else: one of the error codes occurred

5.64.2.30 getCykTaskCount()

```
uint32_t getCykTaskCount (
            cycTask_t const *const cycTask )
```

Get a cycle's/task's current event counter.

This is done under (cyclist's) mutex lock.

Parameters

cycTask	the task structure

Returns

cycTask's event counter value (.count) got under lock; 0x7FffFFffFFf7 on any error (null, lock error) situation

5.64.2.31 stopMSwatch()

```
uint16_t stopMSwatch ( )
```

Get a (stop-watch) ms reading.

This function provides an 16 bit reading of the cyclist's (64 bit) milliseconds. It is intended for measuring short (<= 1min) durations.

Hint: This functions thread safety stems from the hope of 16 bit increments being atomic. Even if no problems in this respect were observed on Raspberry Pi 3s, it may be just hope in the end. Thread-safe values are, of course, provided in the cycTaskEventData_t structure. But those are frozen within one cycle task step, and, hence, not usable as stop-watch readings within such step.

5.64.2.32 getMSinS()

```
uint16_t getMSinS ( )
```

Get a ms in s reading.

This function provides the cyclist's ms in sec as 16 bit unsigned reading. It is intended for measuring and testing durations.

Hint: This functions does nothing for thread safety. It hopes 16 bit accesses being atomic. Even if no problems in this respect were observed on Raspberry Pi 3s, it may be just hope in the end. Thread-safe values are, of course, provided in the cycTaskEventData_t structure. But those are frozen within one cycle task step, and, hence, not usable as stop-watch readings within such step.

5.64.2.33 get10inS()

```
uint8_t get10inS ( )
```

Get a 10th of second in s reading.

This function provides the cyclist's tenth in seconds reading (0..9). It is intended for cyclic tasks with times greater than 100 ms or asynchronous tasks to get a coarse second sub-division.

Hint: Cyclic tasks get this value in their task date valid at start. This function provides an actual value for tasks running longer than 100ms.

5.64.2.34 getAbsS()

```
uint32_t getAbsS ( )
```

Get the absolute s reading.

This function provides a 32 bit monotonic seconds value.
Base of this 32 bit value is the cyclist's 64 bit epoch time in seconds, 0 being 1.1.1970 00:00:00 UTC on almost all Linuxes and C libraries.

This unsigned 32 bit holds until 7. February 2106, which is far longer than the projected lifetime age of this library and of Raspberry Pi3s. (But who knows?) The value may be used for seconds-resolution, absolute (i.e. zone and DST independent) time-stamps and interval calculations (which will be incorrect with leap seconds).

Hint: Cyclic tasks get this value (.realSec) in their task date valid at tick start. Hence, this function is intended for asynchronous tasks or cyclic tasks with periods $>$ 1s.

Since version R.110 we dare to fetch this value without lock, assuming ARMv7 32 bit load and stores being atomic.

5.64.2.35 theCyclistStart()

```
int theCyclistStart (
            int startMsDelay )
```

Start the cycles handler.

This function initialises and then runs the predefined cycles cycles (as of Sept. 2020: 1ms, 10ms, 20ms, 100ms and 1s; see have1msCyc) when enabled.

Besides the absolute / monotonic times for the cycles it also initialises real time and timers handling.

Timers and cycles are run in an extra thread made by this function. And to be precise, the cycles are not run here; instead, cyclic events are generated and broadcast.

As the thread started by this function also provides monotonic and civil times and stamps it should be started with the program (i.e. earliest in main()). Preparation time before the cycles should start can be handled by the delay parameter.

As of September 2020 five cycles (see above) are defined and handled. It is strongly recommended not to use more than two of them and implement other cycles with multiple periods by sub-division. That means, e.g., do not enable the 20ms cycle when having the 10ms one.

Parameters

startMsDelay	number of ms before generating the first cyclic event; allowed range 12 .. 1200; default 1

Returns

0: after having initialised all and having made and started the cyclist thread; other values signal errors

5.64.2.36 theCyclistWaitEnd()

```
int theCyclistWaitEnd ( )
```

Wait for the end of the cycles thread.

This function does so by unconditionally joining the cyclist thread.

Returns

the return value of thread join; 0: join OK

5.64.2.37 endCyclist()

```
int endCyclist (
            void  )
```

The cycles handler arrived.

This function cleans up after theCyclist. It should be called after theCyclist() ending successfully on commonRun false. The controller thread shall call this function after having joined and cleaned up all of its threads. It may also be put in an exit hook.

Returns

0: OK; else: a cycTaskDestroy() error

5.64.2.38 initStartRTime()

```
void initStartRTime ( )
```

Initialise start (real) time.

This will be done in theCyclistStart(int). Hence, this function is for "non-cyclic" applications, mainly. Nevertheless it can be called before theCyclistStart(int) and won't be repeated therein.

5.64.2.39 advanceTmTim()

```
int advanceTmTim (
            struct tm * rTm,
            char * rTmTxt,
            uint8_t sec )
```

Advance broken down real time by seconds.

This function just advances the broken down (local) time structure rTm and the fitting text rTmTxt by 1 to 40s. All fields not affected by adding to the seconds part, won't be touched.

This function won't care about leap seconds nor handle DST rules. If this is to be kept up to date, it is recommended to refresh it on every hour change (return >=3) by
clock_gettime(CLOCK_REALTIME,..) and localtime_r(..).
Depending on OS, that might be an expensive operation with extra locks.

With wrong parameter values this function does nothing (returns 0).

Parameters

rTm	pointer to broken down real time
rTmTxt	date text, length 32, format Fr 2017-10-20 13:55:12.987 UTC+20 NULL is substituted by actRTmTxt
sec	1..40 will be added; else: error

Returns

0: error (rTm NULL e.g.); 1: seconds changed; 2: minute; 3: hour; 4: day; 5: month ; 6: year; 7: zone offset

5.64.3 Variable Documentation

5.64.3.1 parsResult

```
long int parsResult[14]
```

Long array of length 14.

Prepared for non thread safe use with parse2Long()

5.64.3.2 stmp23

```
char const* const stmp23
```

The current time as text.

/code The format is: 2017-10-20 13:55:12.987 UTC+20 .....0123456789x123456789v123456789 /endcode
The length is 30.
Do NOT change the value provided by this pointer.

5.64.3.3 stmpSec

```
uint32_t const* const stmpSec
```

The real time epoch seconds.

Do NOT change the value provided by this pointer.

5.64.3.4 errorText

```
char errorText[182]
```

Common error text.

This text is set by genErrWithText() and hence indirectly by (many) other functions optionally generating error texts.

5.64.3.5 commonRun

```
volatile uint8_t commonRun
```

Common boolean run flag for all threads.

When set false, all threads must exit as soon as possible. On any case, a thread has to exit and clean up on next signal. Setting commonRun false implies the end of the application/program and all of its threads as soon as possible.

Initialised as 1 (true) Set 0 by onSignalStop() (or application program)

5.64.3.6 sigRec

```
volatile int sigRec
```

Storage for the signal (number) requesting exit.

Set by: onSignalStop()
See also: retCode

5.64.3.7 allCycStart

```
timespec allCycStart
```

Common absolute / monotonic start time of all cycles.

May be considered as program's start time when cycles are started early by theCyclist. Normally not to be modified.

5.64.3.8 have1msCyc

```
uint8_t have1msCyc
```

Flag to enable the 1ms cycle.

As a rule no more than two oft the cycles offered — cyc1ms, cyc10ms, cyc20ms, cyc100ms, cyc1sec — shall be enabled. This is no restriction as a faster cycle can easily (and often should) implement slower cycles by subdivision.

The default setting is 1ms and 100ms ON and all others OFF.
If other settings are used the flags should be set at the program's early initialisation phase and afterwards left untouched.

default: ON

See also

cycTask_t cyc1ms

5.64.3.9 have10msCyc

```
uint8_t have10msCyc
```

Flag to enable the 10ms cycle.

default: OFF

See also

have1msCyc cycTask_t cyc10ms

5.64.3.10 have20msCyc

```
uint8_t have20msCyc
```

Flag to enable the 20ms cycle.

default: OFF

See also

have1msCyc cycTask_t cyc20ms

5.64.3.11 have100msCyc

```
uint8_t have100msCyc
```

Flag to enable the 100ms cycle.

default: ON

See also

have1msCyc cycTask_t cyc100ms

5.64.3.12 have1secCyc

```
uint8_t have1secCyc
```

Flag to enable the 1s cycle.

default: OFF

See also

have1msCyc cycTask_t cyc1s

5.64.3.13 startRTime

```
timespec startRTime
```

Start time (structure, monotonic real time clock).

By initStartRTime() or by theCyclistStart() actRTime and this startRTime will initially be set. actRTime may be updated on demand, but startRTime should be left unchanged.

5.64.3.14 actRTmTxt

```
char actRTmTxt[34]
```

Actual broken down time (text).

```
            |-3|-  10  -|1|- 12     -|
```

The format is: Fr 2017-10-20 13:55:12.987 UTC+20 .....0123456789x123456789v123456789t1234 was Fr 2017-10-20 13:55:12 UTC+20 The length is 32.