

POWERFIP Library

User's Guide

Exoligent's Team

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Chapter 1. Disclaimer

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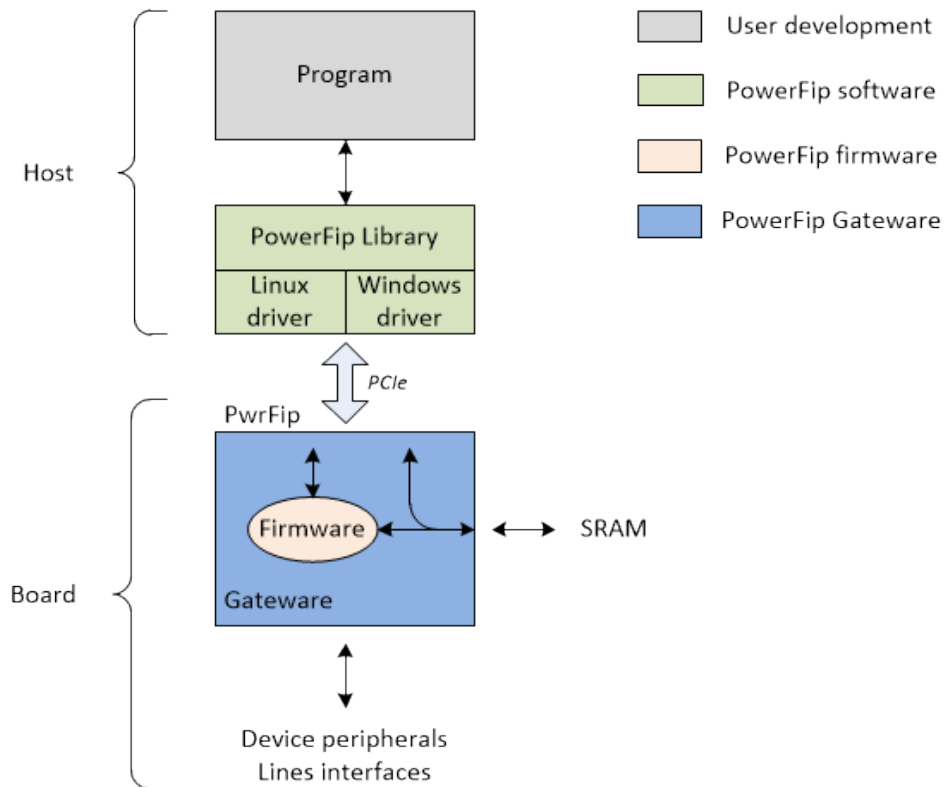
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Chapter 2. Introduction

PowerFIP library is a C API providing a programming interface to the Exoligent's FIP/WorldFIP coprocessor.

It offers a set of functions for the FIP/WorldFIP network control:

- Create/Delete FIP objects
 - Node
 - Bus Arbiter macrocycle(s)
 - AE/LE(s) (Application/Layer Entity)
 - MPS variable(s)
 - SM-MPS variable(s)
- Conduct FIP Exchanges:
 - Periodic MPS variables:
Transfers, reads and writes buffers with *ID_DAT*/*RP_DAT* transactions
 - Aperiodic MPS variables:
Process buffer transfer requests (*RP_DAT_RQx*, *ID_RQx*/*RP_RQx*)
 - Periodic messaging:
Exchanges messages with *ID_MSG*/*RP_MSG_X* using periodic channels.
 - Aperiodic messaging:
Processes messages sent via aperiodic channel.
Requests are made to bus arbiter using *RP_DAT_MSG* frames.
- Bus arbiter capability:
 - Start/Stop/Commute macrocycle(s)
- Medium Redundancy
 - Channels control and status
- Attach user callbacks to process FIP events
 - on *RP_DAT* rx/tx frames
 - on *RP_MSG_X* rx/tx frames
 - on *ID_DAT* rx/tx frames [pure event]
 - on *RP_RQx* tx frames [aperiodic requests]
 - on Bus Arbiter's change of state

PowerFIP overview (Principle Diagram)

Chapter 3. Installation

Let's start by downloading the archive of the latest version of the library from the Exoligent website: [Download section](#)

3.1. Linux

The linux archive has the following tree structure

- **[docs]**
 - PowerFIP Library - User's Guide (*.pdf) :
The User's Guide in PDF format.
 - powerfip.html :
The User's Guide in HTML format.
- **[drivers]**
 - **[linux]**
The source code of the Linux kernel module for Exoligent PowerFIP PCI/PCIe devices:
 - **[udev.rules.d]**
 - 10-powerfip.rules
 - install.sh
 - Makefile
 - powerfip-pci.c
 - powerfip-pci.h
 - uninstall.sh
- **[firmware]**
The PowerFIP coprocessor firmware for RISC-V Soft-CPU target :
 - powerfip-firmware.bin
- **[include]**
Header files to include in your projects to use the library:
 - libpowerfip.h
 - mbox-common.h
 - powerfip-common.h
 - powerfip-drv.h
 - powerfip-mbox-common.h
- **[lib]**
 - **[aarch64]**
 - **[static]**

- libpowerfip.a [aarch64 static lib]
- libpowerfip.so.1.2.0 [aarch64 shared lib]
- **[arm]**
 - **[static]**
 - libpowerfip.a [arm static lib]
 - libpowerfip.so.1.2.0 [arm shared lib]
- **[i386]**
 - **[static]**
 - libpowerfip.a [x86 static lib]
 - libpowerfip.so.1.2.0 [x86 shared lib]
- **[x86_64]**
 - **[static]**
 - libpowerfip.a [x86_64 static lib]
 - libpowerfip.so.1.2.0 [x86_64 shared lib]
- **[tools] :**
Turnkey examples to get started as soon as possible!
 - **[pwrfip_2sta]**
 - **[pwrfip_nsta]**
 - **[pwrfip_perf_long_frm]**
 - **[pwrfip_performance]**
 - **[pwrfip_ping]**
 - **[mbfip_gateway]**
 - **[uafip_tsn_gateway]**
- install.sh
- uninstall.sh
- release-notes.txt
- readme.txt

3.1.1. Kernel Module

Open a terminal, and go to the linux driver directory:

```
$ cd driver/linux
```

Execute the following commands to build and install the kernel module:

```
$ make  
$ sudo ./install.sh
```

**Two files will be copied to your system**

1. **powerfip.ko** file to the path:
/lib/modules/\$(uname -r)/kernel/drivers/fip
2. **10-powerfip.rules** file to the path:
/etc/udev/rules.d

To remove the kernel module, enter the following command :

```
$ sudo ./uninstall.sh
```

3.1.2. Firmware/Library

Open a terminal, and go to the archive package root.

Then, enter the following command to install the PowerFIP firmware and library on your machine:

```
$ sudo ./install.sh
```

**Files will be copied to your system**

1. **powerfip-firmware.bin** file to the path:
/usr/local/lib/firmware
2. **libpowerfip.a** and **libpowerfip.so.1.2.0** files to the path:
/usr/local/lib
3. **header (*.h)** files to the path:
/usr/local/include/powerfip

To remove these files, enter the following command:

```
$ sudo ./uninstall.sh
```

3.2. Windows

Run the latest installer (.exe), and follow the wizard steps. All the files will be copied to the folder:

```
C:\Program Files (x86)\Exoligent\PowerFIP\
```

This directory has the following tree structure

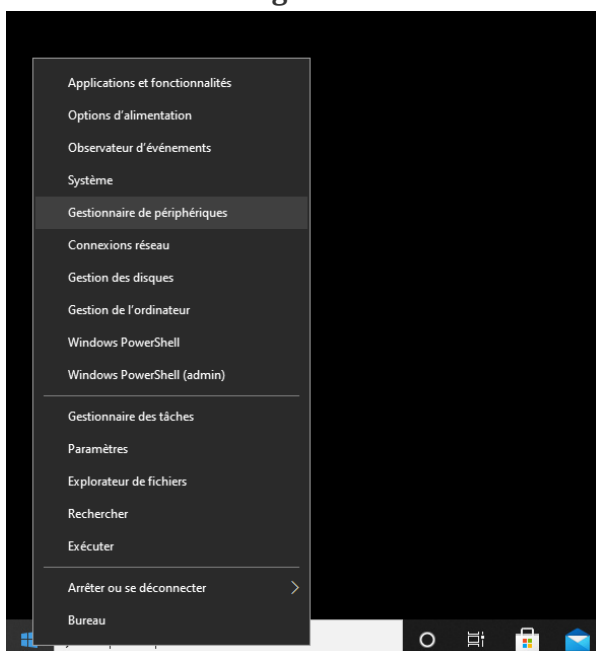
- **[docs]**
 - PowerFIP Library - User's Guide (*.pdf) :
The User's Guide in PDF format.
 - powerfip.html :
The User's Guide in HTML format.
- **[drivers]**
 - **[win]**
The binaries of the Windows driver for Exoligent PowerFIP PCI/PCIe devices:
 - **[Driver]**
 - **[x86]**
 - pwrfig.sys
 - **[x86-64]**
 - pwrfig64.sys
 - pwrfig.cat
 - pwrfig.inf
 - pwrfig64.cat
- **[firmware]**
The PowerFIP coprocessor firmware for RISC-V Soft-CPU target :
 - powerfip-firmware.bin
- **[include]**
Header files to include in your projects to use the library:
 - libpowerfip.h
 - mbox-common.h
 - powerfip-common.h
 - powerfip-drv.h
 - powerfip-mbox-common.h
- **[lib]**
 - **[i686]**
 - **[static]** - MinGW compiler: i686-8.1.0-posix-dwarf-rt_v6-rev0

- libpowerfip.a [x86 static lib]
- libpowerfip.dll [x86 shared lib]
- libpowerfip.lib [x86 import lib]
- [x86_64]
 - [static] - MinGW compiler: x86_64-8.1.0-posix-seh-rt_v6-rev0
 - libpowerfip.a [x86_64 static lib]
 - libpowerfip.dll [x86_64 shared lib]
 - libpowerfip.lib [x86_64 import lib]
- [tools] :
Turnkey examples to get started as soon as possible!
 - [pwrfig_2sta]
 - [pwrfig_nsta]
 - [pwrfig_perf_long_frm]
 - [pwrfig_performance]
 - [pwrfig_ping]
- release-notes.txt
- readme.txt

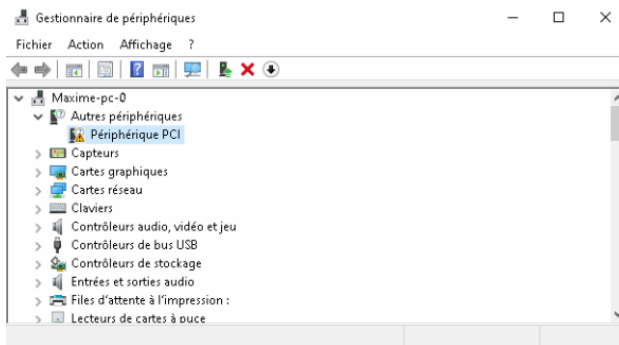
3.2.1. Driver

Installation

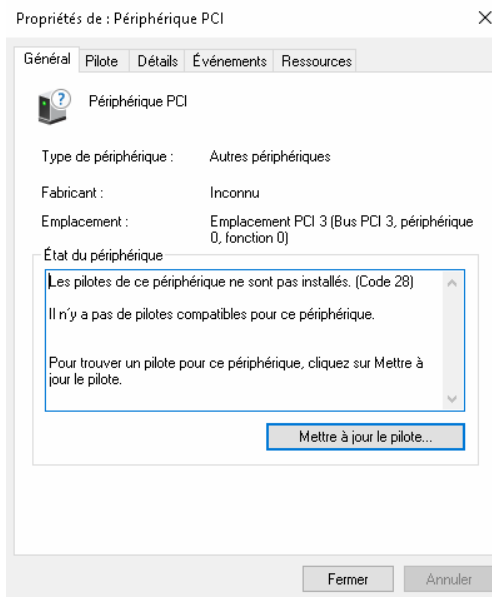
- Open the **Device Manager** window
 - Press **Windows+X** or right-click to **Start** button, then a menu will appear
 - Select **Device Manager** from the list



- Double-click on the new **Other PCI bridge device** detected



- Click on **Update the driver**

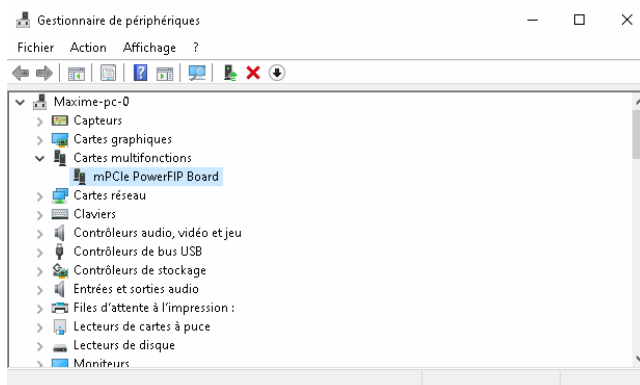


- Select the last package driver, and click on **Next** button

Target directory for driver

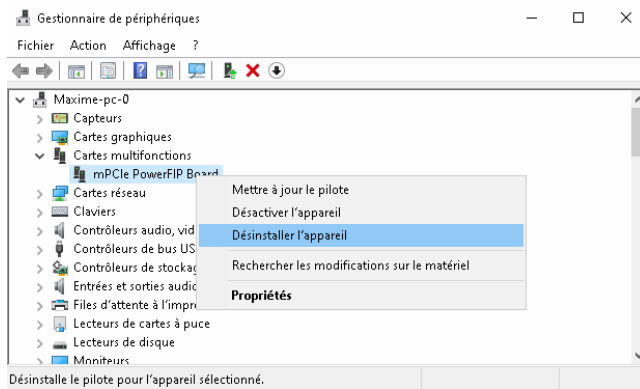
C:\Program Files (x86)\Exoligent\PowerFIP\drivers\win

- PowerFIP driver is now installed !

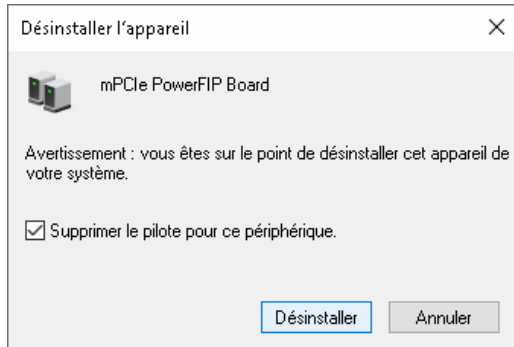


Uninstallation

- Go to the **Device Manager** window
- Right-click on the PowerFIP device to be removed, and click on **Uninstall** button



- Check **Remove the driver for this device**, and confirm the device uninstall



3.2.2. Firmware/Library

The PowerFIP firmware and library will be automatically installed by the package wizard.



Files will be copied to your system

1. **powerfip-firmware.bin** file to the path:
C:\Program Files (x86)\Exoligent\PowerFIP\firmware
2. **libpowerfip.dll** file to the path:
C:\Program Files (x86)\Exoligent\PowerFIP\lib
3. **header (*.h)** files to the path:
C:\Program Files (x86)\Exoligent\PowerFIP\include

To remove the package, execute the uninstaller wizard:

```
C:\Program Files (x86)\Exoligent\PowerFIP\Uninstall.exe
```

3.3. Examples

To quickly get into the swing of things, the source code of some examples is provided with the package.

To access to the examples, open a terminal and enter the following commands:

Linux

```
# From extracted archive directory
$ cd tools
```

Windows

```
$ cd C:\Program Files (x86)\Exoligent\PowerFIP\tools
```



If you do not have administrator rights, it is advisable to copy/paste the following directories into your own workspace:

- C:\Program Files (x86)\Exoligent\PowerFIP\tools
- C:\Program Files (x86)\Exoligent\PowerFIP\lib
- C:\Program Files (x86)\Exoligent\PowerFIP\include

For example paste it to a new directory in 'My Documents':

- C:\Users\%USERNAME%\Documents\PowerFIP\tools
- C:\Users\%USERNAME%\Documents\PowerFIP\lib
- C:\Users\%USERNAME%\Documents\PowerFIP\include

We will now briefly describe the examples:

3.3.1. Simple Test - pwrfig_2sta

This example aims at making two FIP nodes communicate with each other through the FIP network with exchange of periodic and aperiodic variables.

The configuration of FIP nodes is done via static structures (see [tools/pwrfig_2sta/sta.h](#)), and tries to cover all available FIP services (MPS writing/reading, Aperiodic variable list requesting, Messages sending/receiving, SM-MPS reading, Presence Test, ...).



The example will therefore only work completely if you have two PCI/PCIe PowerFIP devices connected together with a FIP cable.

However, it is still possible to start a single station to observe the FIP traffic emitted by the device. Indeed the FIP node will try to start by default in *master* mode (with an active bus arbiter).

Build the example:*Linux*

```
$ cd tools/pwrfip_2sta

# Build for i386 target (32-bit)
$ make MACHINE=i386

# Build for x86_64 target (64-bit)
$ make MACHINE=x86_64
```

Windows

```
# Build the example with static method way.
$ set SYS_NAME=windows
$ cd tools/pwrfip_2sta

# Build for i686 target (32-bit)
# Note: MinGW compiler: i686-8.1.0-posix-dwarf-rt_v6-rev0
$ make MACHINE=i686

# Build for x86_64 target (64-bit)
# Note: MinGW compiler: x86_64-8.1.0-posix-seh-rt_v6-rev0
$ make MACHINE=x86_64
```

Get the help:*Linux*

```
$ ./pwrfip_2sta -h
```

Windows

```
$ pwrfip_2sta.exe -h
```

Usage: pwrfip_2sta [OPTION]...

It tests FIP board communication with PowerFIP library.
By default, if no option is added, the app opens the first PCI/PCIe device with index 1 [-i 1], and starts FIP node 0 (addr=0) [-n 0] with bitrate sets to 1Mbps [-b 1].

Options:

- i device index [default=1]
- n FIP node to start [default=0]

```
0: node 0
1: node 1
-b FIP bitrate [default=1]
0: 31.25Kbps
1: 1Mbps
2: 2.5Mbps
3: 5Mbps
4: 12.5Mbps
5: 25Mbps
-r FIP turn-around time in us [default=0]
default TR times:
@31.25Kbps: 424us
@1Mbps    : 30us
@2.5Mbps  : 30us
@5Mbps    : 32us
@12.5Mbps : 32us
@25Mbps   : 32us
-s FIP silence time in us [default=0]
default TS times:
@31.25Kbps: 4096us
@1Mbps    : 150us
@2.5Mbps  : 96us
@5Mbps    : 92us
@12.5Mbps : 92us
@25Mbps   : 92us
-l list the FIP boards present on the host machine
-h show this help and exit
-v show version and exit
```

Examples:

```
pwrfig_2sta -i 1 -n 0 -b 1 -r 30 -s 150
```

Launch FIP node 0:*Linux*

```
# Adding the SYS_NICE capability as Effective and Permitted to the binary
# => This root command is executed only once after the binary building
$ sudo setcap cap_sys_nice+ep ./pwrfig_2sta
```

```
$ ./pwrfig_2sta -i 1 -n 0 -b 1
```

Windows

```
$ pwrfig_2sta.exe -i 1 -n 0 -b 1
```

```

[01-24 10:17:44.201472] app => [info] [fip] device info
[01-24 10:17:44.201546] app => [info]      index      : 1
[01-24 10:17:44.201578] app => [info]      fsn        : 0x28d00484cf61
[01-24 10:17:44.201601] app => [info]      vid        : 0x11aa
[01-24 10:17:44.201624] app => [info]      did        : 0x1556
[01-24 10:17:44.201645] app => [info]      ssvd       : 0x11aa
[01-24 10:17:44.201662] app => [info]      ssdid      : 0x5811
[01-24 10:17:44.201682] app => [info]      bar_cnt     : 2
[01-24 10:17:44.201705] app => [info]      bar_bsz[0]  : 4096
[01-24 10:17:44.201730] app => [info]      bar_base[0] : 0xa6000000
[01-24 10:17:44.201747] app => [info]      bar_bsz[1]  : 33554432
[01-24 10:17:44.201767] app => [info]      bar_base[1] : 0xa4000000
[01-24 10:17:44.201791] app => [info]      irq_number  : 148
[01-24 10:17:44.201811] app => [info]      drv_version : 1.4.0
[01-24 10:17:44.201831] app => [info] test: v2.2.0 - pwrfig lib: v1.1.0
[01-24 10:17:44.201851] sta0 => [info] [fip] node configuration
[01-24 10:17:44.201872] sta0 => [info] [fip] bus arbiter infos
[01-24 10:17:44.201890] sta0 => [info]      start       : 1306800us
[01-24 10:17:44.201909] sta0 => [info]      election    : 77700us
[01-24 10:17:44.201928] sta0 => [info] [fip] node init
[01-24 10:17:44.258360] sta0 => [event] reset component (powerfip)
[...]
```

The example sequence is as follows:

- Open PCI/PCIe device (index 1)
- Load Configuration (fip node 0)
- Start the Bus Arbiter (start-up time: 1306800us, election time: 77700us)
- Infinite Loop

During this loop, an interrupt is raised by the FIP coprocessor each time an ID_DAT(0x9003) is transmitted on the FIP network (i.e. at the macrocycle frequency: here T=40ms).

This interrupt triggers the user handler linked to the SM-MPS BA synchronization variable (see: `tst_pwrfig_ba_sync_handler` function in the file: `tools/pwrfig_2sta/sta.c`).



As this function is clocked on the macrocycle, we take the opportunity to perform some actions within it:

- Station 0:
 - Produce 1 periodic variable on the network
 - 0x3800 (with aperiodic var/msg request capabilities enabled) [ie. can produce a `RP_DAT_RQx` and `RP_DAT_MSG` frames]
 - Consume 1 periodic variable from the network

- 0x3801
- Request for a list of aperiodic variables (by switching between two lists after each request)
 - 1st list ⇒ 2 IDs: 0x7800, 0x7801
 - 2nd list ⇒ 4 IDs: 0x1000, 0x1001, 0x1100, 0x1101

- Break the loop on an user keyboard press
- Stop Bus Arbiter
- Unload Configuration
- Close PCI/PCIe device

3.3.2. Performance Test - pwrfig_performance

This example is very similar in structure to the previous example.

However, here the goal of the test is to measure the performance of the user read/write operation of the FIP variables from/to the database embedded in the FIP coprocessor.

Thanks to this we can evaluate the min/avg/max access times to the coprocessor depending on the amount of useful data read or written.

At the end of the test, a diagnostic report is generated and gives the access times (minimum, average, maximum) according to the length of the FIP user data produced or consumed: [tools/pwrfig_performance/report_idx1.txt](#).

In the same way as for the previous test, to have a complete performance report, the two FIP nodes in the example must be connected to each other.

Example of two PCI/PCIe PowerFIP devices on the same PC with two terminals:

Linux - Test launch



```
# Adding the SYS_NICE capability as Effective and Permitted to the
binary
# => This root command is executed only once after the binary building
$ sudo setcap cap_sys_nice+ep ./pwrfig_performance
```

```
# => Terminal 1
# starts PCI/PCIe device index 1 with FIP node configuration 0
$ ./pwrfig_performance -i 1 -n 0
```

```
# => Terminal 2
# start PCI/PCIe device index 2 with FIP node configuration 1
$ ./pwrfig_performance -i 2 -n 1
```

Windows - Test launch

```
# => Terminal 1  
# starts PCI/PCIe device index 1 with FIP node configuration 0  
$ pwrfig_performance.exe -i 1 -n 0
```

```
# => Terminal 2  
# start PCI/PCIe device index 2 with FIP node configuration 1  
$ pwrfig_performance.exe -i 2 -n 1
```

This makes it possible to generate performance curves according to the execution context (PC architecture, real-time OS, etc.).

Chapter 4. Functions

In this chapter, we will discover and describe the whole API (Application Programming Interface) of *POWERFIP*.

4.1. General

4.1.1. init

Description

Library internal initialization

Prototype

```
int pwrfig_init()
```

Parameters

- *IN* - None
- *OUT* - None

Return Value

If successful, `pwrfig_init()` returns 0.

If unsuccessful, `pwrfig_init()` returns -1 and sets `errno` value.

Remarks



This function must always be called before using any other function of the library.

4.1.2. exit

Description

Free all internal ressources used by the PowerFIP library

Prototype

```
void pwrfig_exit()
```

Parameters

- *IN* - None
- *OUT* - None

Return Value

NONE

Remarks



This function must always be called at the end of the use of the library.

4.1.3. version_get

Description

Gets the software library version.

Prototype

```
const struct pwrfig_version *pwrfig_version_get()
```

Parameters

- *IN* - None
- *OUT* - None

Return Value

Pointer to a `struct pwrfig_version`.

Example

```
int main(int argc, char *argv[])
{
    const struct pwrfig_version *lib_version;

    pwrfig_init();

    /* pwrfig - get lib version */
    lib_version = pwrfig_version_get();

    printf("pwrfig lib: v%d.%d.%d [build date: %02d/%02d/%02d]\n",
        lib_version->info.major,
        lib_version->info.minor,
        lib_version->info.patch,
        lib_version->date.info.month,
        lib_version->date.info.day,
        lib_version->date.info.year);

    pwrfig_exit();

    return 0;
}
```


4.1.4. error_get

Description

Gets the last error code.

Prototype

```
int pwrfig_error_get()
```

Parameters

- *IN* - None
- *OUT* - None

Return Value

The last error code.

Remarks

See `enum pwrfig_error_code` to get the list of the specific library errors codes.

4.1.5. strerror

Description

Gets the error string specified by its error code.



The library provides this error code via the *lvalue*: ***errno*** or via `pwrftp_error_get()` function.

Prototype

```
const char *pwrftp_strerror(int err)
```

Parameters

- *IN*
 - **err**:
Error code.
- *OUT* - None

Return Value

Error in string format.

Remarks

See `enum pwrftp_error_code` to get the list of the specific library errors codes.

4.2. Device

4.2.1. device_list_get

Description

Gets the list of PCI/PCIe powerfip devices present on the system.



The PowerFIP driver supports up to **16** devices.

Prototype

```
int pwrfig_device_list_get(struct pwrfig_dev_infos *dev_infos,  
                           int *dev_cnt)
```

Parameters

- *IN* - None
- *OUT*
 - **dev_infos**:
Information list of detected devices.
See `struct pwrfig_dev_infos`.
 - **dev_cnt**:
Count of detected devices.

Return Value

If successful, `pwrfig_device_list_get()` returns 0.

If unsuccessful, `pwrfig_device_list_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL**:
Invalid input/output parameter.

4.2.2. device_open

Description

Opens a PCI/PCIe powerfip device.

Prototype

```
struct pwrfip_dev *pwrfip_device_open(uint8_t dev_id)
```

Parameters

- *IN*
 - **dev_id:**
Device index on the system.
- *OUT* - None

Return Value

If successful, `pwrfip_device_open()` returns a new `struct pwrfip_dev` pointer (opaque structure).

If unsuccessful, `pwrfip_device_open()` returns NULL and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameter.
- **ENOMEM:**
Memory allocation error.
- **[..]:**
Other posix errors related to a file opening error

4.2.3. device_reset

Description

Resets PCI/PCIe PowerFIP device.

- FIP Coprocessor reset
- Logic interface reset (of carrier board)

Prototype

```
int pwrfig_device_reset(struct pwrfig_dev *dev)
```

Parameters

- *IN*
 - **dev:**
Pointer to the device to reset.
- *OUT* - None

Return Value

If successful, `pwrfig_device_reset()` returns 0.

If unsuccessful, `pwrfig_device_reset()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameter.

4.2.4. device_close

Description

Closes a PCI/PCIe powerfip device.

Prototype

```
int pwrfip_device_close(struct pwrfip_dev *dev)
```

Parameters

- *IN*
 - **dev:**
Pointer to the device to close.
- *OUT* - None

Return Value

If successful, `pwrfip_device_close()` returns 0.

If unsuccessful, `pwrfip_device_close()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid device pointer.

4.2.5. device_infos_get

Description

Gets information relative to the PCI/PCIe device.

Prototype

```
int pwrfig_device_infos_get(struct pwrfig_dev *dev,  
                           struct pwrfig_dev_infos *info)
```

Parameters

- *IN*
 - **dev:**
Pointer to the device to query.
- *OUT*
 - **info:**
Info structure.
See `struct pwrfig_dev_infos`.

Return Value

If successful, `pwrfig_device_infos_get()` returns 0.

If unsuccessful, `pwrfig_device_infos_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameter.

4.2.6. device_report_get

Description

Gets various information about the PowerFIP board.

Prototype

```
int pwrfig_device_report_get(struct pwrfig_dev *dev,  
                             struct pwrfig_dev_report *report)
```

Parameters

- *IN*
 - **dev:**
Pointer to the device to query.
- *OUT*
 - **report:**
Device report.
See `struct pwrfig_dev_report`.

Return Value

If successful, `pwrfig_device_report_get()` returns 0.

If unsuccessful, `pwrfig_device_report_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameter.

4.3. AE/LE

4.3.1. aele_create

Description

The function `pwrfig_aele_create()` creates an Application/Layer entity attached to a FIP node. This container will gather all the production/consumptions variables and messages related to the local application.

Prototype

```
struct pwrfig_aele *pwrfig_aele_create(struct pwrfig_node *node);
```

Parameters

- *IN*
 - **node:**
Pointer to a `struct pwrfig_node`.
- *OUT* - None

Return Value

Pointer to a `struct pwrfig_aele` (opaque structure).

4.3.2. aele_delete

Description

The function `pwrfig_aele_delete()` deallocates a specific application/layer entity; and removes all items (variable, messages) attached to it.

Prototype

```
int pwrfig_aele_delete(struct pwrfig_aele *aele)
```

Parameters

- *IN*
 - **aele:**
Application entity to delete.
- *OUT* - None

Return Value

If successful, `pwrfig_aele_delete()` returns 0.

If unsuccessful, `pwrfig_aele_delete()` returns -1 and sets `errno` to one of the following values:

- **PWRFIP_ERR_AELE_NOT_STOP:**
AE/LE is currently running. Stop it before try to delete it.

4.3.3. msg_create

Description

Creates a FIP message inside an user's application context.

Prototype

```
struct pwrfig_msg *pwrfig_msg_create(  
    struct pwrfig_aele *aele, struct pwrfig_msg_cfg *cfg)
```

Parameters

- *IN*
 - **aele:**
Pointer to a user's application context (AE/LE).
 - **cfg:**
Pointer to a message's configuration structure.
See `struct pwrfig_msg_cfg`.
- *OUT* - None

Return Value

If successful, `pwrfig_msg_create()` returns a new `struct pwrfig_msg` pointer.

If unsuccessful, `pwrfig_msg_create()` returns NULL and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **ENOMEM:**
Memory allocation error.
- **PWRFIP_ERR_AELE_NOT_STOP:**
AE/LE is currently running. Stop it before trying to create new objects.
- **PWRFIP_ERR_CFG_MSG_EXIST:**
Impossible to create this message. The AE/LE context already contains a message with the same header.
- **PWRFIP_ERR_NODE_MSG_CAP_NOT_SUPPORTED:**
The node doesn't support the messaging service.
See `.msg.enable` field of `struct pwrfig_node_cfg`.
- **PWRFIP_ERR_CFG_MSG_TYPE_UNKNOWN:**
Unknown message type.
See `enum pwrfig_msg_type`.
- **PWRFIP_ERR_CFG_MSG_TX_CH_PER_UNKNOWN:**
Unknown periodic message TX channel.
See `enum pwrfig_msg_tx_channel`.
- **PWRFIP_ERR_CFG_MSG_TX_CH_PER_NOID:**

No ID attached to the periodic TX channel.

See `.msg.tx_per_fifo_id[]` field of `struct pwrfig_node_cfg`.

- **PWRFIP_ERR_CFG_MSG_TX_ACK_MODE_UNKNOWN:**

Unknown message acknowledgement mode.

See `enum pwrfig_msg_tx_ack_mode`.

Example

```
static struct pwrfig_msg_cfg prod_msg_cfg = {
    .type = PWRFIP_MSG_TYPE_SEND,
    .tx.channel = PWRFIP_MSG_TX_CH_APER,
    .tx.ack_mode = PWRFIP_MSG_TX_ACK_MODE_SDA,
    /* local data link layer address: 0x0C0000 */
    .hdr.src.seg = 0,
    .hdr.src.lsap = 0x0C00, /* ssap */
    /* remote data link layer address: 0x0C0100 */
    .hdr.dst.seg = 0,
    .hdr.dst.lsap = 0x0C01, /* dsap (=target) */
    .pwrfig_msg_handler = NULL,
};

static struct pwrfig_msg_cfg cons_msg_cfg = {
    .type = PWRFIP_MSG_TYPE_RECV,
    /* remote data link layer address: 0x0C0100 */
    .hdr.src.seg = 0,
    .hdr.src.lsap = 0x0C01, /* ssap */
    /* local data link layer address: 0x0C0000 */
    .hdr.dst.seg = 0,
    .hdr.dst.lsap = 0x0C00, /* dsap (=target) */
    .pwrfig_msg_handler = NULL,
};

int main(int argc, char *argv[])
{
    int i, err = 0;
    struct pwrfig_node_cfg node_cfg;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;
    struct pwrfig_msg *prod_msg, *cons_msg;

    /**
     * Node initialization
     */
    memset(&node_cfg, 0, sizeof(struct pwrfig_node_cfg));
    node_cfg.fip_phy_addr = 0;
    node_cfg.fip_seg_num = 0;
    node_cfg.msg.enable = 1;
    if (node_cfg.msg.enable) {
```

```

/* set rx messaging sensitivity only for messages destined
 * for segment 0 with DSAP values configured for the node
 */
node_cfg.msg.rx_segment_tab[0] = PWRFIP_MSG_SEG_ACCEPT_LTD;
node_cfg.msg.rx_fifo_size = 0; /* 0 to set default value (30) */
node_cfg.msg.tx_aper_fifo_size = 0; /* default value for tx aper channel:
 * tx fifo depth = 24 messages
 */
node_cfg.msg.tx_max_repeat = 3; /* 3 tx retries in case of error */
/* periodic messaging channels are disabled */
for (i = 0; i < PWRFIP_MSG_TX_CH_PER_CNT; ++i)
    node_cfg.msg.tx_per_fifo_id[i] = 0; /* no id attached */

}
/*...: other node configuration fields to fill (ba, handlers...) */
node = pwrfig_node_init(&node_cfg);
if (!node) {
    printf("node creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* create an aeie context */
al = pwrfig_aeie_create(node);
if (!al) {
    printf("aeie creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* create a tx message */
prod_msg = pwrfig_msg_create(al, &prod_msg_cfg);
if (!prod_msg) {
    printf("tx message creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* create a rx message */
cons_msg = pwrfig_msg_create(al, &cons_msg_cfg);
if (!cons_msg) {
    printf("rx message creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/**
 * Other tasks
 */

```

```
    /* ... */  
  
end:  
    /**  
     * Node exit  
     */  
    /*...*/  
    return err;  
}
```

4.3.4. msg_delete

Description

Deallocates a specific message from an application entity (AE/LE).

Prototype

```
int pwrfig_msg_delete(struct pwrfig_msg *msg)
```

Parameters

- *IN*
 - **msg:**
Pointer to the message to delete.
See `struct pwrfig_msg`.
- *OUT* - None

Return Value

If successful, `pwrfig_msg_delete()` returns 0.

If unsuccessful, `pwrfig_msg_delete()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameter.
- **PWRFIP_ERR_AELE_NOT_STOP:**
AE/LE attached to this message is currently running. Stop it before try to delete it.

4.3.5. sm_var_create

Description

Creates an additionnal SM-MPS variables inside an user's application context.

This function is used to allow the local node to consume SM-MPS variables produced by remote nodes.

Prototype

```
struct pwrfig_var *pwrfig_sm_var_create(  
    struct pwrfig_aele *aele, enum pwrfig_sm_var_type type,  
    uint8_t node_addr)
```

Parameters

- *IN*
 - **aele:**
Pointer to a user's application context (AE/LE).
 - **type:**
Type of SM-MPS variable to create.
See `enum pwrfig_sm_var_type`.
 - **node_addr:**
Remote node address.
- *OUT* - None

Return Value

If successful, `pwrfig_sm_var_create()` returns a new `struct pwrfig_var` pointer.

If unsuccessful, `pwrfig_sm_var_create()` returns NULL and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **ENOMEM:**
Memory allocation error.
- **PWRFIP_ERR_AELE_NOT_STOP:**
AE/LE is currently running. Stop it before trying to create new objects.
- **PWRFIP_ERR_CFG_VAR_EXIST:**
Impossible to create this variable. The AE/LE context already contains a variable with this FIP identifier.
- **PWRFIP_ERR_CFG_VAR_DIR:**
An update of the variable tried to be applied; but it's impossible to change the direction of the variable (prod/cons) for this FIP identifier.
- **PWRFIP_ERR_CFG_MSG_PROD:**

Impossible to link a produced message on this FIP identifier. A consumed variable is already attached to it.

- **PWRFIP_ERR_CFG_MSG_DIR:**

A FIP production message is already attached to this FIP identifier; so it is impossible to change the production channel.

Example

```
int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;

    /**
     * Node initialization.
     * Note: We assume here that the local node created has a FIP address = 1
     */
    /*...*/

    /**
     * Create an aele context.
     * Note: When the AE/LE is created, the following SM-MPS variables are
     * automatically created: 0x9003, 0x9002, 0x10XY, 0x11XY, 0x14XY where
     * XY is the local node address (here, FIP address = 1).
     * If the node is master (ba active), 0x9002 and 0x9003 variables will
     * be automatically produced and updated by the library; otherwise they
     * will only be consumed.
     * Moreover 0x10XY, 0x11XY, 0x14XY are always automatically produced and
     * updated by the library.
     */
    al = pwrfig_aele_create(node);
    if (!al) {
        printf("aele creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /**
     * Creates other sm-mps variables to consume.
     * Note: In this example, the local station will be connected to the remote
     * stations 2 and 3; and we would like to be able to read their system
     * management variables. So we create them.
     */
    /* => creates consumed SM-MPS variables: 0x1002, 0x1102, 0x1402 */
    pwrfig_sm_var_create(al, PWRFIP_SM_VAR_IDENT, 2);
    pwrfig_sm_var_create(al, PWRFIP_SM_VAR_REPORT, 2);
    pwrfig_sm_var_create(al, PWRFIP_SM_VAR_PRESENCE, 2);
}
```

```
/* => creates consumed SM-MPS variables: 0x1003, 0x1103, 0x1403 */
pwrfig_sm_var_create(al, PWRFIG_SM_VAR_IDENT, 3);
pwrfig_sm_var_create(al, PWRFIG_SM_VAR_REPORT, 3);
pwrfig_sm_var_create(al, PWRFIG_SM_VAR_PRESENCE, 3);

/**
 * Other tasks
 */
/* ... */

end:
/**
 * Node exit
 */
/*...*/
return err;
}
```

4.3.6. var_create

Description

Creates a FIP variable inside an user's application context.

Prototype

```
struct pwrfig_var *pwrfig_var_create(struct pwrfig_aele *aele,  
                                     struct pwrfig_var_cfg *cfg)
```

Parameters

- *IN*
 - **aele:**
Pointer to a user's application context (AE/LE).
 - **cfg:**
Pointer to a variable's configuration structure.
See `struct pwrfig_var_cfg`.
- *OUT* - None

Return Value

If successful, `pwrfig_var_create()` returns a new `struct pwrfig_var` pointer.

If unsuccessful, `pwrfig_var_create()` returns NULL and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **ENOMEM:**
Memory allocation error.
- **PWRFIP_ERR_AELE_NOT_STOP:**
AE/LE is currently running. Stop it before trying to create new objects.
- **PWRFIP_ERR_CFG_VAR_EXIST:**
Impossible to create this variable. The AE/LE context already contains a variable with this FIP identifier.
- **PWRFIP_ERR_CFG_VAR_DIR:**
An update of the variable tried to be applied; but it's impossible to change the direction of the variable (prod/cons) for this FIP identifier.
- **PWRFIP_ERR_CFG_MSG_PROD:**
Impossible to link a produced message on this FIP identifier. A consumed variable is already attached to it.
- **PWRFIP_ERR_CFG_MSG_DIR:**
A FIP production message is already attached to this FIP identifier; so it is impossible to change the production channel.

Example

```
void sync_var_handler(struct pwrfig_node *node,
    struct pwrfig_var *var, struct pwrfig_event *evt);

static struct pwrfig_var_cfg prod_var_cfg = {
    .type = PWRFIG_VAR_TYPE_PROD,
    .id = 0x3800,
    .prod.payload_bsz = 8,
    .prod.flags = \
        /* enable prod status */
        PWRFIG_VAR_FLAGS_REFRESH | \
        /* enable aper var request */
        PWRFIG_VAR_FLAGS_APER_VAR_REQ | \
        /* enable aper msg request */
        PWRFIG_VAR_FLAGS_APER_MSG_REQ,
    .prod.refreshment_ustime = 80000, /* 80ms */
    .prod.evt_type = PWRFIG_EVT_TYPE_NONE,
    .pwrfig_var_handler = NULL,
};

static struct pwrfig_var_cfg cons_var_cfg = {
    .type = PWRFIG_VAR_TYPE_CONS,
    .id = 0x3801,
    .cons.payload_bsz = 8,
    .cons.flags = \
        /* enable prod status */
        PWRFIG_VAR_FLAGS_REFRESH | \
        /* enable promptness checking */
        PWRFIG_VAR_FLAGS_PROMPT | \
        /* enable pdu + len bytes checking */
        PWRFIG_VAR_FLAGS_CHK_PDU_LEN,
    .cons.promptness_ustime = 100000, /* 100ms */
    .cons.evt_type = PWRFIG_EVT_TYPE_NONE,
    .pwrfig_var_handler = NULL,
};

static struct pwrfig_var_cfg sync_var_cfg = {
    .type = PWRFIG_VAR_TYPE_SYNC,
    .id = 0x3000,
    .pwrfig_var_handler = sync_var_handler,
};

int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;
    struct pwrfig_var *prod_var, *cons_var, *sync_var;
```

```

/**
 * Node initialization
 */
/*...*/

/* create an aelee context */
al = pwrfig_aelee_create(node);
if (!al) {
    printf("aelee creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* create a production variable */
prod_var = pwrfig_var_create(al, &prod_var_cfg);
if (!prod_var) {
    printf("production variable creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* create a consumption variable */
cons_var = pwrfig_var_create(al, &cons_var_cfg);
if (!cons_var) {
    printf("consumption variable creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* create a synchronization variable */
sync_var = pwrfig_var_create(al, &sync_var_cfg);
if (!sync_var) {
    printf("synchronization variable creation failed: %s\n", pwrfig_strerror(
errno));
    err = -1;
    goto end;
}

/**
 * Other tasks
 */
/* ... */

end:
/**
 * Node exit
 */
/*...*/
return err;

```

```
}
```

4.3.7. var_delete

Description

Deallocates a specific variable from an application entity (AE/LE).

Prototype

```
int pwrfig_var_delete(struct pwrfig_var *var)
```

Parameters

- *IN*
 - **var:**
Pointer to the variable to delete.
See `struct pwrfig_var`.
- *OUT* - None

Return Value

If successful, `pwrfig_var_delete()` returns 0.

If unsuccessful, `pwrfig_var_delete()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameter.
- **PWRFIP_ERR_AELE_NOT_STOP:**
AE/LE attached to this variable is currently running. Stop it before try to delete it.

4.4. Bus Arbiter

4.4.1. ba_mcycle_create

Description

This function creates a new macrocycle (or Bus Arbiter table) attached to a FIP node.



To support this function, the FIP node has to set *Master* capability.

Prototype

```
struct pwrfig_ba_mcycle *pwrfig_ba_mcycle_create(  
    struct pwrfig_node *node,  
    struct pwrfig_ba_mcycle_cfg *cfg)
```

Parameters

- *IN*
 - **node:**
Pointer to the FIP node where to create the new macrocycle.
See `struct pwrfig_node`.
 - **cfg:**
Pointer to a macrocycle configuration structure.
See `struct pwrfig_ba_mcycle_cfg`.
- *OUT* - None

Return Value

If successful, `pwrfig_ba_mcycle_create()` returns a new `struct pwrfig_ba_mcycle` pointer (opaque structure).

If unsuccessful, `pwrfig_ba_mcycle_create()` returns NULL and sets `errno` to one of the following values:

- **EINVAL:**
Invalid node or macrocycle configuration structure.
- **ENOMEM:**
Memory allocation error.
- **PWRFIP_ERR_MCYCLE_WIND_UNKNOWN:**
Invalid macrocycle window type (see `enum pwrfig_ba_wind_type`).
- **PWRFIP_ERR_MCYCLE_WIND_COUNT:**
Macrocycle window count has to be greater than 0.
- **PWRFIP_ERR_MCYCLE_PER_WIND_REQ_COUNT:**
Requests count inside a macrocycle periodic window has to be greater than 0.
- **PWRFIP_ERR_MCYCLE_PER_WIND_REQ_UNKNOWN:**

Invalid request type inside a macrocycle periodic window.

Requests allowed are only *ID_DAT* and *ID_MSG* type.

- **PWRFIP_ERR_MCYCLE_WIND_TIME_INC:**

Overlap on macrocycle windows end times.

The `.end_ustime` field present in the configuration of certain types of bus arbiter window is a time relative to the beginning of the macrocycle.

This time must therefore be increasing as you go through the configuration list.

- **PWRFIP_ERR_MCYCLE_WIND_END:**

The macrocycle configuration must end with a time window (wait).

Example

```
#define TST_BA_PER_REQ_COUNT 3
static struct pwrfig_ba_request tst_ba_per_req[TST_BA_PER_REQ_COUNT] = {
    {
        .type = PWRFIP_BA_ID_DAT,
        .id = 0x3800,
    },
    {
        .type = PWRFIP_BA_ID_DAT,
        .id = 0x3801,
    },
    {
        .type = PWRFIP_BA_ID_DAT,
        .id = 0x9003,
    },
};

static struct pwrfig_ba_wind_cfg tst_ba_wind_cfg[2][4] = {
    /* ba mcycle 1 */
    {
        /* 1 - periodic variable window */
        {
            .type = PWRFIP_BA_WIND_PER,
            .per.req_cnt = TST_BA_PER_REQ_COUNT,
            .per.req_list = &tst_ba_per_req[0],
        },
        /* 2 - aperiodic message window */
        {
            .type = PWRFIP_BA_WIND_APER_MSG,
            .aper_msg.end_ustime = 15000,
        },
        /* 3 - aperiodic variable window */
        {
            .type = PWRFIP_BA_WIND_APER_VAR,
            .aper_var.end_ustime = 35000,
            .aper_var.enable_testp = 1, /* enable presence test if no other
                                         * request to dispatch */
        }
    }
};
```

```

    },
    /* 4 - resync wait window */
    {
        .type = PWRFIP_BA_WIND_WAIT,
        .wait.end_ustime = 40000,
        .wait.is_silent = 0, /* fill window with padding frames */
        .wait.is_ext_resync = 0, /* internal resynchronization */
    },
},
/* ba mcycle 2 */
{
    /* 1 - periodic variable window */
    {
        .type = PWRFIP_BA_WIND_PER,
        .per.req_cnt = TST_BA_PER_REQ_COUNT,
        .per.req_list = &tst_ba_per_req[0],
    },
    /* 2 - aperiodic message window */
    {
        .type = PWRFIP_BA_WIND_APER_MSG,
        .aper_msg.end_ustime = 75000,
    },
    /* 3 - resync wait window */
    {
        .type = PWRFIP_BA_WIND_WAIT,
        .wait.end_ustime = 80000,
        .wait.is_silent = 0, /* fill window with padding frames */
        .wait.is_ext_resync = 0, /* internal resynchronization */
    },
    /* no other window */
    {
        .type = 0,
    }
},
};

static struct pwrfig_ba_mcycle_cfg tst_ba_mcycle_cfg[2] = {
    /* ba mcycle 1 */
    {
        .wind_cnt = 4,
        .wind_list = &tst_ba_wind_cfg[0][0],
    },
    /* ba mcycle 2 */
    {
        .wind_cnt = 3,
        .wind_list = &tst_ba_wind_cfg[1][0],
    },
};

```

```
int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfip_node *node;
    struct pwrfip_ba_mcycle *mcycle[2];

    /**
     * Node initialization
     */
    /*...*/

    /* create two bus arbiter macrocycles */
    for (i = 0; i < 2; ++i) {
        struct pwrfip_ba_mcycle_cfg *mcycle_cfg = &tst_ba_mcycle_cfg[i];

        mcycle[i] = pwrfip_ba_mcycle_create(node, mcycle_cfg);
        if (!mcycle[i]) {
            /* get error */
            printf("macrocycle creation failed: %s\n", pwrfip_strerror(errno));
            err = -1;
            goto end;
        }
    }

    /**
     * Other tasks
     */
    /* ... */

end:
    /**
     * Node exit
     */
    /*...*/
    return err;
}
```

4.4.2. ba_mcycle_delete

Description

The function `pwrfig_ba_mcycle_delete()` deallocates a specific macrocycle.

Prototype

```
int pwrfig_ba_mcycle_delete(struct pwrfig_ba_mcycle *mcycle)
```

Parameters

- *IN*
 - **mcycle:**
Macrocycle to delete.
- *OUT* - None

Return Value

If successful, `pwrfig_ba_mcycle_delete()` returns 0.

If unsuccessful, `pwrfig_ba_mcycle_delete()` returns -1 and sets `errno` to one of the following values:

- **PWRFIP_ERR_BA_NOT_STOP:**
The macrocycle is currently running. Stop it before try to delete it.

4.4.3. ba_startup_calculate

Description

Tool function to calculate compliant start-up and election times for a bus arbiter in an environment where multiple FIP nodes are competing to become *Master*.

Prototype

```
int pwrfig_ba_startup_calculate(uint32_t *stup_ustime, uint32_t *elec_ustime,
                                struct pwrfig_ba_startup_cfg *cfg)
```

Parameters

- *IN*
 - **cfg:**
Input parameters for time calculation.
See `struct pwrfig_ba_startup_cfg`.
- *OUT*
 - **stup_ustime:**
BA start-up time calculated in microseconds.
 - **elec_ustime:**
BA election time calculated in microseconds.

Return Value

If successful, `pwrfig_ba_startup_calculate()` returns 0.

If unsuccessful, `pwrfig_ba_startup_calculate()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIG_ERR_BA_STUP_PHY_ADDR_INVALID:**
Local physical address exceeds maximum physical address given.
- **PWRFIG_ERR_BA_STUP_PRIO_INVALID:**
Local priority is higher than maximum one given.



BA Priority

Priority range is between [0;15], with 0 the highest priority.

- **PWRFIG_ERR_BA_STUP_TS_INVALID:**
Silence Time input parameter should not be 0.

4.4.4. ba_start

Description

Starts a specific macrocycle for the master node attached.

Prototype

```
int pwrfig_ba_start(struct pwrfig_ba_mcycle *mcycle)
```

Parameters

- *IN*
 - **mcycle:**
Macrocycle to start.
- *OUT* - None

Return Value

If successful, `pwrfig_ba_start()` returns 0.

If unsuccessful, `pwrfig_ba_start()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid macrocycle pointer.
- **PWRFIP_ERR_BA_NOT_STOP:**
The node has already a running macrocycle.
Use `pwrfig_ba_commute()` function instead.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.4.5. ba_stop

Description

Stops the macrocycle of a specific FIP node.

Prototype

```
int pwrfig_ba_stop(struct pwrfig_node *node)
```

Parameters

- *IN*
 - **node:**
FIP node to query.
See `struct pwrfig_node`.
- *OUT* - None

Return Value

If successful, `pwrfig_ba_stop()` returns 0.

If unsuccessful, `pwrfig_ba_stop()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid node pointer.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.4.6. ba_commute

Description

Switch to the execution of another FIP macrocycle.

Prototype

```
int pwrfig_ba_commute(struct pwrfig_ba_mcycle *mcycle)
```

Parameters

- *IN*
 - **mcycle:**
Pointer to the new macrocycle to switch to.
- *OUT* - None

Return Value

If successful, `pwrfig_ba_commute()` returns 0.

If unsuccessful, `pwrfig_ba_commute()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid macrocycle pointer.
- **PWRFIP_ERR_BA_NOT_RUN:**
The node does not have a running macrocycle.
Use `pwrfig_ba_start()` function instead.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.4.7. ba_status_get

Description

Gets the bus arbiter status for a given FIP node.

Prototype

```
int pwrfig_ba_status_get(struct pwrfig_node *node, struct pwrfig_ba_status *status)
```

Parameters

- *IN*
 - **node:**
FIP node to query.
See `struct pwrfig_node`.
- *OUT*
 - **status:**
Pointer to an output `struct pwrfig_ba_status`.

Return Value

If successful, `pwrfig_ba_status_get()` returns 0.

If unsuccessful, `pwrfig_ba_status_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.5. Messages

4.5.1. msg_send

Description

Writes a FIP message to the local coprocessor database.

Prototype

```
int pwrfig_msg_send(struct pwrfig_msg *msg)
```

Parameters

- *IN*
 - **msg**:
Pointer to the target message to write.
See `struct pwrfig_msg`.
- *OUT*
 - **msg**:
Message's updated info.
See `struct pwrfig_msg` (`.epoch` and `.error` fields).

Return Value

If successful, `pwrfig_msg_send()` returns 0.

If unsuccessful, `pwrfig_msg_send()` returns -1 and sets `errno` to one of the following values:

- **EINVAL**:
Invalid input parameters.
- **PWRFIG_ERR_INVALID_CTX**:
The AE/LE context attached to the message object does not match that of the running node.
- **PWRFIG_ERR_AELE_NOT_RUN**:
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIG_ERR_COM_XXX**:
Communication error with the coprocessor.

Remarks

There are two possible error levels for this operation:

1. The error returned by the `pwrfig_msg_send()` function is related to a context error inside the library, or a communication error with the coprocessor.
This type of error is quite critical since it indicates a malfunction of the library.
2. The `.error` field returned in the `struct pwrfig_msg` (see `enum pwrfig_msg_err_code`) relates directly to the FIP frame state written to the network.
It is an indicator of the quality of the frame written.

Example

```

static struct pwrfig_msg_cfg prod_msg_cfg = {
    .type = PWRFIG_MSG_TYPE_SEND,
    .tx.channel = PWRFIG_MSG_TX_CH_APER,
    .tx.ack_mode = PWRFIG_MSG_TX_ACK_MODE_SDA,
    /* local data link layer address: 0x0C0000 */
    .hdr.src.seg = 0,
    .hdr.src.lsap = 0x0C00, /* ssap */
    /* remote data link layer address: 0x0C0100 */
    .hdr.dst.seg = 0,
    .hdr.dst.lsap = 0x0C01, /* dsap (=target) */
    .pwrfig_msg_handler = NULL,
};

int main(int argc, char *argv[])
{
    int i, err = 0;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;
    struct pwrfig_msg *prod_msg;
    uint16_t w_counter = 0;

    /**
     * Node initialization
     */
    /*...*/

    /* create an aele context */
    al = pwrfig_aele_create(node);
    if (!al) {
        printf("aele creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /* create a production message */
    prod_msg = pwrfig_msg_create(al, &prod_msg_cfg);
    if (!prod_msg) {
        printf("production message creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /* node startup (slave) */
    err = pwrfig_node_start(al, NULL, 0);
    if (err) {
        printf("node startup failed: %s\n", pwrfig_strerror(errno));
        err = -1;
    }
}

```

```
        goto end;
    }

    /* writing loop */
    for(;;) {
        /* update msg payload */
        w_counter++;
        prod_msg->bsz = sizeof(w_counter);
        memcpy(prod_msg->buffer, &w_counter, prod_msg->bsz);

        /* send it to fip network */
        if (pwrfig_msg_send(prod_msg)) {
            printf("w_msg[header: src=0x%08x dst=0x%08x] failed: %s\n",
                prod_msg->hdr.src.addr, prod_msg->hdr.dst.addr,
                pwrfig_strerror(errno));
            /* we consider this error as fatal error; so we
             * stop the test */
            break;
        }

        /* check msg state errors */
        if (prod_msg->error) {
            printf("w_msg[header: src=0x%08x dst=0x%08x] state error: %d\n",
                prod_msg->hdr.src.addr, prod_msg->hdr.dst.addr,
                prod_msg->error);
        }

        usleep(100000); /* 100ms */
    }

end:
    /**
     * Node exit
     */
    /*...*/
    return err;
}
```

4.5.2. msg_tx_channel_purge

Description

Purges the target periodic/apperiodic message TX channel.

Prototype

```
int pwrfig_msg_tx_channel_purge(struct pwrfig_node *node,  
                                enum pwrfig_msg_tx_channel channel,  
                                uint16_t *purge_cnt, uint8_t *ch_error);
```

Parameters

- *IN*
 - **node:**
Pointer to the target node.
See `struct pwrfig_node`.
 - **channel:**
Message TX channel to purge.
See `enum pwrfig_msg_tx_channel`.
- *OUT*
 - **purge_cnt:**
Number of messages purged.
 - **ch_error:**
Channel error.
See `enum pwrfig_msg_err_code`.

Return Value

If successful, `pwrfig_msg_tx_channel_purge()` returns 0.

If unsuccessful, `pwrfig_msg_tx_channel_purge()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.6. Node

4.6.1. node_init

Description

Creates a new FIP node context inside the library and load it to the local database of a binded coprocessor.

This is the main step in creating a FIP node.

Prototype

```
struct pwrfig_node *pwrfig_node_init(struct pwrfig_node_cfg *cfg)
```

Parameters

- *IN*
 - **cfg:**
Pointer to the FIP node configuration.
See `struct pwrfig_node_cfg`.
- *OUT* - None

Return Value

If successful, `pwrfig_node_init()` returns a new `struct pwrfig_node` pointer.

If unsuccessful, `pwrfig_node_init()` returns NULL and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input configuration.
- **ENOMEM:**
Memory allocation error.
- **PWRFIP_ERR_NODE_BSS_OVERFLOW:**
Node BSS overflow.
You should reduce the FIFO sizes of the node.
- **PWRFIP_ERR_NODE_HANDLER_MISSING:**
Some user handlers are mandatory to continue the node creation:
 - `pwrfig_reset_handler`
 - `pwrfig_error_handler`
- **PWRFIP_ERR_NODE_FRM_TYPE_INVALID:**
Invalid frame type configuration. Should be:
 - `PWRFIP_FRM_FIP`
 - `PWRFIP_FRM_WORLD_FIP`
- **PWRFIP_ERR_NODE_BITRATE_INVALID:**
Invalid FIP bitrate configuration. Should be:

- PWRFIP_BITRATE_31K25
- PWRFIP_BITRATE_1M
- PWRFIP_BITRATE_2M5
- PWRFIP_BITRATE_5M
- **PWRFIP_ERR_NODE_TR_INVALID:**
Invalid FIP turnaround time. Range should be:
 - @31.25Kbps : min=320us, max=8232us, default=424us
 - @1Mbps : min=20us, max=258us, default=30us
 - @2.5Mbps : min=20us, max=103us, default=30us
 - @5Mbps : min=20us, max=103us, default=32us
 - @12.5Mbps : min=20us, max=103us, default=32us
 - @25Mbps : min=20us, max=103us, default=32us
- **PWRFIP_ERR_NODE_TS_INVALID:**
Invalid FIP silence time. Range should be:
 - @31.25Kbps : min=2880us, max=65535us, default=4096us
 - @1Mbps : min=70us, max=65535us, default=150us
 - @2.5Mbps : min=36us, max=65535us, default=96us
 - @5Mbps : min=36us, max=65535us, default=92us
 - @12.5Mbps : min=36us, max=65535us, default=92us
 - @25Mbps : min=36us, max=65535us, default=92us
- **PWRFIP_ERR_NODE_RX_MSG_FIFO_SZ:**
Invalid queue size for message consumption.
Range value should be: [1..64].
- **PWRFIP_ERR_NODE_RX_MSG_SEG_CAP:**
Invalid segment capability for consumption message. Should be:
 - PWRFIP_MSG_SEG_IGNORE
 - PWRFIP_MSG_SEG_ACCEPT_ALL
 - PWRFIP_MSG_SEG_ACCEPT_LTD
- **PWRFIP_ERR_NODE_TX_MSG_FIFO_SZ:**
Invalid queue size for message transmission.
Range value should be: [1..64].
- **PWRFIP_ERR_NODE_TX_MSG_REPEAT:**
Invalid maximum repeats for acknowledged message transmission.
Range value should be: [0..3].
- **PWRFIP_ERR_NODE_BA_STUP_TIMES:**
The bus arbiter election time must be shorter than the start-up time.

- **PWRFIP_ERR_NODE_BA_REQ_FIFO_SZ:**
Invalid queue size for BA requests.
Range value should be: [1..64].
- **PWRFIP_ERR_DEV_ALREADY_BIND:**
The provided device is already bound to another FIP node session.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.
- **[..]:**
Other posix errors related to a file opening error

Example

```
void usr_rst_handler(struct pwrfig_node *node)
{
    /* calling the reset function for a pci/pcie device */
    if (pwrfig_device_reset(node->infos->cfg.dev)) {
        printf("reset failed: %s\n", pwrfig_strerror(errno));
        return;
    }
    _print(src, evt, "reset coprocessor component (powerfig) done\n");
}

void usr_err_handler(struct pwrfig_node *node,
                    enum pwrfig_error_code code)
{
    printf("error_handler: %s (err_code=%d)\n",
          pwrfig_strerror(code), code);
}

int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_dev *dev;
    struct pwrfig_node *node;
    struct pwrfig_node_cfg cfg;

    /* pwrfig lib initialization [mandatory] */
    if (pwrfig_init()) {
        printf("cannot init pwrfig library: %s\n",
              pwrfig_strerror(errno));
        return -1;
    }

    /* open a pci/pcie device (1st index) */
    dev = pwrfig_device_open(1);
    if (!dev) {
        printf("cannot open device: %s\n",
```



```

        pwrfig_strerror(errno));
    pwrfig_exit();
    return -1;
}

/**
 * Node initialization:
 * Minimal set-up for a PCI/PCIe device
 */
cfg.fip_phy_addr = 1; /* fip node addr = 0x01 */
cfg.fip_seg_num = 0; /* fip node belongs to fip segment 0 */
cfg.fip_frm_type = PWRFIG_FRM_WORLDFIG; /* WorldFIG frame (IEC) */
cfg.fip_bitrate = PWRFIG_BITRATE_1M; /* 1Mbps */
cfg.turn_around_ustime = 0; /* default TR time for 1Mbps (30us) */
cfg.silence_ustime = 0; /* default TS time for 1Mbps (150us) */
cfg.enable_bimedium = 0; /* mono-medium topology (just one channel) */
cfg.msg.enable = 0; /* fip messaging not supported */
cfg.ba.enable = 0; /* no master capability for this node */
cfg.ident.manufacturer_name = "MyVendorName\0";
cfg.ident.model_name = "MyModelName\0";
cfg.ident.revision = 0x10; /* v1.0 */
cfg.dev = dev; /* coprocessor attachment: pci/pcie device to bind */
cfg.pwrfig_error_handler = usr_err_handler; /* local handler to notify
                                             the internal errors of
                                             the library */

cfg.pwrfig_reset_handler = usr_rst_handler; /* local handler to reset
                                             the bound device */

node = pwrfig_node_init(&cfg);
if (!node) {
    printf("node initialization failed: %s\n",
        pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/**
 * Other tasks
 */
/* ... */

end:
/**
 * Node exit
 */
/*...*/

/* close device */
pwrfig_device_close(dev);

```

```
/* pwrfig lib exit [mandatory] */  
pwrfig_exit();  
return err;  
}
```

4.6.2. node_exit

Description

Stops the coprocessor and deallocates all resources attached to the FIP node inside the library.

Prototype

```
int pwrfig_node_exit(struct pwrfig_node *node)
```

Parameters

- *IN*
 - **node:**
Pointer to the FIP node to exit.
See `struct pwrfig_node`.
- *OUT* - None

Return Value

If successful, `pwrfig_node_exit()` returns 0.

If unsuccessful, `pwrfig_node_exit()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameter.
- **PWRFIP_ERR_DEV_IRQ_HANDLER_STOPPED:**
Internal IRQ handler for PCI/PCIe device is already stopped.
- **PWRFIP_ERR_AELE_NOT_STOP:**
Cannot stop the Application/Layer entity. The exit procedure has therefore failed.
- **PWRFIP_ERR_BA_NOT_STOP:**
Cannot stop the bus arbiter FSM. The exit procedure has therefore failed.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.6.3. node_status_get

Description

Get the FSM status of the FIP node.

Prototype

```
int pwrfig_node_status_get(struct pwrfig_node *node,
                          struct pwrfig_node_status *status)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
- *OUT*
 - **status:**
Pointer to an output `struct pwrfig_node_status`.

Return Value

If successful, `pwrfig_node_status_get()` returns 0.

If unsuccessful, `pwrfig_node_status_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Example

```
static const char *pwrfig_node_state_str[_PWRFIP_NODE_STATE_MAX] = {
    /* PWRFIP_NODE_STATE_INITIAL */
    "initial",
    /* PWRFIP_NODE_STATE_LOADED */
    "loaded",
    /* PWRFIP_NODE_STATE_READY */
    "ready",
    /* PWRFIP_NODE_STATE_RUNNING */
    "running",
};

static const char *pwrfig_node_op_str[_PWRFIP_NODE_OP_MAX] = {
    /* _PWRFIP_NODE_OP_UNKNOWN */
    "unknown",
};
```

```

    /* PWRFIP_NODE_OP_WAIT_RX_RP_FRM */
    "rx rp frame",
    /* PWRFIP_NODE_OP_WAIT_TX_RP_FRM */
    "tx rp frame",
    /* PWRFIP_NODE_OP_WAIT_RX_ID_FRM */
    "rx id frame",
    /* PWRFIP_NODE_OP_WAIT_TX_ID_FRM */
    "tx id frame",
};

int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_node *node;
    struct pwrfig_node_status n_status;

    /**
     * Node initialization
     */
    /*...*/

    /* get node status */
    err = pwrfig_node_status_get(node, &n_status);
    if (err) {
        printf("node status getter failed: %s\n", pwrfig_strerror(errno));
        goto end;
    }

    printf("node_status\n");
    printf("  node_state      : %d (%s)\n", n_status.state,
        pwrfig_node_state_str[n_status.state]);
    printf("  node_op         : %d (%s)\n", n_status.op,
        pwrfig_node_op_str[n_status.op]);

    /**
     * Other tasks
     */
    /* ... */

end:
    /**
     * Node exit
     */
    /*...*/
    return err;
}

```

4.6.4. node_report_get

Description

Gets the full diagnostic report of the FIP node.

Prototype

```
int pwrfig_node_report_get(struct pwrfig_node *node,
                          struct pwrfig_node_report *report)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
- *OUT*
 - **report:**
Pointer to an output `struct pwrfig_node_report`.

Return Value

If successful, `pwrfig_node_report_get()` returns 0.

If unsuccessful, `pwrfig_node_report_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Example

```
static const char *pwrfig_node_state_str[_PWRFIP_NODE_STATE_MAX] = {
    /* PWRFIP_NODE_STATE_INITIAL */
    "initial",
    /* PWRFIP_NODE_STATE_LOADED */
    "loaded",
    /* PWRFIP_NODE_STATE_READY */
    "ready",
    /* PWRFIP_NODE_STATE_RUNNING */
    "running",
};

static const char *pwrfig_ba_state_str[_PWRFIP_BA_STATE_MAX] = {
    /* PWRFIP_BA_STATE_INITIAL */
    "initial",
```

```

    /* PWRFIP_BA_STATE_READY */
    "ready",
    /* PWRFIP_BA_STATE_STARTING */
    "starting",
    /* PWRFIP_BA_STATE_IDLE */
    "idle",
    /* PWRFIP_BA_STATE_RUNNING */
    "running",
};

static const char *pwrfig_node_op_str[_PWRFIP_NODE_OP_MAX] = {
    /* _PWRFIP_NODE_OP_UNKNOWN */
    "unknown",
    /* PWRFIP_NODE_OP_WAIT_RX_RP_FRM */
    "rx rp frame",
    /* PWRFIP_NODE_OP_WAIT_TX_RP_FRM */
    "tx rp frame",
    /* PWRFIP_NODE_OP_WAIT_RX_ID_FRM */
    "rx id frame",
    /* PWRFIP_NODE_OP_WAIT_TX_ID_FRM */
    "tx id frame",
};

static const char *pwrfig_ba_wind_str[_PWRFIP_BA_WIND_TYPE_MAX] = {
    /* _PWRFIP_BA_WIND_TYPE_NONE */
    "none",
    /* PWRFIP_BA_WIND_PER */
    "periodic",
    /* PWRFIP_BA_WIND_APER_VAR */
    "aper. var",
    /* PWRFIP_BA_WIND_APER_MSG */
    "aper. msg",
    /* PWRFIP_BA_WIND_WAIT */
    "wait",
};

int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_node *node;
    struct pwrfig_node_report n_report; /* full report */
    uint16_t m_state; /* medium state */

    /**
     * Node initialization
     */
    /*...*/

    /**

```

```

    * Node startup
    */
    /*...*/

    /* get node report */
    err = pwrfig_node_report_get(node, &n_report);
    if (err) {
        printf("node report getter failed: %s\n", pwrfig_strerror(errno));
        goto end;
    }

    m_state = n_report.medium_status.state;
    printf("** coprocessor report:\n");
    printf("  node_state      : %d (%s)\n", n_report.node_status.state,
        pwrfig_node_state_str[n_report.node_status.state]);
    printf("  node_op         : %d (%s)\n", n_report.node_status.op,
        pwrfig_node_op_str[n_report.node_status.op]);
    printf("  ba_state        : %d (%s)\n", n_report.ba_status.state,
        pwrfig_ba_state_str[n_report.ba_status.state]);
    printf("  ba_window       : %d (%s)\n", n_report.ba_status.window,
        pwrfig_ba_wind_str[n_report.ba_status.window]);
    printf("  medium_state    : 0x%04x\n", m_state);
    printf("    [channel 1]\n");
    printf("      enable      : %s\n",
        (m_state & PWRFIG_MEDIUM_STATE_CH1_VALID) ? "yes" : "no");
    printf("      tx_err      : %s\n",
        (m_state & PWRFIG_MEDIUM_STATE_CH1_TX_ERROR) ? "yes" : "no");
    printf("      watchdog    : %s\n",
        (m_state & PWRFIG_MEDIUM_STATE_CH1_WATCHDOG) ? "yes" : "no");
    printf("    [channel 2]\n");
    printf("      enable      : %s\n",
        (m_state & PWRFIG_MEDIUM_STATE_CH2_VALID) ? "yes" : "no");
    printf("      tx_err      : %s\n",
        (m_state & PWRFIG_MEDIUM_STATE_CH2_TX_ERROR) ? "yes" : "no");
    printf("      watchdog    : %s\n",
        (m_state & PWRFIG_MEDIUM_STATE_CH2_WATCHDOG) ? "yes" : "no");
    printf("  tx_err          :\n");
    printf("    ok            : %d\n", n_report.tx_err.ok);
    printf("    collision      : %d\n", n_report.tx_err.collusion);
    printf("    consistency   : %d\n", n_report.tx_err.consistency);
    printf("    not_fresh     : %d\n", n_report.tx_err.not_fresh);
    printf("  rx_err          :\n");
    printf("    ok            : %d\n", n_report.rx_err.ok);
    printf("    pre_mis       : %d\n", n_report.rx_err.pre_mis);
    printf("    fsd_mis       : %d\n", n_report.rx_err.fsd_mis);
    printf("    fsd_unk       : %d\n", n_report.rx_err.fsd_unk);
    printf("    fed_mis       : %d\n", n_report.rx_err.fed_mis);
    printf("    crc_bad       : %d\n", n_report.rx_err.crc_bad);
    printf("    pdu_bad       : %d\n", n_report.rx_err.pdu_bad);

```



```
printf("    len_bad      : %d\n", n_report.rx_err.len_bad);
printf("    not_fresh    : %d\n", n_report.rx_err.not_fresh);
printf("    not_prompt    : %d\n", n_report.rx_err.not_prompt);

/**
 * Other tasks
 */
/* ... */

end:
/**
 * Node exit
 */
/*...*/
return err;
}
```

4.6.5. node_start

Description

Starts the FIP node.

The user's application data (AE/LE) as well as the desired macrocycles - if the node has a master capability - are loaded into the local coprocessor database. Then, the node connects to the FIP network in passive mode (slave agent).



To switch the node to active mode (master agent), use `pwrfig_ba_start()` function after this call.

Prototype

```
int pwrfig_node_start(struct pwrfig_aele *aele,
                     struct pwrfig_ba_mcycle **mcycle_list, int mcycle_cnt)
```

Parameters

- *IN*
 - **aele:**
Pointer to the application context (AE/LE: FIP variables/messages) to be loaded to the coprocessor (opaque structure).
 - **mcycle_list:**
List of pointers to the macrocycles to be loaded (opaque structures).
 - **mcycle_cnt:**
Number of macrocycles to be loaded in the FIP coprocessor.
- *OUT* - None

Return Value

If successful, `pwrfig_node_start()` returns 0.

If unsuccessful, `pwrfig_node_start()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_AELE_NOT_STOP:**
The application context to be loaded is already active elsewhere.
- **PWRFIP_ERR_INVALID_CTX:**
A macrocycle to be loaded do not belong to the same FIP node as the application context (AE/LE).
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.6.6. node_stop

Description

Disconnects the FIP node from the network.



Use the `pwrfig_node_start()` function to start a new app session.

No need to reinitialize the node with `pwrfig_node_init()`.

Prototype

```
int pwrfig_node_stop(struct pwrfig_node *node)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
- *OUT* - None

Return Value

If successful, `pwrfig_node_stop()` returns 0.

If unsuccessful, `pwrfig_node_stop()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.7. Variables

4.7.1. var_write

Description

Writes a FIP variable to the local coprocessor database.

Prototype

```
int pwrfig_var_write(struct pwrfig_var *var)
```

Parameters

- *IN*
 - **var:**
Pointer to the target variable to write.
See `struct pwrfig_var`.
- *OUT*
 - **var:**
Variable's updated info.
See `struct pwrfig_var` (`.error` field).

Return Value

If successful, `pwrfig_var_write()` returns 0.

If unsuccessful, `pwrfig_var_write()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_INVALID_CTX:**
The AE/LE context attached to the variable object does not match that of the running node.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Remarks

There are two possible error levels for this operation:

1. The error returned by the `pwrfig_var_write()` function is related to a context error inside the library, or a communication error with the coprocessor.
This type of error is quite critical since it indicates a malfunction of the library.
2. The `.error` field returned in the `struct pwrfig_var` (see `enum pwrfig_var_err_code`) relates directly to the FIP frame state written to the network.
It is an indicator of the quality of the frame written (good or bad freshness).

Example

```
static struct pwrfig_var_cfg prod_var_cfg = {
    .type = PWRFIG_VAR_TYPE_PROD,
    .id = 0x3800,
    .prod.payload_bsz = 8,
    .prod.flags = \
        /* enable prod status */
        PWRFIG_VAR_FLAGS_REFRESH,
    .prod.refreshment_ustime = 80000, /* 80ms */
    .prod.evt_type = PWRFIG_EVT_TYPE_NONE,
    .pwrfig_var_handler = NULL,
};

int main(int argc, char *argv[])
{
    int i, err = 0;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;
    struct pwrfig_var *prod_var;
    uint8_t w_byte = 0;

    /**
     * Node initialization
     */
    /*...*/

    /* create an aele context */
    al = pwrfig_aele_create(node);
    if (!al) {
        printf("aele creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /* create a production variable */
    prod_var = pwrfig_var_create(al, &prod_var_cfg);
    if (!prod_var) {
        printf("production variable creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /* node startup (slave) */
    err = pwrfig_node_start(al, NULL, 0);
    if (err) {
        printf("node startup failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }
}
```

```
}

/* writing loop */
for(;;) {
    /* update var payload */
    /* for the example, we increment all the bytes of the
       frame by 1 at each write */
    w_byte++;
    memset(prod_var->buffer, w_byte, prod_var->bsz);

    /* write it to fip network */
    if (pwrfig_var_write(prod_var)) {
        printf("w_var[0x%04x] failed: %s\n", prod_var->id,
            pwrfig_strerror(errno));
        /* we consider this error as fatal error; so we
           * stop the test */
        break;
    }

    /* check var state errors */
    if (prod_var->error) {
        printf("w_var[0x%04x] state error: %d\n",
            prod_var->id, prod_var->error);
    }

    usleep(5000); /* 5ms */
}

end:
/**
 * Node exit
 */
/*...*/
return err;
}
```

4.7.2. var_read

Description

Reads a FIP variable from the local coprocessor database.

Prototype

```
int pwrfig_var_read(struct pwrfig_var *var)
```

Parameters

- *IN*
 - **var:**
Pointer to the target variable to read.
See `struct pwrfig_var`.
- *OUT*
 - **var:**
Variable's updated content.

Return Value

If successful, `pwrfig_var_read()` returns 0.

If unsuccessful, `pwrfig_var_read()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_INVALID_CTX:**
The AE/LE context attached to the variable object does not match that of the running node.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Remarks

There are two possible error levels for this operation:

1. The error returned by the `pwrfig_var_read()` function is related to a context error inside the library, or a communication error with the coprocessor.
This type of error is quite critical since it indicates a malfunction of the library.
2. The `.error` field returned in the `struct pwrfig_var` (see `enum pwrfig_var_err_code`) relates directly to the FIP frame state read from the network.
It is an indicator of the quality of the frame read (good or bad freshness/promptness), but also an indicator to know if the user configuration matches with the real frame read from the FIP network (length, PDU etc).

Example

```
static struct pwrfig_var_cfg cons_var_cfg = {
    .type = PWRFIG_VAR_TYPE_CONS,
    .id = 0x3801,
    .cons.payload_bsz = 8,
    .cons.flags = \
        /* enable prod status */
        PWRFIG_VAR_FLAGS_REFRESH | \
        /* enable promptness checking */
        PWRFIG_VAR_FLAGS_PROMPT | \
        /* enable pdu + len bytes checking */
        PWRFIG_VAR_FLAGS_CHK_PDU_LEN,
    .cons.promptness_ustime = 100000, /* 100ms */
    .cons.evt_type = PWRFIG_EVT_TYPE_NONE,
    .pwrfig_var_handler = NULL,
};

int main(int argc, char *argv[])
{
    int i, err = 0;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;
    struct pwrfig_var *cons_var;

    /**
     * Node initialization
     */
    /**...*/

    /* create an aele context */
    al = pwrfig_aele_create(node);
    if (!al) {
        printf("aele creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /* create a consumption variable */
    cons_var = pwrfig_var_create(al, &cons_var_cfg);
    if (!cons_var) {
        printf("consumption variable creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }

    /* node startup (slave) */
    err = pwrfig_node_start(al, NULL, 0);
    if (err) {
        printf("node startup failed: %s\n", pwrfig_strerror(errno));
    }
}
```



```
        err = -1;
        goto end;
    }

    /* reading loop */
    for(;;) {
        if (pwrfig_var_read(cons_var)) {
            printf("r_var[0x%04x] failed: %s\n", cons_var->id,
                pwrfig_strerror(errno));
            /* we consider this error as fatal error; so we
             * stop the test */
            break;
        }
        /* print var payload */
        printf("r_var[0x%04x]: ", cons_var->id);
        for (i = 0; i < cons_var->bsz; ++i)
            printf("%02x ", cons_var->buffer[i]);
        printf("\n");

        usleep(5000); /* 5ms */
    }

end:
    /**
     * Node exit
     */
    /*...*/
    return err;
}
```

4.7.3. var_evt_set

Description

Dynamically changes - inside the coprocessor database - the event sensitivity for the pointed variable.

Prototype

```
int pwrfig_var_evt_set(struct pwrfig_var *var,  
                      enum pwrfig_evt_type type)
```

Parameters

- *IN*
 - **var:**
Pointer to the variable on which to change the sensitivity to events.
See `struct pwrfig_var`.
 - **type:**
Type of event sensitivity (see `enum pwrfig_evt_type`):
 - `PWRFIG_EVT_TYPE_NONE`:
Never report the transmission/reception of this variable to the user space.
 - `PWRFIG_EVT_TYPE_PERMANENT`:
Always report the transmission/reception of this variable to the user space.
 - `PWRFIG_EVT_TYPE_TEMPORARY`:
Report just once the transmission/reception of this variable to the user space.
- *OUT* - None

Return Value

If successful, `pwrfig_var_evt_set()` returns 0.

If unsuccessful, `pwrfig_var_evt_set()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIG_ERR_INVALID_CTX:**
The AE/LE context attached to the variable object does not match that of the running node.
- **PWRFIG_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to change the variable's event on the fly.
- **PWRFIG_ERR_COM_XXX:**
Communication error with the coprocessor.

4.7.4. varidlist_aper_request

Description

Sends an aperiodic request for a list of variable IDs.

Prototype

```
int pwrfig_varidlist_aper_request(struct pwrfig_node *node,
                                uint16_t *varid_list, int varid_cnt,
                                enum pwrfig_var_aper_channel_type channel,
                                uint8_t *ch_error);
```

Parameters

- *IN*
 - **node:**
Pointer to the node that makes the request.
See `struct pwrfig_node`.
 - **varid_list:**
Pointer to a list of IDs (16-bit) to request.
 - **varid_cnt:**
Number of IDs contained in the list.
 - **channel:**
Channel used to make the request.
See `enum pwrfig_var_aper_channel_type`.
- *OUT*
 - **ch_error:**
Channel error.
See `enum pwrfig_var_err_code`.

Return Value

If successful, `pwrfig_varidlist_aper_request()` returns 0.

If unsuccessful, `pwrfig_varidlist_aper_request()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Remarks

There are two possible error levels for this operation:

1. The error returned by the `pwrfig_varidlist_aper_request()` function is related to a context error inside the library, or a communication error with the coprocessor.
This type of error is quite critical since it indicates a malfunction of the library.
2. The `ch_error` value indicates a potential problem with the FIP channel inside the coprocessor, but doesn't compromise the operation of the library.
For example, if the request queue is full, use `pwrfig_var_aper_channel_purge()` to clear the contents of the saturated channel.

Example

```
static struct pwrfig_var_cfg prod_var_cfg = {
    .type = PWRFIG_VAR_TYPE_PROD,
    .id = 0x3800,
    .prod.payload_bsz = 8,
    .prod.flags = \
        /* enable prod status */
        PWRFIG_VAR_FLAGS_REFRESH | \
        /* enable aper var request */
        PWRFIG_VAR_FLAGS_APER_VAR_REQ,
    .prod.refreshment_ustime = 80000, /* 80ms */
    .prod.evt_type = PWRFIG_EVT_TYPE_NONE,
    .pwrfig_var_handler = NULL,
};

static uint16_t ids[4] = {
    0x1000,
    0x1001,
    0x1100,
    0x1101,
};

int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_node *node;
    struct pwrfig_aele *al;
    uint8_t channel_error = 0;

    /**
     * Node initialization
     */
    /*...*/

    /* create an aele context */
    al = pwrfig_aele_create(node);
    if (!al) {
        printf("aele creation failed: %s\n", pwrfig_strerror(errno));
        err = -1;
        goto end;
    }
}
```

```

}

/* create a production variable which support aperiodic variable requests */
/* note: this variable must be queried cyclically by the master node */
prod_var = pwrfig_var_create(al, &prod_var_cfg);
if (!prod_var) {
    printf("production variable creation failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* node startup (slave) */
err = pwrfig_node_start(al, NULL, 0);
if (err) {
    printf("node startup failed: %s\n", pwrfig_strerror(errno));
    err = -1;
    goto end;
}

/* main loop */
for(;;) {
    /* request for an IDs list each 1 second */

    if (pwrfig_varidlist_aper_request(node, ids, 4,
        PWRFIG_VAR_APER_CH_NORMAL, &channel_error)) {
        printf("var_aper_request failed: %s\n", pwrfig_strerror(errno));
        /* we consider this error as fatal error; so we
         * stop the test */
        break;
    }

    /* check channel error */
    if (channel_error)
        printf("var_aper_request state error: %d\n", channel_error);

    sleep(1); /* 1s */
}

end:
/**
 * Node exit
 */
/*...*/
return err;
}

```

4.7.5. varlist_aper_request

Description

Sends an aperiodic request for a list of FIP variables.



This function is similar to `pwrfig_varidlist_aper_request()` but use `struct pwrfig_var` objects instead of variable IDs (16-bit) in input parameter.

Prototype

```
int pwrfig_varlist_aper_request(struct pwrfig_node *node,
                               struct pwrfig_var **var_list, int var_cnt,
                               enum pwrfig_var_aper_channel_type channel,
                               uint8_t *ch_error);
```

Parameters

- *IN*
 - **node:**
Pointer to the node that makes the request.
See `struct pwrfig_node`.
 - **var_list:**
Pointer to a list of variables to request.
See `struct pwrfig_var`.
 - **var_cnt:**
Number of variables contained in the list.
 - **channel:**
Channel used to make the request.
See `enum pwrfig_var_aper_channel_type`.
- *OUT*
 - **ch_error:**
Channel error.
See `enum pwrfig_var_err_code`.

Return Value

If successful, `pwrfig_varlist_aper_request()` returns 0.

If unsuccessful, `pwrfig_varlist_aper_request()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**

Communication error with the coprocessor.

4.7.6. var_aper_channel_purge

Description

Purges the target aperiodic variable channel.

Prototype

```
int pwrfig_var_aper_channel_purge(struct pwrfig_node *node,  
    enum pwrfig_var_aper_channel_type channel,  
    uint16_t *purge_cnt, uint8_t *ch_error);
```

Parameters

- *IN*
 - **node:**
Pointer to the target node.
See `struct pwrfig_node`.
 - **channel:**
Channel to purge.
See `enum pwrfig_var_aper_channel_type`.
- *OUT*
 - **purge_cnt:**
Number of variable IDs purged.
 - **ch_error:**
Channel error.
See `enum pwrfig_var_err_code`.

Return Value

If successful, `pwrfig_var_aper_channel_purge()` returns 0.

If unsuccessful, `pwrfig_var_aper_channel_purge()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is not running. It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.8. System Management Variables

4.8.1. sm_ba_sync_get

Description

Gets the BA synchronization information from the network (ID[0x9003]).

Prototype

```
int pwrfig_sm_ba_sync_get(struct pwrfig_node *node,  
                          struct pwrfig_sm_ba_sync *ba_sync)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
- *OUT*
 - **ba_sync:**
BA synchronization structure to retrieve.
See `struct pwrfig_sm_ba_sync`.

Return Value

If successful, `pwrfig_sm_ba_sync_get()` returns 0.

If unsuccessful, `pwrfig_sm_ba_sync_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is currently stopped.
It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.8.2. sm_identification_get

Description

Gets the identification information from a remote FIP node (ID[0x10XY] where XY is the remote address).

Prototype

```
int pwrfig_sm_identification_get(struct pwrfig_node *node,
                                uint8_t node_addr, struct pwrfig_sm_identification *ident)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node (local node).
See `struct pwrfig_node`.
 - **node_addr:**
Remote node address to request.
- *OUT*
 - **ident:**
Identification structure to retrieve from the remote node.
See `struct pwrfig_sm_identification`.

Return Value

If successful, `pwrfig_sm_identification_get()` returns 0.

If unsuccessful, `pwrfig_sm_identification_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is currently stopped.
It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_AELE_VAR_NOT_FOUND:**
Unknown variable ID for this FIP node.
Use `pwrfig_sm_var_create()` with the correct remote node address before using this function.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.8.3. sm_presence_get

Description

Gets the presence information from a remote FIP node (ID[0x14XY] where XY is the remote address).

Prototype

```
int pwrfig_sm_presence_get(struct pwrfig_node *node,
                          uint8_t node_addr, struct pwrfig_sm_presence *pres)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node (local node).
See `struct pwrfig_node`.
 - **node_addr:**
Remote node address to request.
- *OUT*
 - **pres:**
Presence structure to retrieve from the remote node.
See `struct pwrfig_sm_presence`.

Return Value

If successful, `pwrfig_sm_presence_get()` returns 0.

If unsuccessful, `pwrfig_sm_presence_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is currently stopped.
It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_AELE_VAR_NOT_FOUND:**
Unknown variable ID for this FIP node.
Use `pwrfig_sm_var_create()` with the correct remote node address before using this function.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.8.4. sm_presence_list_get

Description

Gets the presence list information from the network (ID[0x9002]).

Prototype

```
int pwrfig_sm_presence_list_get(struct pwrfig_node *node,  
                               struct pwrfig_sm_presence_list *pres_list)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
- *OUT*
 - **pres_list:**
Presence list structure to retrieve.
See `struct pwrfig_sm_presence_list`.

Return Value

If successful, `pwrfig_sm_presence_list_get()` returns 0.

If unsuccessful, `pwrfig_sm_presence_list_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is currently stopped.
It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.8.5. sm_report_get

Description

Gets the report information from a remote FIP node (ID[0x11XY] where XY is the remote address).

Prototype

```
int pwrfig_sm_report_get(struct pwrfig_node *node,
                        uint8_t node_addr, struct pwrfig_sm_report *report)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node (local node).
See `struct pwrfig_node`.
 - **node_addr:**
Remote node address to request.
- *OUT*
 - **report:**
Report structure to retrieve from the remote node.
See `struct pwrfig_sm_report`.

Return Value

If successful, `pwrfig_sm_report_get()` returns 0.

If unsuccessful, `pwrfig_sm_report_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_AELE_NOT_RUN:**
FIP node is currently stopped.
It is therefore impossible to query the coprocessor database.
- **PWRFIP_ERR_AELE_VAR_NOT_FOUND:**
Unknown variable ID for this FIP node.
Use `pwrfig_sm_var_create()` with the correct remote node address before using this function.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.9. Medium

4.9.1. medium_status_get

Description

Get the status of the FIP channels.

Prototype

```
int pwrfig_medium_status_get(struct pwrfig_node *node,
                             struct pwrfig_medium_status *status)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
- *OUT*
 - **status:**
Pointer to an output `struct pwrfig_medium_status`.

Return Value

If successful, `pwrfig_medium_status_get()` returns 0.

If unsuccessful, `pwrfig_medium_status_get()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input/output parameters.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Example

```
int main(int argc, char *argv[])
{
    int err = 0;
    struct pwrfig_node *node;
    struct pwrfig_medium_status m_status;
    uint16_t m_state;

    /**
     * Node initialization
     */
    /*...*/
```

```
/**
 * Node startup
 */
/*...*/

/* get medium state */
err = pwrfig_medium_status_get(node, &m_status);
if (err) {
    printf("medium status getter failed: %s\n", pwrfig_strerror(errno));
    goto end;
}

m_state = m_status.state;
printf("medium_state : 0x%04x\n", m_state);
printf(" [channel 1]\n");
printf("    enable    : %s\n",
       (m_state & PWRFIG_MEDIUM_STATE_CH1_VALID) ? "yes": "no");
printf("    tx_err     : %s\n",
       (m_state & PWRFIG_MEDIUM_STATE_CH1_TX_ERROR) ? "yes": "no");
printf("    watchdog   : %s\n",
       (m_state & PWRFIG_MEDIUM_STATE_CH1_WATCHDOG) ? "yes": "no");
printf(" [channel 2]\n");
printf("    enable    : %s\n",
       (m_state & PWRFIG_MEDIUM_STATE_CH2_VALID) ? "yes": "no");
printf("    tx_err     : %s\n",
       (m_state & PWRFIG_MEDIUM_STATE_CH2_TX_ERROR) ? "yes": "no");
printf("    watchdog   : %s\n",
       (m_state & PWRFIG_MEDIUM_STATE_CH2_WATCHDOG) ? "yes": "no");

/**
 * Other tasks
 */
/* ... */

end:
/**
 * Node exit
 */
/*...*/
return err;
}
```

4.9.2. medium_cmd_set

Description

Sends a command to the coprocessor to control the FIP channels.

The following operations are allowed for each channel:

- Enable/Disable
- Reset
- Clear error

Prototype

```
int pwrfig_medium_cmd_set(struct pwrfig_node *node, uint16_t flags)
```

Parameters

- *IN*
 - **node:**
Pointer to the target FIP node.
See `struct pwrfig_node`.
 - **flags:**
Command to send to the FIP channels manager.



The available commands are described by the `enum pwrfig_medium_cmd_flag`.

- *OUT* - None

Return Value

If successful, `pwrfig_medium_cmd_set()` returns 0.

If unsuccessful, `pwrfig_medium_cmd_set()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameters.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

4.10. Events

4.10.1. evt_process

Description

Reads and processes all FIP asynchronous events notified by the coprocessor.

Prototype

```
int pwrfig_evt_process(struct pwrfig_node *node)
```

Parameters

- *IN*
 - **node:**
Pointer to the node to treat.
See `struct pwrfig_node`.
- *OUT* - None

Return Value

If successful, `pwrfig_evt_process()` returns 0.

If unsuccessful, `pwrfig_evt_process()` returns -1 and sets `errno` to one of the following values:

- **EINVAL:**
Invalid input parameter.
- **PWRFIP_ERR_COM_XXX:**
Communication error with the coprocessor.

Remarks

Case of PCI/PCIe devices

If a PCI/PCIe PowerFIP device is bound to the node (see `struct pwrfig_node_cfg`, `.dev` field), this function will be called automatically by an internal interrupt handler inside the library.



In order to correctly raise the interrupt, the user must configure at least one synchronous event during the FIP periodic cycle:

- set-up a synchronization variable.
(see `enum pwrfig_var_type` [PWRFIP_VAR_TYPE_SYNC])
- set-up a prod/cons variable with a permanent event on request detection.
(see `enum pwrfig_evt_type` [PWRFIP_EVT_TYPE_PERMANENT_ID]).



User handlers called inside this function

- `pwrfig_var_handler`

- pwrfig_msg_rcv_handler
- pwrfig_msg_send_handler
- pwrfig_urg_req_handler
- pwrfig_nor_req_handler
- pwrfig_ba_state_handler
- pwrfig_ba_sync_handler

Chapter 5. Structures

5.1. General

5.1.1. date

Description

Date structure.

Definition

```
struct pwrfig_date {  
    union {  
        uint32_t raw;  
        struct {  
            uint8_t day;  
            uint8_t month;  
            uint8_t year;  
            uint8_t reserved;  
        } info;  
    };  
};
```

Members

| Name | Type | Description |
|-------|---------|--------------------|
| day | uint8_t | Day of the date. |
| month | uint8_t | Month of the date. |
| year | uint8_t | Year of the date. |

5.1.2. version

Description

Version structure.

Definition

```
struct pwrfig_version {  
    union {  
        uint32_t raw;  
        struct {  
            uint8_t patch;  
            uint8_t minor;  
            uint8_t major;  
            uint8_t reserved;  
        } info;  
    };  
    /* build date */  
    struct pwrfig_date date;  
};
```

Members

| Name | Type | Description |
|-------|--------------------|--|
| patch | uint8_t | Patch version Marks bug fixes |
| minor | uint8_t | Minor version New features without break of compatibility |
| major | uint8_t | Major version Break of compatibility (ex: API changes) |
| date | struct pwrfig_date | Build date See struct pwrfig_date |

5.2. Device

5.2.1. dev_infos

Description

System information about the PowerFIP board.

Definition

```
struct pwrfip_dev_infos {  
    uint32_t    index;  
    uint64_t    fsn;  
    /* device general info */  
    uint16_t    vid;  
    uint16_t    did;  
    uint16_t    ssvid;  
    uint16_t    ssdid;  
    /* physical BAR addresses */  
    int         bar_cnt;  
    uint64_t    bar_bsz[BAR_MAX];  
    uint64_t    bar_base[BAR_MAX];  
    /* irq infos */  
    int         irq_number;  
    /* driver infos */  
    uint32_t    drv_version;  
    uint32_t    drv_date;  
};
```

Members

| Name | Type | Description |
|------------|-------------------|---|
| index | uint32_t | Device index |
| fsn | uint64_t | Factory Serial Number |
| vid | uint16_t | Vendor ID |
| did | uint16_t | Device ID |
| ssvid | uint16_t | Subsystem Vendor ID |
| ssdid | uint16_t | Subsystem Device ID |
| bar_cnt | int | Number of BAR (Base Address Register) for this device |
| bar_bsz | uint64_t[BAR_MAX] | Size of the BAR areas |
| bar_base | uint64_t[BAR_MAX] | Memory base start address for each area. |
| irq_number | int | IRQ number |

| Name | Type | Description |
|-------------|----------|-------------------|
| drv_version | uint32_t | Driver version |
| drv_date | uint32_t | Driver built date |

5.2.2. dev_report

Description

Global report of the PowerFIP board.

Definition

```
struct pwrfip_dev_report {  
    float temperature;  
};
```

Members

| Name | Type | Description |
|-------------|-------|-------------------------|
| temperature | float | Temperature sensor (°C) |

5.3. Configuration

5.3.1. ba_request

Description

Structure used to set-up an ID_DAT/ID_MSG request during a macrocycle periodic window.

Definition

```
struct pwrfip_ba_request {  
    enum pwrfip_ba_id_type type;  
    uint16_t id;  
};
```

Members

| Name | Type | Description |
|-------------|-------------------------------------|---|
| type | <code>enum pwrfip_ba_id_type</code> | Frame control code for the request See <code>enum pwrfip_ba_id_type</code> |
| id | <code>uint16_t</code> | FIP identifier to request |

5.3.2. ba_aper_msg_wind_cfg

Description

Structure used to set-up a macrocycle aperiodic message window.

Definition

```
struct pwrfig_ba_aper_msg_wind_cfg {  
    uint32_t end_ustime;  
};
```

Members

| Name | Type | Description |
|-------------------|-----------------------|--|
| end_ustime | <code>uint32_t</code> | End of aperiodic message window in microseconds (relative to macrocycle start) |

5.3.3. ba_aper_var_wind_cfg

Description

Structure used to set-up a macrocycle aperiodic variable window.

Definition

```
struct pwrfip_ba_aper_var_wind_cfg {  
    uint32_t end_ustime;  
    int enable_testp;  
};
```

Members

| Name | Type | Description |
|---------------------|----------|--|
| end_ustime | uint32_t | End of aperiodic variable window in microseconds (relative to macrocycle start) |
| enable_testp | int | Enable the presence test if the bus arbiter doesn't have other tasks to perform during this window |

5.3.4. ba_per_wind_cfg

Description

Structure used to set-up a macrocycle periodic window.

Definition

```
struct pwrfig_ba_per_wind_cfg {  
    int req_cnt;  
    struct pwrfig_ba_request *req_list;  
};
```

Members

| Name | Type | Description |
|-----------------|----------------------------|---|
| req_cnt | int | Number of periodic request |
| req_list | struct pwrfig_ba_request * | List of periodic requests See struct pwrfig_ba_request |

5.3.5. ba_wait_wind_cfg


Description

Structure used to set-up a macrocycle wait window.

Definition

```
struct pwrfip_ba_wait_wind_cfg {  
    uint32_t end_ustime;  
    int is_silent;  
    int is_ext_resync;  
};
```

Members

| Name | Type | Description |
|---------------|----------|--|
| end_ustime | uint32_t | End of waiting window in microseconds (relative to the macrocycle start time) |
| is_silent | int | Waiting type <ul style="list-style-type: none">• 0: Padding frame emission• 1: No frame during waiting <div><p>In a context where several bus arbiters are waiting on the FIP network, it is not recommended to use the <i>silent</i> mode to avoid conflicts between potential masters</p></div> |
| is_ext_resync | int | Resynchronization type <ul style="list-style-type: none">• 0: internal The coprocessor itself initiates the looping of the macrocycle. To do this, it uses its own internal timer• 1: external The coprocessor listens to an external trigger before looping the macrocycle |

5.3.6. ba_wind_cfg

Description

Structure used to set-up a macrocycle window for a master FIP node.

Definition

```
struct pwrfig_ba_wind_cfg {  
    enum pwrfig_ba_wind_type type;  
    union {  
        struct pwrfig_ba_per_wind_cfg per;  
        struct pwrfig_ba_aper_var_wind_cfg aper_var;  
        struct pwrfig_ba_aper_msg_wind_cfg aper_msg;  
        struct pwrfig_ba_wait_wind_cfg wait;  
    };  
};
```

Members

| Name | Type | Description |
|--|---|--|
| type | enum pwrfig_ba_wind_type | Macrocycle window type See enum pwrfig_ba_wind_type |
| <ul style="list-style-type: none">• per• aper_var• aper_msg• wait | union { struct pwrfig_ba_per_wind_cfg per; struct pwrfig_ba_aper_var_wind_cfg aper_var; struct pwrfig_ba_aper_msg_wind_cfg aper_msg; struct pwrfig_ba_wait_wind_cfg wait; }; | Specialized configuration structure according to the .type field of the macrocycle window See: struct pwrfig_ba_per_wind_cfg struct pwrfig_ba_aper_var_wind_cfg struct pwrfig_ba_aper_msg_wind_cfg struct pwrfig_ba_wait_wind_cfg |

5.3.7. ba_mcycle_cfg

Description

Structure used to set-up a macrocycle for a master FIP node.

Definition

```
struct pwrfig_ba_mcycle_cfg {  
    int wind_cnt;  
    struct pwrfig_ba_wind_cfg *wind_list;  
};
```

Members

| Name | Type | Description |
|----------|-----------------------------|--|
| wind_cnt | int | Number of macrocycle window configurations |
| req_list | struct pwrfig_ba_wind_cfg * | List of window configurations See struct pwrfig_ba_wind_cfg |

5.3.8. ba_startup_cfg



Description

This structure is used to set start-up and election times of a master node (Bus Arbiter).

Definition

```
struct pwrfig_ba_startup_cfg {  
    enum pwrfig_ba_startup_mode mode;  
    uint32_t silence_ustime;  
    uint8_t max_phy_addr;  
    uint8_t max_prio;  
    uint8_t my_phy_addr;  
    uint8_t my_prio;  
};
```

Members

| Name | Type | Description |
|-----------------------|--|---|
| mode | <code>enum pwrfig_ba_startup_mode</code> | Calculation method for bus arbiter startup and election times. See <code>enum pwrfig_ba_startup_mode</code> |
| silence_ustime | <code>uint32_t</code> | Silence time in microseconds. |
| max_phy_addr | <code>uint8_t</code> | Last FIP agent address with master capability on network. |
| max_prio | <code>uint8_t</code> | Highest BA priority on the network. Should be in [0..15] range. <div> 0 is the highest priority.</div> |
| my_phy_addr | <code>uint8_t</code> | Physical address of this BA. |
| my_prio | <code>uint8_t</code> | Priority of this BA. Should be in [0..15] range. <div> 0 is the highest priority.</div> |

5.3.9. msg_rx_cfg

Description

Specific set-up structure for an incoming FIP message.

Definition

```
struct pwrfig_msg_rx_cfg {  
    uint16_t reserved;  
};
```

Members

| Name | Type | Description |
|-----------------|-----------------------|-----------------------|
| reserved | <code>uint16_t</code> | Not significant field |

5.3.10. msg_tx_cfg

Description

Specific set-up structure for an outgoing FIP message.

Definition

```
struct pwrfig_msg_tx_cfg {  
    uint8_t channel;  
    uint8_t ack_mode;  
};
```

Members

| Name | Type | Description |
|-----------------|---------|--|
| channel | uint8_t | Message TX channel number. See enum pwrfig_msg_tx_channel |
| ack_mode | uint8_t | Message acknowledgement mode. See enum pwrfig_msg_tx_ack_mode |

5.3.11. msg_cfg

Description



Generic set-up structure of a FIP message for a FIP node.

Definition

```
struct pwrfig_msg_cfg {
    enum pwrfig_msg_type type;
    struct pwrfig_msg_hdr hdr;
    union {
        struct pwrfig_msg_tx_cfg tx;
        struct pwrfig_msg_rx_cfg rx;
    };
    void *user_ctx;
    void (* pwrfig_msg_handler)(struct pwrfig_node *node,
        struct pwrfig_msg *msg, struct pwrfig_event *evt);
};
```

Members

| Name | Type | Description |
|-----------------|--|--|
| type | enum pwrfig_msg_type | Message type (Transmission, Reception). See enum pwrfig_msg_type. |
| hdr | struct pwrfig_msg_hdr | Message header. See struct pwrfig_msg_hdr. |
| tx/rx | union { struct pwrfig_msg_tx_cfg tx; struct pwrfig_msg_rx_cfg rx; } | Specialized configuration structure according to the .type field of the message. See: struct pwrfig_msg_tx_cfg struct pwrfig_msg_rx_cfg |
| user_ctx | void * | User-specified context associated with this message. <i>[Optional]</i> |

| Name | Type | Description |
|---------------------------|--|---|
| pwrfig_msg_handler | <pre>void (* handler) (struct pwrfig_node *node, struct pwrfig_msg *msg, struct pwrfig_event *evt)</pre> | <p>Local handler definition for a message.</p> <div><p>If <code>pwrfig_msg_handler=NULL</code>, the general handlers <code>pwrfig_msg_send_handler</code> or <code>pwrfig_msg_rcv_handler</code> located in the <code>node_cfg</code> structure, will take over in case of an event.</p></div> <div><p>If neither - local or general - handler is set, the user will not be notified of the message events.</p></div> <p>See: <code>struct pwrfig_node</code> <code>struct pwrfig_msg</code> <code>struct pwrfig_event</code></p> |

5.3.12. node_ba_cfg


Description


Bus Arbiter configuration structure for a FIP node.


Definition

```
struct pwrfip_node_ba_cfg {  
    int enable;  
    /**  
     * => BA: StartUp/Election settings  
     */  
    uint32_t priority;  
    uint32_t start_ustime;  
    uint32_t election_ustime;  
    /**  
     * => BA: Aperiodic requests FIFOs settings  
     */  
    uint32_t msg_req_fifo_size;  
    uint32_t urgent_var_req_fifo_size;  
    uint32_t normal_var_req_fifo_size;  
};
```

Members

| Name | Type | Description |
|----------|----------|---|
| enable | int | Enable/Disable bus arbiter (master) capability. If disabled, all other structure members are non significant. |
| priority | uint32_t | Bus arbiter priority. Should be in [0..15] range. <div> 0 is the highest priority.</div> |

| Name | Type | Description |
|--------------|----------|--|
| start_ustime | uint32_t | <p>Bus arbiter start-up time in microseconds.</p> <p> When the user calls the <code>pwrfig_ba_start()</code> function, the node initiates its bus arbiter start procedure with settings of the start-up timeout. Before the end of the start-up countdown, if an activity is detected on the network, the bus arbiter enter in <i>idle</i> mode and considers itself as potentially eligible. At the start-up timeout, having detected no activity on the network, the bus arbiter sends three padding identifiers on the line to check its ability to transmit. If faults are detected, the BA reports the anomaly to the user (event code: PWRFIG_EVT_BA_STOP_ERR) and switches to <i>stopped</i> status. Otherwise it enters <i>idle</i> status, and starts its election countdown.</p> |

| Name | Type | Description |
|--------------------------|----------|--|
| election_ustime | uint32_t | <p>Bus arbiter election time in microseconds.</p> <div>  <p>Several bus arbiters can be started on the FIP network, but only one is <i>active</i> at a time (the others are in <i>idle</i> mode). This time is set differently for each potential bus arbiter. When the active bus arbiter fails (no traffic on the line), the other arbiters start their <i>election</i> countdown. The first one to arrive at the end of the countdown becomes <i>active</i> (master) and the other nodes are put to <i>idle</i> mode.</p> </div> |
| msg_req_fifo_size | uint32_t | <p>Bus arbiter queue size for aperiodic message requests.</p> <p>Should be in [1..128] range. If value is 0, it will be automatically set to default value (60).</p> |
| urgent_var_req_fifo_size | uint32_t | <p>Bus arbiter queue size for aperiodic variable requests (urgent priority).</p> <p>Should be in [1..128] range. If value is 0, it will be automatically set to default value (60).</p> |
| normal_var_req_fifo_size | uint32_t | <p>Bus arbiter queue size for aperiodic variable requests (normal priority).</p> <p>Should be in [1..128] range. If value is 0, it will be automatically set to default value (60).</p> |

5.3.13. node_cfg

Description

Node configuration structure.

Definition

```
struct pwrfig_node_cfg {  
    /**  
     * General FIP settings  
     */  
    uint8_t fip_phy_addr;  
    uint8_t fip_seg_num;  
    uint8_t fip_frm_type;  
    uint8_t fip_bitrate;  
    uint32_t turn_around_ustime;  
    uint32_t silence_ustime;  
    /**  
     * Extra FIP settings  
     */  
    int enable_bimedium;  
    struct pwrfig_node_msg_cfg msg;  
    struct pwrfig_node_ba_cfg ba;  
    struct pwrfig_node_ident_cfg ident;  
    struct pwrfig_node_prctl_cfg prctl_ext;  
    /**  
     * Hardware access  
     */  
    struct pwrfig_dev *dev;  
    unsigned long dpm_base_addr;  
    /**  
     * General Handlers  
     */  
    void *user_ctx;  
    void (* pwrfig_var_handler)(  
        struct pwrfig_node *node,  
        struct pwrfig_var *var,  
        struct pwrfig_event *evt);  
    void (* pwrfig_msg_rcv_handler)(  
        struct pwrfig_node *node,  
        struct pwrfig_msg *msg,  
        struct pwrfig_event *evt);  
    void (* pwrfig_msg_send_handler)(  
        struct pwrfig_node *node,  
        struct pwrfig_msg *msg,  
        struct pwrfig_event *evt);  
    void (* pwrfig_urg_req_handler)(  
        struct pwrfig_node *node,
```

```
    struct pwrfig_event *evt);  
void (* pwrfig_nor_req_handler)(  
    struct pwrfig_node *node,  
    struct pwrfig_event *evt);  
void (* pwrfig_ba_state_handler)(  
    struct pwrfig_node *node,  
    struct pwrfig_event *evt);  
void (* pwrfig_ba_sync_handler)(  
    struct pwrfig_node *node,  
    struct pwrfig_var *var,  
    struct pwrfig_event *evt);  
void (* pwrfig_error_handler)(  
    struct pwrfig_node *node,  
    enum pwrfig_error_code error);  
void (* pwrfig_reset_handler)(  
    struct pwrfig_node *node);  
};
```


Members

| Name | Type | Description |
|---------------------|---------|--|
| fip_phy_addr | uint8_t | Physical address of the agent (node address) |
| fip_seg_num | uint8_t | FIP segment number to which the agent belongs |
| fip_frm_type | uint8_t | FIP frame type See enum pwrfig_frame_type |
| fip_bitrate | uint8_t | FIP bitrate See enum pwrfig_bitrate |

| Name | Type | Description |
|--------------------|----------|---|
| turn_around_ustime | uint32_t | <div><div>Turn-Around time in microseconds (0=default time)</div><div><div><div><div><div><div></div><div>i</div></div></div><div></div></div></div><div><div><div><div><div></div><div>Time range according to bitrate</div></div><div><div><div>• 31.25Kbps<ul style="list-style-type: none">min=320usmax=8232usdefault=424us</div><div><div>• 1Mbps<ul style="list-style-type: none">min=20usmax=258usdefault=30us</div><div><div>• 2.5Mbps<ul style="list-style-type: none">min=20usmax=103usdefault=30us</div><div><div>• 5Mbps<ul style="list-style-type: none">min=20usmax=103usdefault=32us</div><div><div>• 12.5Mbps<ul style="list-style-type: none">min=20usmax=103usdefault=32us</div><div><div>• 25Mbps<ul style="list-style-type: none">min=20usmax=103usdefault=32us</div></div></div></div></div></div></div></div></div></div></div></div></div> |

| Name | Type | Description |
|------------------------|---|--|
| silence_ustime | <code>uint32_t</code> | <p>Silence time in microseconds (0=default time)</p> <div>  <div> <p>Time range according to bitrate</p> <ul style="list-style-type: none"> • 31.25Kbps <ul style="list-style-type: none"> ◦ min=2880us ◦ max=65535us ◦ default=4096us • 1Mbps <ul style="list-style-type: none"> ◦ min=70us ◦ max=65535us ◦ default=150us • 2.5Mbps <ul style="list-style-type: none"> ◦ min=36us ◦ max=65535us ◦ default=96us • 5Mbps <ul style="list-style-type: none"> ◦ min=36us ◦ max=65535us ◦ default=92us • 12.5Mbps <ul style="list-style-type: none"> ◦ min=36us ◦ max=65535us ◦ default=92us • 25Mbps <ul style="list-style-type: none"> ◦ min=36us ◦ max=65535us ◦ default=92us </div> </div> |
| enable_bimedium | <code>int</code> | Enable/Disable Medium redundancy (eq. <i>fieldual</i>) |
| msg | <code>struct pwrfip_node_msg_cfg</code> | <p>Messaging capability. <i>[Optional]</i> See <code>struct pwrfip_node_msg_cfg</code></p> |

| Name | Type | Description |
|--------------------------------|--|--|
| ba | <code>struct pwrfig_node_ba_cfg</code> | Master (Bus Arbiter) capability. <i>[Optional]</i> See <code>struct pwrfig_node_ba_cfg</code> |
| ident | <code>struct pwrfig_node_ident_cfg</code> | Node identification. The SM-MPS identification variable (0x10XY where XY is the node address) will be automatically created from this structure. <i>[Mandatory]</i> See <code>struct pwrfig_node_ident_cfg</code> |
| prtcl_ext | <code>struct pwrfig_node_prtcl_cfg</code> | Protocol extension capability. <i>[Optional]</i> See <code>struct pwrfig_node_prtcl_cfg</code> |
| dev | <code>struct pwrfig_dev *</code> | PCI/PCIe device to bind with node. Opaque structure created by the <code>pwrfig_device_open()</code> function. |
| dpm_base_addr | <code>unsigned long</code> | Dual-port memory area start address |
| user_ctx | <code>void *</code> | User context pointer <i>[Optional]</i> |
| pwrfig_var_handler | <code>void (* handler) (struct pwrfig_node *node, struct pwrfig_var *var, struct pwrfig_event *evt)</code> | General variable handler (Node Level) <i>[Optional]</i> See: <code>struct pwrfig_node</code> <code>struct pwrfig_var</code> <code>struct pwrfig_event</code> |
| pwrfig_msg_rcv_handler | <code>void (* handler) (struct pwrfig_node *node, struct pwrfig_msg *msg, struct pwrfig_event *evt)</code> | General message reception handler <i>[Optional]</i> See: <code>struct pwrfig_node</code> <code>struct pwrfig_msg</code> <code>struct pwrfig_event</code> |
| pwrfig_msg_send_handler | <code>void (* handler) (struct pwrfig_node *node, struct pwrfig_msg *msg, struct pwrfig_event *evt)</code> | General message emission handler <i>[Optional]</i> See: <code>struct pwrfig_node</code> <code>struct pwrfig_msg</code> <code>struct pwrfig_event</code> |

| Name | Type | Description |
|--------------------------------|--|---|
| pwrfip_urg_req_handler | <code>void (* handler) (struct pwrfip_node *node, struct pwrfip_event *evt)</code> | Urgent aperiodic variable transmission request handler <i>[Optional]</i> See: <code>struct pwrfip_node</code> <code>struct pwrfip_event</code> |
| pwrfip_nor_req_handler | <code>void (* handler) (struct pwrfip_node *node, struct pwrfip_event *evt)</code> | Normal aperiodic variable transmission request handler <i>[Optional]</i> See: <code>struct pwrfip_node</code> <code>struct pwrfip_event</code> |
| pwrfip_ba_state_handler | <code>void (* handler) (struct pwrfip_node *node, struct pwrfip_event *evt)</code> | Bus arbiter state event handler <i>[Optional]</i> See: <code>struct pwrfip_node</code> <code>struct pwrfip_event</code> |
| pwrfip_ba_sync_handler | <code>void (* handler) (struct pwrfip_node *node, struct pwrfip_var *var, struct pwrfip_event *evt)</code> | Dedicated handler for the SM-MPS BA synchronization variable (0x9003). <i>[Optional]</i> <div> It is usual to use this identifier as pure event to synchronize tasks between FIP nodes. By convention, the ID_DAT(0x9003) ends the macrocycle of the bus arbiter.</div> See: <code>struct pwrfip_node</code> <code>struct pwrfip_var</code> <code>struct pwrfip_event</code> |
| pwrfip_error_handler | <code>void (* handler) (struct pwrfip_node *node, enum pwrfip_error_code error)</code> | Internal library error handler [Mandatory] See: <code>struct pwrfip_node</code> <code>enum pwrfip_error_code</code> |
| pwrfip_reset_handler | <code>void (* handler) (struct pwrfip_node *node)</code> | Reset chip procedure handler [Mandatory] See <code>struct pwrfip_node</code> |

Remarks

**Hardware access**

Two methods are provided to bind the FIP component with the library:

1. Use the `.dpm_base_addr` field to manually configure the PowerFIP chip DPM (Dual-Port Memory) address access.
2. Use the `.dev` field to attach a PCI/PCIe device.

Note: In this case no need to configure `.dpm_base_addr` field.

5.3.14. node_ident_cfg

Description

Identification configuration structure.

This structure allows to create the SM-MPS identification variable in production for the local FIP node.

(0x10XY where XY is node address).

Definition

```
struct pwr_fip_node_ident_cfg {  
    char *manufacturer_name;  
    char *model_name;  
    uint8_t revision;  
    char *tag_name;  
    char *vendor_field;  
};
```

Members

| Name | Type | Description |
|-------------------|---------|--|
| manufacturer_name | char* | Vendor (or manufacturer) name in ASCII. |
| model_name | char* | Model name in ASCII. |
| revision | uint8_t | Revision number (ex: 0x23 [v2.3]). |
| tag_name | char* | Tag name. [Optional] |
| vendor_field | char* | Additional information. Free for the vendor. [Optional] |

5.3.15. node_msg_cfg

Description

Messaging configuration structure for a FIP node.

Definition

```
#define PWRFIP_MSG_TX_CH_PER_CNT 8

struct pwrfig_node_msg_cfg {
    int enable;
    /**
     * => Reception settings
     */
    uint32_t rx_fifo_size;
    uint8_t rx_segment_tab[256];
    /**
     * => Emission settings
     */
    uint32_t tx_aper_fifo_size;
    uint32_t tx_per_fifo_size[PWRFIP_MSG_TX_CH_PER_CNT];
    uint16_t tx_per_fifo_id[PWRFIP_MSG_TX_CH_PER_CNT];
    uint8_t tx_max_repeat;
};
```

Members

| Name | Type | Description |
|---------------------|----------|---|
| enable | int | Enable/Disable FIP messaging. If disabled, all other structure members are non significant. |
| rx_fifo_size | uint32_t | Consumption queues sizes for FIP messages min=1, max=64, default=30 (0: default value) |
| rx_segment_tab[256] | uint8_t | Sensitivity of the node for the message reception according to the segment destination. See enum pwrfig_msg_rx_seg_cap |
| tx_aper_fifo_size | uint32_t | Transmission queues sizes for FIP aperiodic messages. min=1, max=64; default=24 (0: default value) |

| Name | Type | Description |
|---------------------|----------|---|
| tx_per_fifo_size[8] | uint32_t | Transmission queues sizes for FIP periodic messages (8 channels). min=1, max=64; default=24 (0: default value) |
| tx_per_fifo_id[8] | uint16_t | FIP identifier attached to the periodic message transmission queue (8 channels). 0: no ID attached, else: ID to query via ID_MSG frame |
| tx_max_repeat | uint8_t | Number of retries to send a message if no acknowledgement received. |

5.3.16. node_prctl_cfg

Description

Protocol extension configuration structure.




Do not use this structure configuration if you want to keep the strict definition of the FIP/WorldFIP protocol (IEC 61158)

Definition

```
struct pwr_fip_node_prctl_cfg {  
    int enable;  
    int enable_var_long_form;  
};
```

Members

| Name | Type | Description |
|----------------------|------|---|
| enable | int | Enable/Disable protocol extension capability. If disabled, all other structure members are non significant. |
| enable_var_long_form | int | Extend FIP/WorldFIP variable length: <ul style="list-style-type: none">• up to 505 bytes on copper medium<ul style="list-style-type: none">◦ PDU(1B) + LEN(3B) + DATA(up to 501B)• up to 1024 bytes on optical medium<ul style="list-style-type: none">◦ PDU(1B) + LEN(3B) + DATA(up to 1020B) <div> This parameter changes the length encoding byte for RP_DAT frames ('long form' instead of 'short form') (ISO/IEC 8825-1 ASN.1 - BER)</div> |

5.3.17. var_cons_cfg

Description

Specific set-up structure for a consumption FIP variable.

Definition

```
struct pwrfig_var_cons_cfg {  
    uint16_t payload_bsz;  
    uint16_t flags;  
    uint32_t promptness_ustime;  
    uint32_t evt_type;  
};
```

Members

| Name | Type | Description |
|--------------------------|----------|---|
| payload_bsz | uint16_t | User data payload in bytes |
| flags | uint16_t | Set-up flags for consumption. See enum pwrfig_var_flags |
| promptness_ustime | uint32_t | Promptness period in microseconds |
| evt_type | uint32_t | Set-up flags for event (Enable/Disable + Lifetime). See enum pwrfig_evt_type |

5.3.18. var_prod_cfg

Description

Specific set-up structure for a production FIP variable.

Definition

```
struct pwrfig_var_prod_cfg {  
    uint16_t payload_bsz;  
    uint16_t flags;  
    uint32_t refreshment_ustime;  
    uint32_t evt_type;  
};
```

Members

| Name | Type | Description |
|---------------------------|----------|--|
| payload_bsz | uint16_t | User data payload in bytes |
| flags | uint16_t | Set-up flags for production. See enum <code>pwrfig_var_flags</code> |
| refreshment_ustime | uint32_t | Refreshment period in microseconds |
| evt_type | uint32_t | Set-up flags for event (Enable/Disable + Lifetime). See enum <code>pwrfig_evt_type</code> |

5.3.19. var_sync_cfg

Description

Specific set-up structure for a synchronization FIP variable.

Definition

```
struct pwrfig_var_sync_cfg {  
    uint32_t reserved[3];  
};
```

Members

| Name | Type | Description |
|-----------------|--------------------------|-------------------|
| reserved | <code>uint32_t[3]</code> | Unused parameters |

Remarks

A **synchronization** data has no user payload attached to it (no *RP_DAT* frame on network).

Only a **FIP identifier** and a ***permanent* event** are set-up.

When the *ID_DAT* frame associated with this FIP identifier is received - or produced (master) - by the node, an **event** is triggered and the *user handler* is executed.

5.3.20. var_cfg

Description



Generic set-up structure of a FIP variable for a FIP node.

Definition

```
struct pwrfig_var_cfg {
    enum pwrfig_var_type type;
    uint16_t id;
    union {
        struct pwrfig_var_cons_cfg cons;
        struct pwrfig_var_prod_cfg prod;
        struct pwrfig_var_sync_cfg sync;
    };
    void *user_ctx;
    void (* pwrfig_var_handler) (
        struct pwrfig_node *node,
        struct pwrfig_var *var,
        struct pwrfig_event *evt
    );
};
```

Members

| Name | Type | Description |
|-----------------------|---|---|
| type | <code>enum pwrfig_var_type</code> | Variable type (Production, Consumption or Synchronization) See <code>enum pwrfig_var_type</code> . |
| id | <code>uint16_t</code> | FIP identifier |
| cons/prod/sync | <code>union { struct pwrfig_var_cons_cfg cons; struct pwrfig_var_prod_cfg prod; struct pwrfig_var_sync_cfg sync; }</code> | Specialized configuration structure according to the <code>.type</code> field of the variable. See: <code>struct pwrfig_var_cons_cfg</code> <code>struct pwrfig_var_prod_cfg</code> <code>struct pwrfig_var_sync_cfg</code> |
| user_ctx | <code>void *</code> | User-specified context associated with this variable. <i>[Optional]</i> |

| Name | Type | Description |
|---------------------------|--|--|
| pwrfig_var_handler | <pre>void (* handler) (struct pwrfig_node *node, struct pwrfig_var *var, struct pwrfig_event *evt)</pre> | <p>Local handler definition for a <i>synchronization</i> variable.</p> <p>Or, if <code>.evt_type</code> field is set, for a <i>production/consumption</i> variable.</p> <div>  <p>If <code>pwrfig_var_handler=NULL</code>, the general handler, with the same name and located in the <code>node_cfg</code> structure, will take over in case of an event.</p> </div> <div>  <p>If neither - local or general - handler is set, the user will not be notified of the variable events.</p> </div> <p>See:</p> <pre>struct pwrfig_node struct pwrfig_var struct pwrfig_event</pre> |

5.4. Objects

5.4.1. msg

Description

FIP Message object.

This is the handle structure to interact with a FIP message.

Definition

```
struct pwrfip_msg {  
    struct pwrfip_msg_hdr hdr;  
    uint16_t bsz;  
    uint8_t *buffer;  
    uint64_t epoch;  
    uint8_t channel_num;  
    uint8_t error;  
    void *user_ctx;  
    void *priv;  
};
```

Members

| Name | Type | Description |
|--------------------|------------------------------------|---|
| hdr | <code>struct pwrfip_msg_hdr</code> | Message header. See <code>struct pwrfip_msg_hdr</code> |
| bsz | <code>uint16_t</code> | Useful message byte size (without header). Range = [1;256] |
| buffer | <code>uint8_t *</code> | Pointer to the useful message data. |
| epoch | <code>uint64_t</code> | RX/TX epoch info. |
| channel_num | <code>uint8_t</code> | RX/TX channel number. <ul style="list-style-type: none">• TX: See <code>enum pwrfip_msg_tx_channel</code>• RX: Always 0 |
| error | <code>uint8_t</code> | Error code for the read/write operation on the message (eq. msg_state). This report is generated directly by the coprocessor according to the state of the message in its local database. See <code>enum pwrfip_msg_err_code</code> |
| user_ctx | <code>void *</code> | User-specified context. |
| priv | <code>void *</code> | Pointer to a reserved opaque structure |

5.4.2. node

Description

FIP Node object.

This is the handle structure to interact with a FIP node.

Definition

```
struct pwrfip_node {  
    struct pwrfip_node_infos *infos;  
    void *priv;  
};
```

Members

| Name | Type | Description |
|--------------|---|--|
| infos | <code>struct pwrfip_node_infos *</code> | Pointer to the FIP node information See <code>struct pwrfip_node_infos</code> |
| priv | <code>void *</code> | Pointer to a reserved opaque structure |

5.4.3. var

Description

FIP Variable object.

This is the handle structure to interact with a FIP variable.

Definition

```
struct pwrfip_var {
    uint16_t id;
    uint16_t bsz;
    uint8_t *buffer;
    struct {
        uint32_t prod_ustime;
        uint32_t send_ustime;
        uint32_t cons_ustime;
    } time_info;
    uint8_t error;
    void *user_ctx;
    void *priv;
};
```

Members

| Name | Type | Description |
|---------------|-----------|--------------------------------------|
| id | uint16_t | FIP identifier of the variable |
| bsz | uint16_t | Useful variable byte size |
| buffer | uint8_t * | Pointer to the useful variable data. |

| Name | Type | Description |
|--------------------|-----------------------|---|
| prod_ustime | <code>uint32_t</code> | <ul style="list-style-type: none"> Consumed variable case: This value is significant only for a variable configured with dynamic refreshment status (see <code>enum pwrfig_var_flags</code>). This time expressed in microseconds is recorded by the producer node in the last four variable data byte (just before the production status). It indicates the time difference between the moment of updating in the database (variable write) and the moment of effective production on the network by the remote node. Produced variable case: In the case of a produced variable, this information is local to the node. It indicates the time elapsed since the last write on the network and the new write in the local database (write variable). |
| send_ustime | <code>uint32_t</code> | Frame transmission time on the network in microseconds. |
| cons_ustime | <code>uint32_t</code> | Time in microseconds between last variable reception from the network and its reading from local database by user. (Only significant for consumed variables) |
| error | <code>uint8_t</code> | <p>Error code for the read/write operation on the variable (eq. <code>var_state</code>).</p> <p>This report is generated directly by the coprocessor according to the state of the variable in its local database (freshness, promptness, etc).</p> <p>See <code>enum pwrfig_var_err_code</code></p> |
| user_ctx | <code>void *</code> | User-specified context. |
| priv | <code>void *</code> | Pointer to a reserved opaque structure |

5.5. Infos/Status/Report

5.5.1. ba_status

Description

Bus Arbiter status of FIP coprocessor.

Definition

```
struct pwrfip_ba_status {  
    uint16_t state;  
    uint16_t window;  
    uint32_t index;  
};
```

Members

| Name | Type | Description |
|--------|----------|--|
| state | uint16_t | Bus arbiter state (FSM: Finite State Machine) See enum pwrfip_ba_state |
| window | uint16_t | Macrocycle window currently active See enum pwrfip_ba_wind_type |
| index | uint32_t | Macrocycle index currently active |

5.5.2. medium_status

Description

Medium (Channels) status of FIP coprocessor.

Definition

```
struct pwr_fip_medium_status {  
    uint16_t state;  
    uint16_t reserved;  
};
```

Members

| Name | Type | Description |
|----------|----------|--|
| state | uint16_t | Medium state. See enum <code>pwr_fip_medium_state</code> . |
| reserved | uint16_t | Reserved field. |

5.5.3. node_infos

Description

Structure containing information about the FIP node (node configuration, software versions/dates).

Definition

```
struct pwrfig_node_infos {  
    struct pwrfig_node_cfg cfg;  
    uint64_t cpu_id;  
    uint32_t bss_bsz;  
    uint32_t bss_max_bsz;  
    struct pwrfig_version gw_version;  
    struct pwrfig_version fw_version;  
    struct pwrfig_version drv_version;  
    struct pwrfig_version lib_version;  
};
```

Members

| Name | Type | Description |
|--------------------|-------------------------------------|---|
| cfg | <code>struct pwrfig_node_cfg</code> | User configuration attached to the node See <code>struct pwrfig_node_cfg</code> |
| cpu_id | <code>uint64_t</code> | Coprocessor unique identifier |
| bss_bsz | <code>uint32_t</code> | Size in bytes of the node data contained in the BSS space of the coprocessor |
| bss_max_bsz | <code>uint32_t</code> | Maximum size in bytes of the coprocessor BSS space |
| gw_version | <code>struct pwrfig_version</code> | Coprocessor gateware version (FPGA) See <code>struct pwrfig_version</code> |
| fw_version | <code>struct pwrfig_version</code> | Coprocessor firmware version (C binary) <i>powerfip-firmware.bin</i> See <code>struct pwrfig_version</code> |
| drv_version | <code>struct pwrfig_version</code> | Driver version See <code>struct pwrfig_version</code> |
| lib_version | <code>struct pwrfig_version</code> | Library version See <code>struct pwrfig_version</code> |

5.5.4. node_report

Description

Global report of the FIP coprocessor.

Definition

```
struct pwrfip_node_report {  
    struct pwrfip_node_status node_status;  
    struct pwrfip_ba_status ba_status;  
    struct pwrfip_medium_status medium_status;  
    /* stats */  
    struct pwrfip_tx_err tx_err;  
    struct pwrfip_rx_err rx_err;  
};
```

Members

| Name | Type | Description |
|---------------|-----------------------------|--|
| node_status | struct pwrfip_node_status | Node FSM and operation status See struct pwrfip_node_status |
| ba_status | struct pwrfip_ba_status | Bus arbiter FSM and window status See struct pwrfip_ba_status |
| medium_status | struct pwrfip_medium_status | Medium (Channels) Status See struct pwrfip_medium_status |
| tx_err | struct pwrfip_tx_err | Transmission errors statistics See struct pwrfip_tx_err |
| rx_err | struct pwrfip_rx_err | Reception errors statistics See struct pwrfip_rx_err |

5.5.5. node_status

Description

General status of FIP node.

Definition

```
struct pwrfip_node_status {  
    uint16_t state;  
    uint16_t op;  
};
```

Members

| Name | Type | Description |
|-------|----------|--|
| state | uint16_t | Node state (FSM: Finite State Machine) See enum <code>pwrfip_node_state</code> |
| op | uint16_t | Operation currently in progress See enum <code>pwrfip_node_operation</code> |

5.5.6. rx_err

Description

Report of RX error by the coprocessor.

Definition

```
struct pwrfip_rx_err {  
    /**  
     * MAU frame errors  
     */  
    /* no mau rx error occurs */  
    uint64_t ok;  
    /* -> Physical Layer errors */  
    uint64_t pre_mis;  
    uint64_t fsd_mis;  
    uint64_t fsd_unk;  
    uint64_t fed_mis;  
    /* -> Data-Link Layer errors */  
    uint64_t crc_bad;  
    uint64_t reserved[10];  
    /**  
     * Application layer errors  
     */  
    uint64_t pdu_bad;  
    uint64_t len_bad;  
    uint64_t not_fresh;  
    uint64_t not_prompt;  
};
```

Members

| Name | Type | Description |
|----------|--------------|--------------------------------------|
| ok | uint64_t | Frame Ok. No MAU TX error occurs |
| pre_mis | uint64_t | Missing preamble (glitches on line) |
| fsd_mis | uint64_t | Missing Frame Start Delimiter (FSD) |
| fsd_unk | uint64_t | Unknown Frame Start Delimiter (FSD) |
| fed_mis | uint64_t | Missing Frame End Delimiter (FED) |
| crc_bad | uint64_t | Wrong Cyclic Redundancy Check (CRC) |
| reserved | uint64_t[10] | Internal errors (not documented) |
| pdu_bad | uint64_t | Unknown FIP Protocol Data Unit (PDU) |
| len_bad | uint64_t | Bad FIP frame length (LEN) |

| Name | Type | Description |
|------------|----------|--|
| not_fresh | uint64_t | Consumed variable has not been correctly refreshed by a remote fip node (agent) |
| not_prompt | uint64_t | Consumed variable is not prompt. Local database hasn't been read (by the user) during promptness period |

5.5.7. tx_err

Description

Report of TX error by the coprocessor.

Definition

```
struct pwrfig_tx_err {  
    /**  
     * Medium Attachment Unit (MAU) errors  
     */  
    uint64_t ok;  
    uint64_t collision;  
    uint64_t consistency;  
    uint64_t reserved[5];  
    /**  
     * Application layer errors  
     */  
    uint64_t not_fresh;  
};
```

Members

| Name | Type | Description |
|-------------|-------------|---|
| ok | uint64_t | Frame Ok. No MAU TX error occurs |
| collision | uint64_t | Other frame present on network during transmission |
| consistency | uint64_t | The coprocessor listens to the FIP line at the time of its own transmission. This counter is incremented if a consistency problem is detected between the data sent and the data read back |
| reserved | uint64_t[5] | Internal errors (not documented) |
| not_fresh | uint64_t | Produced variable is not correctly refreshed inside local database (refreshment period has expired) |

5.5.8. sm_ba_sync

Description

This structure allows to retrieve the BA synchronization SM-MPS variable (0x9003) from network.

For more information about this variable, see this [appendix](#).

Definition

```
struct pwrfig_sm_ba_sync {  
    uint8_t addr;  
    uint8_t mcycle_num;  
    struct pwrfig_var *var;  
};
```

Members

| Name | Type | Description |
|------------|---------------------|------------------------------------|
| addr | uint8_t | Master node address (Bus Arbiter). |
| mcycle_num | uint8_t | Macrocycle number in progress. |
| var | struct pwrfig_var * | pointer to 0x9003 SM-MPS variable. |

5.5.9. sm_identification

Description

This structure allows to retrieve an identification SM-MPS variable (0x10XY) from network.
For more information about this variable, see this [appendix](#).

Definition

```
struct pwrfig_sm_identification {  
    char manufacturer_name[128];  
    char model_name[128];  
    uint8_t revision;  
    char tag_name[128];  
    uint8_t smmps_class;  
    char vendor_field[128];  
    struct pwrfig_var *var;  
};
```

Members

| Name | Type | Description |
|-------------------|---------------------|---|
| manufacturer_name | char[128] | Vendor (or manufacturer) name in ASCII. |
| model_name | char[128] | Model name in ASCII. |
| revision | uint8_t | Revision number (ex: 0x23 [v2.3]). |
| tag_name | char[128] | Tag name. |
| smmps_class | uint8_t | SM-MPS conformity class. |
| vendor_field | char[128] | Additional information of the vendor. |
| var | struct pwrfig_var * | pointer to 0x10XY SM-MPS variable. |

5.5.10. sm_presence

Description

This structure allows to retrieve a presence SM-MPS variable (0x14XY) from network.

For more information about this variable, see this [appendix](#).

Definition

```
struct pwrfig_sm_presence {  
    uint8_t ident_len;  
    uint8_t ba_state;  
    uint8_t ba_prio;  
    struct pwrfig_var *var;  
};
```

Members

| Name | Type | Description |
|-----------|---------------------|--|
| ident_len | uint8_t | Length of the SM-MPS identification variable related to this node. |
| ba_state | uint8_t | Bus arbiter state. See enum pwrfig_ba_state |
| ba_prio | uint8_t | BA priority of the node (if master supported). Within the range [0..15] (0: higher) |
| var | struct pwrfig_var * | pointer to 0x14XY SM-MPS variable. |

5.5.11. sm_presence_list

Description

This structure allows to retrieve the presence list SM-MPS variable (0x9002) from network.
For more information about this variable, see this [appendix](#).

Definition

```
struct pwrfip_sm_presence_list {  
    int count;  
    uint8_t addr[256];  
    struct pwrfip_var *var;  
};
```

Members

| Name | Type | Description |
|-------|---------------------|--|
| count | int | Count of present FIP nodes on network. |
| addr | uint8_t[256] | Adresses table of present FIP nodes. |
| var | struct pwrfip_var * | pointer to 0x9002 SM-MPS variable. |

5.5.12. sm_report

Description

This structure allows to retrieve a report SM-MPS variable (0x11XY) from network.

For more information about this variable, see this [appendix](#).

Definition

```
union pwrfig_sm_report_ch_status {
    uint16_t value;
    struct {
        uint16_t tx_quality_ch1:1;
        uint16_t tx_quality_ch2:1;
        uint16_t rx_quality_ch1:1;
        uint16_t rx_quality_ch2:1;
        uint16_t valid_ch1:1;
        uint16_t valid_ch2:1;
        uint16_t traffic_ch1:1;
        uint16_t traffic_ch2:1;
        uint16_t summary_ch1:1;
        uint16_t summary_ch2:1;
        uint16_t reserved:6;
    };
};

struct pwrfig_sm_report {
    uint16_t rx_ok_ch1;
    uint16_t rx_ok_ch2;
    uint16_t rx_nok_ch1;
    uint16_t rx_nok_ch2;
    union pwrfig_sm_report_ch_status channel_status;
    struct pwrfig_var *var;
};
```

Members

| Name | Type | Description |
|------------|----------|--|
| rx_ok_ch1 | uint16_t | Frames correctly received on channel 1 by time unit. |
| rx_ok_ch2 | uint16_t | Frames correctly received on channel 2 by time unit. |
| rx_nok_ch1 | uint16_t | Frames incorrectly received on channel 1 by time unit. |
| rx_nok_ch2 | uint16_t | Frames incorrectly received on channel 2 by time unit. |

| Name | Type | Description |
|----------------|---|------------------------------------|
| channel_status | <code>union pwrfip_sm_report_ch_status</code> | Medium status of the node. |
| var | <code>struct pwrfip_var *</code> | pointer to 0x11XY SM-MPS variable. |

5.6. Extras

5.6.1. event

Description

FIP event.

Definition

```
struct pwrfig_event {  
    uint64_t epoch;  
    uint16_t code;  
    uint16_t param;  
    uint32_t reserved[2];  
};
```

Members

| Name | Type | Description |
|----------|-------------|--|
| epoch | uint64_t | Event epoch (10ns) |
| code | uint16_t | Event Code See enum pwrfig_event_code |
| param | uint16_t | Event Parameter. This parameter is significant only for some event codes. For more information, see enum pwrfig_event_code . |
| reserved | uint32_t[2] | Not documented fields |

5.6.2. msg_addr

Description

FIP message address.

Definition

```
struct pwrfip_msg_addr {
    union {
        uint32_t addr;
        struct {
            union {
                uint8_t seg;
                struct {
                    uint8_t seg_num:7;
                    uint8_t seg_group:1;
                };
            };
            union {
                uint16_t lsap;
                struct {
                    uint16_t lsap_num:15;
                    uint16_t lsap_group:1;
                };
            };
            uint8_t reserved;
        };
    };
};
```

Members

| Name | Type | Description |
|------------------|--------------------------|---|
| addr | <code>uint32_t</code> | Data Link Layer (DLL) address |
| seg | <code>uint8_t</code> | FIP Segment field |
| seg_num | <code>uint8_t:7</code> | FIP Segment number |
| seg_group | <code>uint8_t:1</code> | Segment group: <ul style="list-style-type: none">• 0: Individual segment• 1: Group segment |
| lsap | <code>uint16_t</code> | Link Service Access Point (LSAP) |
| lsap_num | <code>uint16_t:15</code> | LSAP number |

| Name | Type | Description |
|------------|------------|--|
| lsap_group | uint16_t:1 | LSAP group: <ul style="list-style-type: none">• 0: Individual address• 1: Group address |
| reserved | uint8_t | Reserved field |

5.6.3. msg_hdr

Description

FIP Message header.

Definition

```
struct pwrfig_msg_hdr {  
    struct pwrfig_msg_addr src;  
    struct pwrfig_msg_addr dst;  
};
```

Members

| Name | Type | Description |
|------------|-------------------------------------|---|
| src | <code>struct pwrfig_msg_addr</code> | Message source address. See <code>struct pwrfig_msg_addr</code> |
| dst | <code>struct pwrfig_msg_addr</code> | Message destination address. See <code>struct pwrfig_msg_addr</code> |

Chapter 6. Enumerations

6.1. ba_id_type

Description

ID request type allowed inside a macrocycle periodic window (for a master node only).

Definition

```
enum pwrfig_ba_id_type {  
    PWRFIG_BA_ID_DAT = 0x03,  
    PWRFIG_BA_ID_MSG = 0x05,  
};
```

Values

| Constant | Value | Description |
|------------------|-------|---|
| PWRFIG_BA_ID_DAT | 0x03 | Bus arbiter request for a FIP variable. |
| PWRFIG_BA_ID_MSG | 0x05 | Bus arbiter request for a FIP message. |

6.2. ba_startup_mode

Description

Start-up mode of the bus arbiter.

In a context where several bus arbiters are competing on the network to become master, it is necessary to give election priorities for each of them.

This enumeration defines these calculation methods (or mode) allowing to set-up the start-up/election times of the bus arbiter according to the characteristics of the FIP node.



Bus Arbiter 's Start-up and Election times

- $BA_StartUp_Time \text{ (microseconds)} = T0 \times BA_StartUp_Par$
- $BA_Election_Time \text{ (microseconds)} = T0 \times BA_Election_Par$


Where T0 is the Silence Time in microseconds.

Definition

```
enum pwr_fip_ba_startup_mode {
    PWRFIP_BA_STUP_STANDARD,
    PWRFIP_BA_STUP_OPTIMIZE_1,
    PWRFIP_BA_STUP_OPTIMIZE_2,
    PWRFIP_BA_STUP_OPTIMIZE_3,
};
```

Values

| Constant | Value | Description |
|----------------------------------|-------|--|
| PWRFIP_BA_STUP_STANDARD | 0 | <ul style="list-style-type: none"> • $BA_StartUp_Par = 8712$ • $BA_Election_Par = 2 \times [256 \times (BA_Priority + 1) + Node_Phy_Addr + 3]$ |
| PWRFIP_BA_STUP_OPTIMIZE_1 | 1 | <ul style="list-style-type: none"> • $BA_StartUp_Par = 2 \times [(BA_Max_Phy_Addr + 1) \times 16 + 257 + 3]$ • $BA_Election_Par = 2 \times [(BA_Max_Phy_Addr + 1) \times (BA_Priority + 1) + Node_Phy_Addr + 3]$ |
| PWRFIP_BA_STUP_OPTIMIZE_2 | 2 | <ul style="list-style-type: none"> • $BA_StartUp_Par = 2 \times [(BA_Max_Phy_Addr + 1) \times (BA_Max_Priority + 1) + 257 + 3]$ • $BA_Election_Par = 2 \times [(BA_Max_Phy_Addr + 1) \times (BA_Priority + 1) + Node_Phy_Addr + 3]$ |

| Constant | Value | Description |
|---------------------------|-------|---|
| PWRFIP_BA_STUP_OPTIMIZE_3 | 3 | <ul style="list-style-type: none">• $BA_Startup_Par = 2 \times [(BA_Max_Phy_Addr + 1) \times (BA_Max_Priority + 1) + 3]$• $BA_Election_Par = 2 \times [(BA_Max_Phy_Addr + 1) \times (BA_Priority + 1) + Node_Phy_Addr + 3]$ <div> Only for mono-medium topology.</div> |

Remarks

These times can be automatically calculated with `pwrfig_ba_startup_calculate()` function.

6.3. ba_state

Description

State of the bus arbiter.

Definition

```
enum pwrfig_ba_state {  
    PWRFIG_BA_STATE_INITIAL,  
    PWRFIG_BA_STATE_READY,  
    PWRFIG_BA_STATE_STARTING,  
    PWRFIG_BA_STATE_IDLE,  
    PWRFIG_BA_STATE_RUNNING,  
    _PWRFIG_BA_STATE_MAX,  
};
```

Values

| Constant | Value | Description |
|--------------------------|-------|--|
| PWRFIG_BA_STATE_INITIAL | 0 | Initial state. No bus arbiter config loaded |
| PWRFIG_BA_STATE_READY | 1 | User macrocycles context loaded. Here, FIP node is in stopped state, and is ready to start. |
| PWRFIG_BA_STATE_STARTING | 2 | Starting-up state (not yet active). The bus arbiter is inside start-up procedure. |
| PWRFIG_BA_STATE_IDLE | 3 | Idle state (maybe another bus arbiter is active on network) |
| PWRFIG_BA_STATE_RUNNING | 4 | Running state. Current node is master. Bus arbiter is active on network |
| _PWRFIG_BA_STATE_MAX | 5 | Max BA state number |

6.4. ba_wind_type

Description

Type of macrocycle window.

Definition

```
enum pwrfig_ba_wind_type {  
    _PWRFIG_BA_WIND_TYPE_NONE,  
    _PWRFIG_BA_WIND_TYPE_MIN,  
    PWRFIG_BA_WIND_PER = _PWRFIG_BA_WIND_TYPE_MIN,  
    PWRFIG_BA_WIND_APER_VAR,  
    PWRFIG_BA_WIND_APER_MSG,  
    PWRFIG_BA_WIND_WAIT,  
    _PWRFIG_BA_WIND_TYPE_MAX,  
};
```

Values

| Constant | Value | Description |
|--|-------|---|
| <code>_PWRFIG_BA_WIND_TYPE_NONE</code> | 0 | Invalid BA window type |
| <code>_PWRFIG_BA_WIND_TYPE_MIN</code> | 1 | Minimal valid type for a bus arbiter window |
| <code>PWRFIG_BA_WIND_PER</code> | 1 | Periodic window |
| <code>PWRFIG_BA_WIND_APER_VAR</code> | 2 | Aperiodic variable window |
| <code>PWRFIG_BA_WIND_APER_MSG</code> | 3 | Aperiodic message window |
| <code>PWRFIG_BA_WIND_WAIT</code> | 4 | External/Internal resync waiting window |
| <code>_PWRFIG_BA_WIND_TYPE_MAX</code> | 5 | Maximal valid type for a bus arbiter window |

6.5. bitrate

Description

FIP bitrate.

Definition

```
enum pwrfig_bitrate {  
    _PWRFIG_BITRATE_MIN = 1,  
    PWRFIG_BITRATE_31K25 = _PWRFIG_BITRATE_MIN,  
    PWRFIG_BITRATE_1M,  
    PWRFIG_BITRATE_2M5,  
    PWRFIG_BITRATE_5M,  
    PWRFIG_BITRATE_12M5,  
    PWRFIG_BITRATE_25M,  
    _PWRFIG_BITRATE_MAX,  
    _PWRFIG_BITRATE_UNKNOWN = 0,  
};
```

Values

| Constant | Value | Description |
|-----------------------------|-------|---------------------------------------|
| _PWRFIG_BITRATE_MIN | 1 | Minimum valid enum code for bitrate. |
| PWRFIG_BITRATE_31K25 | 1 | FIP/WorldFIP bitrate at 31.25Kbps. |
| PWRFIG_BITRATE_1M | 2 | FIP/WorldFIP bitrate at 1Mbps. |
| PWRFIG_BITRATE_2M5 | 3 | FIP/WorldFIP bitrate at 2.5Mbps. |
| PWRFIG_BITRATE_5M | 4 | FIP/WorldFIP bitrate at 5Mbps. |
| PWRFIG_BITRATE_12M5 | 5 | FIP/WorldFIP bitrate at 12.5Mbps. |
| PWRFIG_BITRATE_25M | 6 | FIP/WorldFIP bitrate at 25Mbps. |
| _PWRFIG_BITRATE_MAX | 7 | Maximum enum code for bitrate. |
| _PWRFIG_BITRATE_UNKNOW N | 0 | Not supported or unknown FIP bitrate. |

6.6. error_code

Description

Library and coprocessor communication error codes.

Definition

```
enum pwrfig_error_code {
    _PWRFIG_ERR_CODE_MIN = 256,
    /* library error codes */
    PWRFIG_ERR_DEV_ALREADY_BIND = _PWRFIG_ERR_CODE_MIN,
    PWRFIG_ERR_DEV_IRQ_HANDLER_STARTED,
    PWRFIG_ERR_DEV_IRQ_HANDLER_STOPPED,
    PWRFIG_ERR_DEV_DIAG_TASK_STARTED,
    PWRFIG_ERR_DEV_DIAG_TASK_STOPPED,
    PWRFIG_ERR_AELE_NOT_STOP,
    PWRFIG_ERR_AELE_NOT_RUN,
    PWRFIG_ERR_AELE_VAR_NOT_FOUND,
    PWRFIG_ERR_BA_NOT_STOP,
    PWRFIG_ERR_BA_NOT_RUN,
    PWRFIG_ERR_INVALID_CTX,
    PWRFIG_ERR_CFG_VAR_TYPE_UNKNOWN,
    PWRFIG_ERR_CFG_VAR_DIR,
    PWRFIG_ERR_CFG_MSG_PROD,
    PWRFIG_ERR_CFG_MSG_DIR,
    PWRFIG_ERR_CFG_VAR_EXIST,
    PWRFIG_ERR_CFG_MSG_EXIST,
    PWRFIG_ERR_CFG_VAR_BAD_LEN,
    PWRFIG_ERR_CFG_MSG_TYPE_UNKNOWN,
    PWRFIG_ERR_CFG_MSG_TX_ACK_MODE_UNKNOWN,
    PWRFIG_ERR_CFG_MSG_TX_CH_PER_EXIST,
    PWRFIG_ERR_CFG_MSG_TX_CH_PER_UNKNOWN,
    PWRFIG_ERR_CFG_MSG_TX_CH_PER_NOID,
    PWRFIG_ERR_MCYCLE_WIND_COUNT,
    PWRFIG_ERR_MCYCLE_WIND_UNKNOWN,
    PWRFIG_ERR_MCYCLE_WIND_END,
    PWRFIG_ERR_MCYCLE_PER_WIND_REQ_COUNT,
    PWRFIG_ERR_MCYCLE_PER_WIND_REQ_UNKNOWN,
    PWRFIG_ERR_MCYCLE_WIND_TIME_INC,
    PWRFIG_ERR_NODE_BSS_OVERFLOW,
    PWRFIG_ERR_NODE_HANDLER_MISSING,
    PWRFIG_ERR_NODE_FRM_TYPE_INVALID,
    PWRFIG_ERR_NODE_BITRATE_INVALID,
    PWRFIG_ERR_NODE_MSG_CAP_NOT_SUPPORTED,
    PWRFIG_ERR_NODE_RX_MSG_FIFO_SZ,
    PWRFIG_ERR_NODE_RX_MSG_SEG_CAP,
    PWRFIG_ERR_NODE_TX_MSG_FIFO_SZ,
    PWRFIG_ERR_NODE_TX_MSG_REPEAT,
```


```

PWRFIP_ERR_NODE_BA_STUP_TIMES,
PWRFIP_ERR_NODE_BA_REQ_FIFO_SZ,
PWRFIP_ERR_NODE_TR_INVALID,
PWRFIP_ERR_NODE_TS_INVALID,
PWRFIP_ERR_NODE_IDENT_PARAM,
PWRFIP_ERR_NODE_IDENT_LEN,
PWRFIP_ERR_BA_STUP_TS_INVALID,
PWRFIP_ERR_BA_STUP_PHY_ADDR_INVALID,
PWRFIP_ERR_BA_STUP_PRIO_INVALID,
/* communication errors codes (mailboxes) */
_PWRFIP_ERR_COM_CODE_OFFSET,
PWRFIP_ERR_COM_DIR_UNKNOWN = _PWRFIP_ERR_COM_CODE_OFFSET,
PWRFIP_ERR_COM_NOT_OUTBOX,
PWRFIP_ERR_COM_NOT_INBOX,
PWRFIP_ERR_COM_INVAL,
PWRFIP_ERR_COM_TMO,
PWRFIP_ERR_COM_BUSY,
PWRFIP_ERR_COM_NO_PKT,
PWRFIP_ERR_COM_PKT_BAD_SZ,
PWRFIP_ERR_COM_PKT_BAD_CMD,
PWRFIP_ERR_COM_PKT_RES_FAILED,
PWRFIP_ERR_COM_DMA_BAD_OP,
_PWRFIP_ERR_CODE_MAX,
};

```

Values

| Constant | Description |
|---|--|
| PWRFIP_ERR_DEV_ALREADY_BIND | The device is already bound to another FIP node session. |
| PWRFIP_ERR_DEV_IRQ_HANDLER_STARTED | IRQ handler is already started. |
| PWRFIP_ERR_DEV_IRQ_HANDLER_STOPPED | IRQ handler is already stopped. |
| PWRFIP_ERR_DEV_DIAG_TASK_STARTED | Diagnostic task is already started. |
| PWRFIP_ERR_DEV_DIAG_TASK_STOPPED | Diagnostic task is already stopped. |
| PWRFIP_ERR_AELE_NOT_STOP | FIP node is currently running. |
| PWRFIP_ERR_AELE_NOT_RUN | FIP node is currently stopped. |
| PWRFIP_ERR_AELE_VAR_NOT_FOUND | Unknown variable ID for this FIP node. |
| PWRFIP_ERR_BA_NOT_STOP | Macrocycle (BA) is not stopped. |
| PWRFIP_ERR_BA_NOT_RUN | No BA is currently running. |

| Constant | Description |
|--|--|
| PWRFIP_ERR_INVALID_CTX | Objects (aele, mcycle...) do not belong to the same node context. |
| PWRFIP_ERR_CFG_VAR_TYPE_UNKOWN | Unknown variable type. |
| PWRFIP_ERR_CFG_VAR_DIR | Impossible to change the direction of the variable (prod/cons) for this ID. |
| PWRFIP_ERR_CFG_MSG_PROD | Impossible to link a produced message on this ID. A consumed variable is already attached to it. |
| PWRFIP_ERR_CFG_MSG_DIR | Impossible to change direction. A produced message is already attached to it. |
| PWRFIP_ERR_CFG_VAR_EXIST | A variable already exists for this ID. |
| PWRFIP_ERR_CFG_MSG_EXIST | A message already exists with this header. |
| PWRFIP_ERR_CFG_VAR_BAD_LEN | <div> <div>  </div> <div> <p>Incorrect payload size configuration.</p> <p>Maximum size:</p> <ul style="list-style-type: none"> • 126: variable without MPS status • 125: variable with MPS status (refreshment) • 121: variable with dynamic refreshment </div> </div> |
| PWRFIP_ERR_CFG_MSG_TYPE_UNKOWN | Unknown message type. |
| PWRFIP_ERR_CFG_MSG_TX_ACK_MODE_UNKNOWN | Unknown message acknowledgement mode. |
| PWRFIP_ERR_CFG_MSG_TX_CH_PER_EXIST | A periodic message channel is already attached to this ID. |
| PWRFIP_ERR_CFG_MSG_TX_CH_PER_UNKNOWN | Unknown periodic message channel number. |
| PWRFIP_ERR_CFG_MSG_TX_CH_PER_NOID | No ID attached to this periodic message channel number. |
| PWRFIP_ERR_MCYCLE_WIND_COUNT | Invalid macrocycle windows count (should be at least 1). |
| PWRFIP_ERR_MCYCLE_WIND_UNKOWN | Unknown macrocycle windows type. |
| PWRFIP_ERR_MCYCLE_WIND_END | Invalid macrocycle (should end with a WAIT window). |

| Constant | Description |
|---|--|
| PWRFIP_ERR_MCYCLE_PER_WIND_REQ_COUNT | At least one request is required for BA periodic window. |
| PWRFIP_ERR_MCYCLE_PER_WIND_REQ_UNKNOWN | Unknown macrocycle periodic request (ID_DAT or ID_MSG). |
| PWRFIP_ERR_MCYCLE_WIND_TIME_INC | Overlap on macrocycle windows end times. |
| PWRFIP_ERR_NODE_BSS_OVERFLOW | BSS overflow. Queues size of the node should be reduced. |
| PWRFIP_ERR_NODE_HANDLER_MISSING | Reset/Error/Warning handlers are mandatory. |
| PWRFIP_ERR_NODE_FRM_TYPE_INVALID | Invalid frame type (FIP or WorldFIP). |
| PWRFIP_ERR_NODE_BITRATE_INVALID | Invalid node bitrate configuration. |
| PWRFIP_ERR_NODE_MSG_CAP_NOT_SUPPORTED | The node does not support messaging capability. |
| PWRFIP_ERR_NODE_RX_MSG_FIFO_SZ | Queue size for message consumption should be in [1..64] range. |
| PWRFIP_ERR_NODE_RX_MSG_SEG_CAP | Segment capability for consumption message should be [0..2]. |
| PWRFIP_ERR_NODE_TX_MSG_FIFO_SZ | Queue size for message transmission should be in [1..64] range. |
| PWRFIP_ERR_NODE_TX_MSG_REPEAT | Maximum repeats for acknowledged message transmission should be in [0..3] range. |
| PWRFIP_ERR_NODE_BA_STUP_TIME_S | The election time must be shorter than the start-up time. |
| PWRFIP_ERR_NODE_BA_REQ_FIFO_SZ | Queue size for BA requests should be in [1..64] range. |
| PWRFIP_ERR_NODE_TR_INVALID | Invalid FIP turn around time configuration. |
| PWRFIP_ERR_NODE_TS_INVALID | Invalid FIP silence time configuration. |
| PWRFIP_ERR_NODE_IDENT_PARAM | Mandatory parameters are missing for the node identification. |
| PWRFIP_ERR_NODE_IDENT_LEN | Node identification parameters exceed limit size. |
| PWRFIP_ERR_BA_STUP_TS_INVALID | Silence time should not be 0. |
| PWRFIP_ERR_BA_STUP_PHY_ADDR_INVALID | Local physical address should not exceed maximum network address. |

| Constant | Description |
|--|---|
| PWRFIP_ERR_BA_STUP_PRIO_INVALID | Local BA priority should not exceed max priority (0: highest prio). |
| PWRFIP_ERR_COM_DIR_UNKNOW | Unknown direction for the mailbox. |
| PWRFIP_ERR_COM_NOT_OUTBOX | The mailbox is not configured as output. |
| PWRFIP_ERR_COM_NOT_INBOX | The mailbox is not configured as input. |
| PWRFIP_ERR_COM_INVALID | Mailbox invalid argument. |
| PWRFIP_ERR_COM_TMO | Mailbox timeout. |
| PWRFIP_ERR_COM_BUSY | Mailbox is busy. |
| PWRFIP_ERR_COM_NO_PKT | Mailbox has no packet to treat. |
| PWRFIP_ERR_COM_PKT_BAD_SZ | Incorrect packet size for the mailbox. |
| PWRFIP_ERR_COM_PKT_BAD_CMD | Unknown packet command id for the mailbox. |
| PWRFIP_ERR_COM_PKT_RES_FAILED | Error during response procedure (inbox). |
| PWRFIP_ERR_COM_DMA_BAD_OP | Bad DMA operation for mailbox. |

6.7. event_code




Description




FIP event codes of the library.

Definition

```
enum pwrfig_event_code {  
    PWRFIG_EVT_SEND_VAR_P = 0x8100,  
    PWRFIG_EVT_SEND_VAR_T = 0x0100,  
    PWRFIG_EVT_RECV_VAR_P = 0x8200,  
    PWRFIG_EVT_RECV_VAR_T = 0x0200,  
    PWRFIG_EVT_RECV_MSG = 0x0240,  
    PWRFIG_EVT_SEND_MSG = 0x0140,  
    PWRFIG_EVT_SEND_APU = 0x0130,  
    PWRFIG_EVT_SEND_APN = 0x0131,  
    PWRFIG_EVT_BA_ACTIVITY = 0x0400,  
    PWRFIG_EVT_BA_STOP_TMO = 0x0401,  
    PWRFIG_EVT_BA_STOP_ERR = 0x0402,  
    PWRFIG_EVT_BA_STOP_USR = 0x0404,  
    PWRFIG_EVT_BA_IDLE = 0x0408,  
};
```

Values

| Constant | Value | Description |
|-----------------------|--------|--|
| PWRFIG_EVT_SEND_VAR_P | 0x8100 | <div>A variable set-up with <i>permanent</i> event has been sent on the FIP network.</div> <div> The variable ID attached to this event code is saved in <code>.param</code> field of <code>struct pwrfig_event</code></div> |
| PWRFIG_EVT_SEND_VAR_T | 0x0100 | <div>A variable set-up with <i>temporary</i> event (once) has been sent on the FIP network.</div> <div> The variable ID attached to this event code is saved in <code>.param</code> field of <code>struct pwrfig_event</code></div> |
| PWRFIG_EVT_RECV_VAR_P | 0x8200 | <div>A variable set-up with <i>permanent</i> event has been received from the FIP network.</div> <div> The variable ID attached to this event code is saved in <code>.param</code> field of <code>struct pwrfig_event</code></div> |

| Constant | Value | Description |
|----------------------------|--------|---|
| PWRFIP_EVT_RECV_VAR_T | 0x0200 | <p>A variable set-up with <i>temporary</i> event (once) has been received from the FIP network.</p> <div>  <p>The variable ID attached to this event code is saved in <code>.param</code> field of <code>struct pwr_fip_event</code></p> </div> |
| PWRFIP_EVT_RECV_MSG | 0x0240 | A FIP message has been received from the FIP network. |
| PWRFIP_EVT_SEND_MSG | 0x0140 | A FIP message has been sent to the FIP network. |
| PWRFIP_EVT_SEND_APU | 0x0130 | An <i>urgent</i> aperiodic variable list has been sent to the FIP network. |
| PWRFIP_EVT_SEND_APN | 0x0131 | An <i>normal</i> aperiodic variable list has been sent to the FIP network. |
| PWRFIP_EVT_BA_ACTIVITY | 0x0400 | The bus arbiter is running. The local node is master. |
| PWRFIP_EVT_BA_STOP_TM O | 0x0401 | <p>The bus arbiter has stopped on timeout.</p> <div>  <p>This event occurs when the macrocycle executes a waiting window (with external trigger waiting). If the external signal does not occur within the configured time, this event is emitted and the bus arbiter stops.</p> </div> |
| PWRFIP_EVT_BA_STOP_ER R | 0x0402 | <p>The bus arbiter has stopped on network fault.</p> <div>  <p>This event occurs if the macrocycle executes an unknown or incorrect program instruction code. (see <code>struct pwr_fip_ba_wind_cfg</code> - <code>.type</code> field) It can also occur during the start-up phase of the macrocycle, if tx errors are reported during sending of 3 padding frames.</p> </div> |
| PWRFIP_EVT_BA_STOP_US R | 0x0404 | The bus arbiter has been stopped by an user command. |
| PWRFIP_EVT_BA_IDLE | 0x0408 | The bus arbiter has switched to IDLE mode. Another BA is already active on the network. |

6.8. evt_type



Description


FIP event type.

Definition

```
enum pwr_fip_evt_type {  
    PWR_FIP_EVT_TYPE_NONE,  
    PWR_FIP_EVT_TYPE_PERMANENT_ID,  
    PWR_FIP_EVT_TYPE_PERMANENT,  
    PWR_FIP_EVT_TYPE_TEMPORARY,  
};
```

Values

| Constant | Value | Description |
|-------------------------------|-------|---|
| PWR_FIP_EVT_TYPE_NONE | 0 | No event. |
| PWR_FIP_EVT_TYPE_PERMANENT_ID | 1 | <div><p>Permanent event on request detection. Raises a synchronous event each time the specific ID_DAT frame is detected on network.</p><div><p>This event - attached to a prod/cons variable - is equivalent to a synchronization variable but with a defined payload. An IRQ is raised each time the event appears.</p></div></div> |
| PWR_FIP_EVT_TYPE_PERMANENT | 2 | <div><p>Permanent event on response detection. Adds an entry to node event queue each time the specific RP_DAT frame is detected on network.</p><div><p>This event is asynchronous. There exists two ways to dequeue it:</p><ul style="list-style-type: none">• Polling method: The user has to call periodically the <code>pwr_fip_evt_process()</code> function.• Interrupt method: By configuring at least one synchronous event attached to the FIP periodic cycle.</div></div> |

| Constant | Value | Description |
|---------------------------|-------|--|
| PWRFIP_EVT_TYPE_TEMPORARY | 3 | <div><div>Temporary event on response detection. Adds an entry to node event queue only once at the specific RP_DAT frame detection.</div><div><div>This event is asynchronous. (see PWRFIP_EVT_TYPE_PERMANENT)</div></div></div> |

6.9. frame_type



Description

Frame type.

Definition

```
enum pwrfig_frame_type {  
    _PWRFIG_FRM_TYPE_MIN = 1,  
    PWRFIG_FRM_FIP = _PWRFIG_FRM_TYPE_MIN,  
    PWRFIG_FRM_WORLDFIP,  
    _PWRFIG_FRM_TYPE_MAX,  
    _PWRFIG_FRM_TYPE_UNKNOWN = 0,  
};
```

Values

| Constant | Value | Description |
|---------------------------------|-------|--|
| _PWRFIG_FRM_TYPE_MIN | 1 | Minimum valid enum code for frame type. |
| PWRFIG_FRM_FIP | 1 | FIP frame type. <div> <i>Type of frame delimiters and CRC</i> UTE (Union Technique de l'Electricité)</div> |
| PWRFIG_FRM_WORLDFIP | 2 | WorldFIP frame type. <div> <i>Type of frame delimiters and CRC</i> IEC (International Electrotechnical Commission)</div> |
| _PWRFIG_FRM_TYPE_MAX | 3 | Maximum enum code for frame type. |
| _PWRFIG_FRM_TYPE_UNKNOWN | 0 | Unknown frame type. |

6.10. medium_cmd_flag

Description

Medium management command.

The PowerFIP coprocessor provides a medium redundancy management solution for a FIP/WorldFIP bi-medium connection node. These commands allow to manage these two FIP channels.

Definition

```
enum pwrfig_medium_cmd_flag {  
    PWRFIG_MEDIUM_CMD_ENABLE_CH_1 = (1 << 0),  
    PWRFIG_MEDIUM_CMD_DISABLE_CH_1 = (1 << 1),  
    PWRFIG_MEDIUM_CMD_ENABLE_CH_2 = (1 << 2),  
    PWRFIG_MEDIUM_CMD_DISABLE_CH_2 = (1 << 3),  
    PWRFIG_MEDIUM_CMD_ENABLE_CH_1_2 = ((PWRFIG_MEDIUM_CMD_ENABLE_CH_1) |  
                                         (PWRFIG_MEDIUM_CMD_ENABLE_CH_2)),  
    PWRFIG_MEDIUM_CMD_DISABLE_CH_1_2 = ((PWRFIG_MEDIUM_CMD_DISABLE_CH_1) |  
                                         (PWRFIG_MEDIUM_CMD_DISABLE_CH_2)),  
    PWRFIG_MEDIUM_CMD_CLEAR_TX_ERR = (1 << 4),  
    PWRFIG_MEDIUM_CMD_RESET_CH_1 = (1 << 5),  
    PWRFIG_MEDIUM_CMD_RESET_CH_2 = (1 << 6),  
    PWRFIG_MEDIUM_CMD_RESET_CH_1_2 = ((PWRFIG_MEDIUM_CMD_RESET_CH_1) |  
                                       (PWRFIG_MEDIUM_CMD_RESET_CH_2)),  
};
```

Values

| Constant | Value | Description |
|----------------------------------|--------|--|
| PWRFIG_MEDIUM_CMD_ENABLE_CH_1 | 0x0001 | Enable FIP channel 1. |
| PWRFIG_MEDIUM_CMD_DISABLE_CH_1 | 0x0002 | Disable FIP channel 1. |
| PWRFIG_MEDIUM_CMD_ENABLE_CH_2 | 0x0004 | Enable FIP channel 2. |
| PWRFIG_MEDIUM_CMD_DISABLE_CH_2 | 0x0008 | Disable FIP channel 2. |
| PWRFIG_MEDIUM_CMD_ENABLE_CH_1_2 | 0x0005 | Enable both FIP channels. |
| PWRFIG_MEDIUM_CMD_DISABLE_CH_1_2 | 0x000a | Disable both FIP channels. |
| PWRFIG_MEDIUM_CMD_CLEAR_TX_ERR | 0x0010 | Clear TX error flag for both channels. |

| Constant | Value | Description |
|------------------------------------|--------|----------------------|
| PWRFIP_MEDIUM_CMD_RE SET_CH_1 | 0x0020 | Reset FIP channel 1. |
| PWRFIP_MEDIUM_CMD_RE SET_CH_2 | 0x0040 | Reset FIP channel 2. |
| PWRFIP_MEDIUM_CMD_RE SET_CH_1_2 | 0x0060 | Reset both channels. |

6.11. medium_state

Description

Flags describing FIP medium (channels) state.

Definition

```
enum pwrfig_medium_state {
    PWRFIG_MEDIUM_STATE_CH1_VALID = (1 << 0),
    PWRFIG_MEDIUM_STATE_CH2_VALID = (1 << 1),
    PWRFIG_MEDIUM_STATE_CH1_TX_ERROR = (1 << 2),
    PWRFIG_MEDIUM_STATE_CH2_TX_ERROR = (1 << 3),
    PWRFIG_MEDIUM_STATE_CH1_WATCHDOG = (1 << 4),
    PWRFIG_MEDIUM_STATE_CH2_WATCHDOG = (1 << 5),
};
```

Values

| Constant | Value | Description |
|----------------------------------|--------|--|
| PWRFIG_MEDIUM_STATE_CH1_VALID | 0x0001 | Channel 1 is active |
| PWRFIG_MEDIUM_STATE_CH2_VALID | 0x0002 | Channel 2 is active |
| PWRFIG_MEDIUM_STATE_CH1_TX_ERROR | 0x0004 | TX Error detected on channel 1 |
| PWRFIG_MEDIUM_STATE_CH2_TX_ERROR | 0x0008 | TX Error detected on channel 2 |
| PWRFIG_MEDIUM_STATE_CH1_WATCHDOG | 0x0010 | Watchdog on channel 1. MAU has to be reset. |
| PWRFIG_MEDIUM_STATE_CH2_WATCHDOG | 0x0020 | Watchdog on channel 2. MAU has to be reset. |

6.12. msg_err_code

Description

FIP message error codes after read/write operation.

Definition

```
enum pwrfig_msg_err_code {
    _PWRFIG_MSG_OK,
    _PWRFIG_MSG_ERR_MIN,
    /* configuration errors */
    PWRFIG_MSG_TX_CH_UNKNOWN = _PWRFIG_MSG_ERR_MIN,
    /* context error */
    PWRFIG_MSG_TYPE_BAD,
    PWRFIG_MSG_LEN_BAD,
    /* -> rx msg */
    PWRFIG_MSG_RX_FIFO_EMPTY,
    /* -> tx msg */
    PWRFIG_MSG_TX_FIFO_EMPTY,
    PWRFIG_MSG_TX_FIFO_FULL,
    PWRFIG_MSG_TX_TMO,
    PWRFIG_MSG_TX_ACK_TMO,
    PWRFIG_MSG_TX_ACK_NACK,
    _PWRFIG_MSG_ERR_MAX,
};
```

Values

| Constant | Value | Description |
|---------------------------------------|-------|---|
| <code>_PWRFIG_MSG_OK</code> | 0 | No error. Operation correctly performed. |
| <code>_PWRFIG_MSG_ERR_MIN</code> | 1 | Minimal error code. |
| <code>PWRFIG_MSG_TX_CH_UNKNOWN</code> | 1 | Unknown message TX channel number. |
| <code>PWRFIG_MSG_TYPE_BAD</code> | 2 | Bad message type. See <code>.type</code> field of <code>struct pwrfig_msg_cfg</code> . |
| <code>PWRFIG_MSG_LEN_BAD</code> | 3 | Bad message length. A message byte size (header + payload) should be in [7;262] range. |
| <code>PWRFIG_MSG_RX_FIFO_EMPTY</code> | 4 | RX message queue is empty. |
| <code>PWRFIG_MSG_TX_FIFO_EMPTY</code> | 5 | TX message queue is empty. |

| Constant | Value | Description |
|--------------------------------|-------|--|
| PWRFIP_MSG_TX_FIFO_FULL | 6 | TX message queue is full. |
| PWRFIP_MSG_TX_TMO | 7 | Message not sent and timeout expired (both mode: ack/noack). It's a local timeout. No transmission attempt on the network by the local node. Maybe TX message channel is not correctly set-up, or the BA node never queries the identifier attached to the TX channel. |
| PWRFIP_MSG_TX_ACK_TMO | 8 | Message sent but never acked (ack mode only). It's a remote timeout. No ACK frame received despite SDA request. The remote target node is absent or not working properly. |
| PWRFIP_MSG_TX_ACK_NACK | 9 | Message sent but negatively acknowledged (ack mode only). The remote target node has sent a NACK frame (RP_ACKme/RP_ACKmo) to reject the received message. Maybe the message reception queue of the remote target node is full or not correctly set-up. |
| _PWRFIP_MSG_ERR_MAX | 10 | Maximum error code |

6.13. msg_rx_seg_cap

Description

Message reception capability for the node depending on the destination segment of the FIP message.




A FIP node can be configured to be more or less sensitive to receiving FIP messages from the network.

Depending on the header of the received message (destination address), it is possible to filter all messages destined to a particular FIP segment or to accept only particular header values.

Definition

```
enum pwrfig_msg_rx_seg_cap {  
    _PWRFIG_MSG_SEG_CAP_MIN = 0,  
    PWRFIG_MSG_SEG_IGNORE = _PWRFIG_MSG_SEG_CAP_MIN,  
    PWRFIG_MSG_SEG_ACCEPT_ALL,  
    PWRFIG_MSG_SEG_ACCEPT_LTD,  
    _PWRFIG_MSG_SEG_CAP_MAX,  
};
```

Values

| Constant | Value | Description |
|--|-------|---|
| <code>_PWRFIG_MSG_SEG_CAP_MIN</code> | 0 | Minimum capacity value. |
| <code>PWRFIG_MSG_SEG_IGNORE</code> | 0 | Ignore all messages sent to the segment. |
| <code>PWRFIG_MSG_SEG_ACCEPT_ALL</code> | 1 | Accept all messages sent to the segment (regardless of the DSAP). |
| <code>PWRFIG_MSG_SEG_ACCEPT_LTD</code> | 2 | Limited acceptance. <div> Only if the DSAP is configured for the node. See <code>.rx.dst.lsap</code> field of <code>struct pwrfig_msg_cfg</code>.</div> |
| <code>_PWRFIG_MSG_SEG_CAP_MAX</code> | 3 | Maximum capacity value. |

6.14. msg_tx_ack_mode

Description

Acknowledgement mode for a FIP message.

Definition

```
enum pwrfig_msg_tx_ack_mode {  
    _PWRFIG_MSG_TX_ACK_MODE_MIN = 0,  
    PWRFIG_MSG_TX_ACK_MODE_SDN = _PWRFIG_MSG_TX_ACK_MODE_MIN,  
    PWRFIG_MSG_TX_ACK_MODE_SDA,  
    _PWRFIG_MSG_TX_ACK_MODE_MAX,  
};
```

Values

| Constant | Value | Description |
|-----------------------------|-------|---|
| _PWRFIG_MSG_TX_ACK_MODE_MIN | 0 | Minimum TX acknowledgment mode value |
| PWRFIG_MSG_TX_ACK_MODE_SDN | 0 | Send message without acknowledgment request (SDN) |
| PWRFIG_MSG_TX_ACK_MODE_SDA | 1 | Send message with acknowledgment request (SDA) |
| _PWRFIG_MSG_TX_ACK_MODE_MAX | 2 | Maximum TX acknowledgment mode value |

6.15. msg_tx_channel

Description

Transmission channels number for FIP messages.

Definition

```
enum pwrfig_msg_tx_channel {  
    _PWRFIG_MSG_TX_CH_MIN = 0,  
    PWRFIG_MSG_TX_CH_APER = _PWRFIG_MSG_TX_CH_MIN,  
    PWRFIG_MSG_TX_CH_PER_1,  
    PWRFIG_MSG_TX_CH_PER_2,  
    PWRFIG_MSG_TX_CH_PER_3,  
    PWRFIG_MSG_TX_CH_PER_4,  
    PWRFIG_MSG_TX_CH_PER_5,  
    PWRFIG_MSG_TX_CH_PER_6,  
    PWRFIG_MSG_TX_CH_PER_7,  
    PWRFIG_MSG_TX_CH_PER_8,  
    _PWRFIG_MSG_TX_CH_MAX,  
};
```

Values

| Constant | Value | Description |
|------------------------|-------|---|
| _PWRFIG_MSG_TX_CH_MIN | 0 | Minimum message TX channel value |
| PWRFIG_MSG_TX_CH_APER | 0 | Aperiodic message transmission channel |
| PWRFIG_MSG_TX_CH_PER_1 | 1 | Periodic message transmission channel 1 |
| PWRFIG_MSG_TX_CH_PER_2 | 2 | Periodic message transmission channel 2 |
| PWRFIG_MSG_TX_CH_PER_3 | 3 | Periodic message transmission channel 3 |
| PWRFIG_MSG_TX_CH_PER_4 | 4 | Periodic message transmission channel 4 |
| PWRFIG_MSG_TX_CH_PER_5 | 5 | Periodic message transmission channel 5 |
| PWRFIG_MSG_TX_CH_PER_6 | 6 | Periodic message transmission channel 6 |
| PWRFIG_MSG_TX_CH_PER_7 | 7 | Periodic message transmission channel 7 |

| Constant | Value | Description |
|------------------------|-------|---|
| PWRFIP_MSG_TX_CH_PER_8 | 8 | Periodic message transmission channel 8 |
| _PWRFIP_MSG_TX_CH_MAX | 9 | Maximum message TX channel value |

6.16. msg_type

Description

FIP message type.

Definition

```
enum pwrfig_msg_type {  
    _PWRFIG_MSG_TYPE_MIN = 0,  
    PWRFIG_MSG_TYPE_RECV = _PWRFIG_MSG_TYPE_MIN,  
    PWRFIG_MSG_TYPE_SEND,  
    _PWRFIG_MSG_TYPE_MAX,  
};
```

Values

| Constant | Value | Description |
|----------------------|-------|----------------------------|
| _PWRFIG_MSG_TYPE_MIN | 0 | Minimum message type value |
| PWRFIG_MSG_TYPE_RECV | 0 | Message to receive |
| PWRFIG_MSG_TYPE_SEND | 1 | Message to send |
| _PWRFIG_MSG_TYPE_MAX | 2 | Maximum message type value |

6.17. node_operation

Description

Operation type inside a FIP node.

Definition

```
enum pwrfig_node_operation {  
    _PWRFIG_NODE_OP_UNKNOWN,  
    PWRFIG_NODE_OP_WAIT_RX_RP_FRM,  
    PWRFIG_NODE_OP_WAIT_TX_RP_FRM,  
    PWRFIG_NODE_OP_WAIT_RX_ID_FRM,  
    PWRFIG_NODE_OP_WAIT_TX_ID_FRM,  
    _PWRFIG_NODE_OP_MAX,  
};
```

Values

| Constant | Value | Description |
|--------------------------------------|-------|---|
| _PWRFIG_NODE_OP_UNKNOWN | 0 | Unknown operation |
| PWRFIG_NODE_OP_WAIT_RX_RP_FRM | 1 | Wait for reception of <i>RP_XX</i> frame |
| PWRFIG_NODE_OP_WAIT_TX_RP_FRM | 2 | <i>RP_XX</i> frame transmission in progress |
| PWRFIG_NODE_OP_WAIT_RX_ID_FRM | 3 | Wait for reception of <i>ID_XX</i> frame |
| PWRFIG_NODE_OP_WAIT_TX_ID_FRM | 4 | <i>ID_XX</i> frame transmission in progress |
| _PWRFIG_NODE_OP_MAX | 5 | Max node operation |

6.18. node_state

Description

FSM (Finite State Machine) for a FIP node.

Definition

```
enum pwr_fip_node_state {  
    PWR_FIP_NODE_STATE_INITIAL,  
    PWR_FIP_NODE_STATE_LOADED,  
    PWR_FIP_NODE_STATE_READY,  
    PWR_FIP_NODE_STATE_RUNNING,  
    _PWR_FIP_NODE_STATE_MAX,  
};
```

Values

| Constant | Value | Description |
|----------------------------|-------|--|
| PWR_FIP_NODE_STATE_INITIAL | 0 | Initial state. No config loaded |
| PWR_FIP_NODE_STATE_LOADED | 1 | General node config loaded. |
| PWR_FIP_NODE_STATE_READY | 2 | User context loaded (AE/LE). Here, FIP node is in stopped state, and is ready to start. |
| PWR_FIP_NODE_STATE_RUNNING | 3 | Running state. Node is active on network |
| _PWR_FIP_NODE_STATE_MAX | 4 | Max node state number |

6.19. sm_var_type

Description

FIP system management variable type (SM-MPS).

Definition

```
enum pwrfig_sm_var_type {  
    PWRFIG_SM_VAR_IDENT,  
    PWRFIG_SM_VAR_REPORT,  
    PWRFIG_SM_VAR_PRESENCE,  
};
```

Values

| Constant | Value | Description |
|------------------------|-------|--|
| PWRFIG_SM_VAR_IDENT | 0 | Identification SM-MPS variable (0x10XY). |
| PWRFIG_SM_VAR_REPORT | 1 | Report SM-MPS variable (0x11XY). |
| PWRFIG_SM_VAR_PRESENCE | 2 | Presence SM-MPS variable (0x14XY). |

6.20. var_aper_channel_type

Description

Priority level for the channel dedicated to aperiodic variable requests.

Definition

```
enum pwrfig_var_aper_channel_type {  
    PWRFIG_VAR_APER_CH_NORMAL = 0,  
    PWRFIG_VAR_APER_CH_URGENT,  
};
```

Values

| Constant | Value | Description |
|---------------------------|-------|------------------|
| PWRFIG_VAR_APER_CH_NORMAL | 0 | Normal priority. |
| PWRFIG_VAR_APER_CH_URGENT | 1 | Urgent priority. |

6.21. var_err_code

Description


FIP variable error codes after read/write operation.

Definition

```
enum pwrfig_var_err_code {
    _PWRFIG_VAR_OK,
    _PWRFIG_VAR_ERR_MIN,
    /* configuration errors */
    PWRFIG_VAR_ID_UNKNOWN = _PWRFIG_VAR_ERR_MIN,
    PWRFIG_VAR_NOT_PRODUCING,
    PWRFIG_VAR_NOT_CONSUMING,
    PWRFIG_VAR_TX_APER_CH_UNKNOWN,
    /* context error */
    PWRFIG_VAR_PDU_INCONSISTENT,
    PWRFIG_VAR_LEN_TOO_LONG,
    PWRFIG_VAR_LEN_TOO_SHORT,
    PWRFIG_VAR_NEVER_RECEIVED,
    PWRFIG_VAR_TX_APER_FIFO_EMPTY,
    PWRFIG_VAR_TX_APER_FIFO_FULL,
    /* payload error */
    /* -> cons var */
    PWRFIG_VAR_NOT_MEANING,
    PWRFIG_VAR_NOT_REFRESH,
    PWRFIG_VAR_NOT_PROMPT,
    PWRFIG_VAR_BAD_PROMPT_PER,
    /* -> prod var */
    PWRFIG_VAR_BAD_REFRESH_PER,
    _PWRFIG_VAR_ERR_MAX,
};
```

Values

| Constant | Value | Description |
|---------------------------------------|-------|---|
| <code>_PWRFIG_VAR_OK</code> | 0 | No error. Operation correctly performed. |
| <code>_PWRFIG_VAR_ERR_MIN</code> | 1 | Minimal error code. |
| <code>PWRFIG_VAR_ID_UNKNOWN</code> | 1 | Unknown variable ID. The FIP identifier is not set to support a variable. No RP_DAT frame attached to local database. |
| <code>PWRFIG_VAR_NOT_PRODUCING</code> | 2 | The FIP variable is not set to production. |

| Constant | Value | Description |
|------------------------------------|-------|--|
| PWRFIP_VAR_NOT_CONSUMING | 3 | The FIP variable is not set to consumption. |
| PWRFIP_VAR_TX_APER_CHANNEL_UNKNOWN | 4 | Unknown TX channel number for aperiodic variable. <div>  <ul style="list-style-type: none"> • Normal channel number = 0 • Urgent channel number = 1 </div> |
| PWRFIP_VAR_PDU_INCONSISTENT | 5 | Inconsistent variable PDU (Protocol Data Unit). The PDU read on the FIP network does not match with the PDU configured for the variable. |
| PWRFIP_VAR_LEN_TOO_LONG | 6 | The size of the variable read on the FIP network is longer than the one configured in the local database. |
| PWRFIP_VAR_LEN_TOO_SHORT | 7 | The size of the variable read on the FIP network is shorter than the one configured in the local database. |
| PWRFIP_VAR_NEVER_RECEIVED | 8 | The variable has never been received on the FIP node. |
| PWRFIP_VAR_TX_APER_FIFO_EMPTY | 9 | TX aperiodic variable queue is empty. |
| PWRFIP_VAR_TX_APER_FIFO_FULL | 10 | TX aperiodic variable queue is full. |
| PWRFIP_VAR_NOT_MEANINGFUL | 11 | The FIP variable read is not significant. |
| PWRFIP_VAR_NOT_FRESH | 12 | The FIP variable is not fresh. (see <i>production status</i> byte) |
| PWRFIP_VAR_NOT_PROMPT | 13 | The FIP variable is not prompt. |
| PWRFIP_VAR_BAD_PROMPT_PERIOD | 14 | Bad reading frequency for application layer (promptness). User app is not reading the FIP variable with a correct period. This may be due to excessive OS latencies. |
| PWRFIP_VAR_BAD_REFRESH_PERIOD | 15 | Bad writing frequency for application layer (refreshment) User app is not writing the FIP variable with a correct period. This may be due to excessive OS latencies. |
| _PWRFIP_VAR_ERR_MAX | 16 | Maximum error code |

6.22. var_flags




Description




Set-up flags for a FIP variable

Definition

```
enum pwrfig_var_flags {  
    /**  
     * PROD/CONS  
     */  
    PWRFIG_VAR_FLAGS_REFRESH = (1 << 0),  
    PWRFIG_VAR_FLAGS_DYN_REFRESH = (1 << 1),  
    /**  
     * PROD only  
     */  
    PWRFIG_VAR_FLAGS_APER_VAR_REQ = (1 << 8),  
    PWRFIG_VAR_FLAGS_APER_MSG_REQ = (1 << 9),  
    /**  
     * CONS only  
     */  
    PWRFIG_VAR_FLAGS_PROMPT = (1 << 12),  
    PWRFIG_VAR_FLAGS_CHK_PDU_LEN = (1 << 13),  
  
    PWRFIG_VAR_FLAGS_MAX_VAL = (1 << 15),  
};
```

Values

| Constant | Value | Description |
|---|--------|---|
| PWRFIP_VAR_FLAGS_REFRESH | 0x0001 | <p>Enable/Disable production status (refreshment)</p> <div>  <ul style="list-style-type: none"> • Production variable case: If this option is enabled, an extra byte - called <i>production status</i> - is automatically added to the end of the payload by the coprocessor. This byte is updated by the producer to inform other nodes if the payload is correctly refreshed inside its local database. • Consumption variable case: If this option is enabled, the last useful byte of the frame is considered to be a <i>production state</i>. It is then interpreted by the coprocessor to know the freshness state of the variable consumed on the network. </div> |
| PWRFIP_VAR_FLAGS_DYNAMIC_REFRESH | 0x0002 | <p>Enable/Disable dynamic production status (eq. var_time)</p> <div>  <p>In addition to the <i>production status</i> byte added at the end of the user payload, 4 extra bytes are inserted by the producer to inform the <i>production time</i> of the variable to other nodes. This time - in microseconds - expresses the delay between the user's write command and the actual production by the MAU of producer on the network.</p> </div> |
| PWRFIP_VAR_FLAGS_APERIODIC_VARIABLE_REQUEST | 0x0100 | <p>Enable/Disable aperiodic variable request capability</p> <div>  <p>This flag is reserved only for a variable set in production.</p> </div> |

| Constant | Value | Description |
|-------------------------------|--------|---|
| PWRFIP_VAR_FLAGS_APER_MSG_REQ | 0x0200 | Enable/Disable aperiodic message request capability <div> This flag is reserved only for a variable set in production.</div> |
| PWRFIP_VAR_FLAGS_PROMPT | 0x1000 | Enable/Disable promptness status <div> This flag is reserved only for a variable set in consumption.</div> |
| PWRFIP_VAR_FLAGS_CHK_PDU_LEN | 0x2000 | Enable/Disable PDU+LEN bytes frame check <div> This flag is reserved only for a variable set in consumption.</div> |
| PWRFIP_VAR_FLAGS_MAX_VAL | 0x8000 | Maximal setting flag for variable |

6.23. var_type


Description

FIP variable type.

Definition

```
enum pwr_fip_var_type {  
    PWR_FIP_VAR_TYPE_CONS,  
    PWR_FIP_VAR_TYPE_PROD,  
    PWR_FIP_VAR_TYPE_SYNC,  
    _PWR_FIP_VAR_TYPE_MAX,  
};
```

Values

| Constant | Value | Description |
|-----------------------|-------|--|
| PWR_FIP_VAR_TYPE_CONS | 0 | Consumption variable. |
| PWR_FIP_VAR_TYPE_PROD | 1 | Production variable. |
| PWR_FIP_VAR_TYPE_SYNC | 2 | Synchronization variable. <div><p>No payload is attached to this kind of variable but the node is sensitive to (RX/TX) ID_DAT frame. An IRQ is raised each time the event appears and immediately signals the user-space with a synchronous event. This event attached to an ID_DAT without payload is called a pure event.</p></div> |
| _PWR_FIP_VAR_TYPE_MAX | 3 | Maximum variable type value. |

Appendix A: SM-MPS variables

The network management variables SM-MPS are automatically created and internally managed by the PowerFIP library.

These variables are useful to know the general state of the network as well as to get information about a particular FIP node.

A.1. Identification - 0x10XY

Description

The variable attached to the ID number 0x10XY (where XY is the node address) is called the *Identification* variable.

Each node produces this variable, and its payload allows to clearly identify the node on the network.

Frame Format

| Bytes | Description |
|-------|--|
| 0x50 | PDU type (SM-MPS) |
| 0xZZ | PDU length (must not exceed 126 bytes) |
| 0x80 | Manufacturer name field |
| 0xZZ | Manufacturer name field length |
| 0xZZ | First character for manufacturer name |
| ... | ... |
| 0xZZ | Last character for manufacturer name |
| 0x81 | Model name field |
| 0xZZ | Model name field length |
| 0xZZ | First character for model name |
| ... | ... |
| 0xZZ | Last character for model name |
| 0x82 | Revision field |
| 0x01 | Revision field length |
| 0xZZ | Revision number (ex: 0x10 for v1.0) |
| 0x83 | Device tag name field <i>[Optional]</i> |
| 0xZZ | Device tag name field length |
| 0xZZ | First character for tag name |
| ... | ... |

| Bytes | Description |
|-----------------|---|
| 0xZZ | Last character for tag name |
| 0x84 | SM-MPS secondary function field |
| 0x01 | SM-MPS secondary function field length |
| 0x10 (fixed) | SM-MPS secondary function field value: <ul style="list-style-type: none"> • bit0: set to 1 if loading supported • bit1: set to 1 if remote reading supported • bit2: set to 1 if remote control supported • bit3: set to 1 if remote checking supported • bit4: set to 1 if report supported • the other bits are always set to 0 |
| 0x8A | Vendor field <i>[Optional]</i> |
| 0xZZ | Vendor field length |
| 0xZZ | First byte for vendor field |
| ... | ... |
| 0xZZ | Last byte for vendor field |

A.2. Report - 0x11XY



Description

The variable attached to the ID number 0x11XY (where XY is the node address) is called the *Report* variable.

Each node produces this variable, and its payload contains various node-specific status counters (rx faults, number of transactions, ...).

Frame Format

| Bytes | Description |
|-------|---|
| 0x50 | PDU type (SM-MPS) |
| 0x0F | PDU length |
| 0x50 | Tag for counter of frames correctly received on channel 1 by Time Unit ⁽¹⁾ |
| 0xZZ | Counter Most Significant Byte |
| 0xZZ | Counter Least Significant Byte |
| 0x51 | Tag for counter of frames correctly received on channel channel 2 by Time Unit ⁽¹⁾ |
| 0xZZ | Counter Most Significant Byte |

| Bytes | Description |
|-------------|--|
| 0xZZ | Counter Least Significant Byte |
| 0x52 | Tag for counter of frames incorrectly received on channel 1 by Time Unit ⁽¹⁾ |
| 0xZZ | Counter Most Significant Byte |
| 0xZZ | Counter Least Significant Byte |
| 0x53 | Tag for counter of frames incorrectly received on channel 2 by Time Unit ⁽¹⁾ |
| 0xZZ | Counter Most Significant Byte |
| 0xZZ | Counter Least Significant Byte |
| 0x54 | Tag for channel status |
| 0xZZ | <p>Channel status (MSB)</p> <ul style="list-style-type: none"> bit1: Synthesis for channel 2 (1: OK, 0: NOK) <div>  <p>Result of the binary operation for channel status LSB: b1 & b3 & b5 & b7</p> </div> <ul style="list-style-type: none"> bit0: Synthesis for channel 1 (1: OK, 0: NOK) <div>  <p>Result of the binary operation for channel status LSB: b0 & b2 & b4 & b6</p> </div> |
| 0xZZ | <p>Channel status (LSB)</p> <ul style="list-style-type: none"> bit7: Traffic⁽²⁾ on channel 2 (1: OK, 0: NOK) bit6: Traffic⁽²⁾ on channel 1 (1: OK, 0: NOK) bit5: Validity⁽³⁾ on channel 2 (1: OK, 0: NOK) bit4: Validity⁽³⁾ on channel 1 (1: OK, 0: NOK) bit3: RX quality⁽⁴⁾ on channel 2 (1: OK, 0: NOK) bit2: RX quality⁽⁴⁾ on channel 1 (1: OK, 0: NOK) bit1: TX quality⁽⁴⁾ on channel 2 (1: OK, 0: NOK) bit0: TX quality⁽⁴⁾ on channel 1 (1: OK, 0: NOK) |

Remarks

- (1) Time Unit corresponds to the diagnostic period of the medium. This task is internally performed by the library, and the period is automatically set according to the FIP bitrate:
 - @31.25Kbps: 1.6s
 - @1Mbps: 500ms
 - @2.5Mbps: 200ms
 - @5Mbps: 100ms

- @12.5Mbps: 40ms
- @25Mbps: 20ms
- (2): Traffic signal is the measure of frames correctly received and/or transmitted on/by the channel by Time Unit⁽¹⁾. To be OK, you need:
 - (TX frames OK + RX frames OK) > 0
- (3): Validity of a channel is given by the medium redundancy component.
See `enum pwr_fip_medium_state`:
 - PWRFIP_MEDIUM_STATE_CH1_VALID
 - PWRFIP_MEDIUM_STATE_CH2_VALID
- (4): RX/TX quality is the measure of the error rate on the channel by Time Unit⁽¹⁾. This error threshold is set to 5% by the library.
To be OK, you need:
 - (RX frames faults / RX frames OK) < Threshold
 - (TX frames faults / TX frames OK) < Threshold

A.3. Presence - 0x14XY

Description

The variable attached to the ID number 0x14XY (where XY is the node address) is called the *Presence* variable.

Each node produces this variable and thus informs the other nodes of the FIP network of its presence.

Frame Format

| Bytes | Description |
|-------|--|
| 0x50 | PDU type (SM-MPS) |
| 0x05 | PDU length |
| 0x80 | Presence parameter |
| 0x03 | Presence parameter length |
| 0xZZ | Identification characteristics. See: PDU length for 0x10XY <ul style="list-style-type: none">• 0: Unknown length• 1 to 0xFE: Known length• 0xFF: No identification variable |
| 0x00 | Reserved |

| Bytes | Description |
|-------|--|
| 0xZZ | Bus Arbiter global status (about the producer). <ul style="list-style-type: none">• bit4-bit7: BA status:<ul style="list-style-type: none">◦ 0: BA not supported◦ 1: BA not eligible (stopped mode)◦ 2: BA idle (on standby)◦ 3: BA active (master node)• bit0-bit3: BA priority (if BA is supported). Range is [0;15], with 0 the highest priority. |

A.4. Presence Check - 0x9002

Description

The variable attached to the ID number 0x9002 is called the *Presence Check* or *Present List* variable.

This variable is produced by the master node (Bus arbiter active).

It summarizes in a single variable the whole list of nodes presence on the network.

Frame Format

| Bytes | Description |
|-------|--|
| 0x50 | PDU type (SM-MPS) |
| 0x44 | PDU length |
| 0x80 | Channel 1 presence list |
| 0x20 | Channel 1 presence list length |
| 0xZZ | Status of nodes address 0 to 7. (0: absent, 1: present) <ul style="list-style-type: none">• bit0: node 0• ...• bit7: node 7 |
| ... | ... |
| 0xZZ | Status of nodes address 248 to 255. (0: absent, 1: present) <ul style="list-style-type: none">• bit0: node 248• ...• bit7: node 255 |

| Bytes | Description |
|-------|--|
| 0x81 | Channel 2 presence list |
| 0x20 | Channel 2 presence list length |
| 0xZZ | Status of nodes address 0 to 7. (0: absent, 1: present) <ul style="list-style-type: none">• bit0: node 0• ...• bit7: node 7 |
| ... | ... |
| 0xZZ | Status of nodes address 248 to 255. (0: absent, 1: present) <ul style="list-style-type: none">• bit0: node 248• ...• bit7: node 255 |

A.5. BA synchronization - 0x9003

Description

The variable attached to the ID number 0x9003 is called the *BA synchronisation* variable.

This variable is produced by the master node, and indicates the current status of the Bus Arbiter on the network.

Frame Format

| Bytes | Description |
|-------|---|
| 0x50 | PDU type (SM-MPS) |
| 0x04 | PDU length |
| 0x80 | BA synchro parameter |
| 0x02 | BA synchro parameter length |
| 0xZZ | Macrocycle number of current BA program |
| 0xZZ | Physical node address of the master |

Appendix B: Glossary of acronyms

| | |
|---------------|---|
| AE/LE | Application Entity/Link Entity |
| BA | Bus Arbiter |
| BSS | Block Starting Symbol |
| DLL | Data Link Layer |
| DSAP | Destination Service Access Point |
| LLC | Logical Link Control |
| LSAP | Link Service Access Point |
| MPS | Manufacturing Periodic/aperiodic Services |
| SDA | Send Data with Acknowledgement |
| SDN | Send Data with No acknowledgement |
| SM-MPS | System Management Manufacturing Periodic/aperiodic Services |
| SSAP | Source Service Access Point |

Appendix C: Revision History

| Revision | Changes | Authors | Date |
|----------|---|---------|------------|
| 1.2.0 | <ul style="list-style-type: none"> New binary architectures [GNU/Linux OS] <ul style="list-style-type: none"> aarch64 [arm64] arm [arm32] | MC | 2023-06-27 |
| 1.1.0 | <ul style="list-style-type: none"> Add a protocol extension setting to extend the length of FIP variables <ul style="list-style-type: none"> On optic medium: payload up to 1020B On copper medium: payload up to 501B (FielDrive component limitation) Add <code>.prctl_ext</code> field to <code>struct pwrfig_node_cfg</code> Add new bitrates to <code>enum pwrfig_bitrate</code>: <ul style="list-style-type: none"> PWRFIP_BITRATE_12M5 PWRFIP_BITRATE_25M Add dynamic refreshment status support Add <code>.time_info</code> field to <code>struct pwrfig_var</code> Update min/max ranges time for silence/turn-around time | MC | 2022-06-21 |
| 1.0.2 | <ul style="list-style-type: none"> Add support of synchronous events on ID_DAT request frame for FIP variables (prod/cons) Add new event to <code>enum pwrfig_evt_type</code>: <ul style="list-style-type: none"> PWRFIP_EVT_TYPE_PERMANENT_ID | MC | 2022-03-01 |
| 1.0.1 | <ul style="list-style-type: none"> Add multiarch powerfig lib binaries <ul style="list-style-type: none"> Windows: x86_64, i686 Linux: x86_64, i386 Add support for running 32-bit programs in a 64-bit kernel Remove libwinpthread-1.dll dependency for Windows PowerFIP DLL Fix an incorrect FIP coprocessor initialization from 32-bit apps | MC | 2022-01-13 |

| Revision | Changes | Authors | Date |
|----------|--|---------|------------|
| 1.0.0 | <ul style="list-style-type: none"> • Add SM-MPS variables support (next): <ul style="list-style-type: none"> ◦ <code>pwrfig_sm_var_create()</code> ◦ <code>pwrfig_sm_ba_sync_get()</code> ◦ <code>pwrfig_sm_identification_get()</code> ◦ <code>pwrfig_sm_presence_list_get()</code> ◦ <code>pwrfig_sm_presence_get()</code> ◦ <code>pwrfig_sm_report_get()</code> • Add new structure: <ul style="list-style-type: none"> ◦ <code>struct pwrfig_sm_ba_sync</code> ◦ <code>struct pwrfig_sm_identification</code> ◦ <code>struct pwrfig_sm_presence_list</code> ◦ <code>struct pwrfig_sm_presence</code> ◦ <code>struct pwrfig_sm_report</code> • Add <code>.fsn</code> field to <code>struct pwrfig_dev_infos</code> • Add <code>pwrfig_error_get()</code> • Update <code>struct pwrfig_msg_addr</code> • Add new errors to <code>enum pwrfig_error_code</code>: <ul style="list-style-type: none"> ◦ <code>PWRFIG_ERR_AELE_VAR_NOT_FOUND</code> | MC | 2022-01-07 |

| Revision | Changes | Authors | Date |
|----------|---|---------|------------|
| 0.9.0 | <ul style="list-style-type: none"> • Add support for periodic/apperiodic message service: <ul style="list-style-type: none"> ◦ <code>pwrfig_msg_create()</code> ◦ <code>pwrfig_msg_delete()</code> ◦ <code>pwrfig_msg_tx_channel_purge()</code> ◦ <code>pwrfig_msg_send()</code> • Add new structure: <ul style="list-style-type: none"> ◦ <code>struct pwrfig_msg_cfg</code> ◦ <code>struct pwrfig_msg_tx_cfg</code> ◦ <code>struct pwrfig_msg_rx_cfg</code> ◦ <code>struct pwrfig_msg_addr</code> ◦ <code>struct pwrfig_msg_hdr</code> ◦ <code>struct pwrfig_msg</code> • Add <code>.tx_aper_fifo_size</code>, <code>.tx_per_fifo_size[8]</code> and <code>.tx_per_fifo_id[8]</code> fields to <code>struct pwrfig_node_msg_cfg</code> • Add <code>.bss_bsz</code> and <code>.bss_max_bsz</code> fields to <code>struct pwrfig_node_infos</code> • Add <code>.reserved[2]</code> field to <code>struct pwrfig_event</code> • Add new errors to <code>enum pwrfig_error_code</code>: <ul style="list-style-type: none"> ◦ <code>PWRFIG_ERR_CFG_VAR_TYPE_UNKNOWN</code> ◦ <code>PWRFIG_ERR_CFG_MSG_EXIST</code> ◦ <code>PWRFIG_ERR_CFG_VAR_BAD_LEN</code> ◦ <code>PWRFIG_ERR_CFG_MSG_TYPE_UNKNOWN</code> ◦ <code>PWRFIG_ERR_CFG_MSG_TX_ACK_MODE_UNKNOWN</code> ◦ <code>PWRFIG_ERR_CFG_MSG_TX_CH_PER_EXIST</code> ◦ <code>PWRFIG_ERR_CFG_MSG_TX_CH_PER_UNKNOWN</code> ◦ <code>PWRFIG_ERR_CFG_MSG_TX_CH_PER_NOID</code> ◦ <code>PWRFIG_ERR_NODE_BSS_OVERFLOW</code> ◦ <code>PWRFIG_ERR_NODE_MSG_CAP_NOT_SUPPORTED</code> | MC | 2021-12-07 |

| Revision | Changes | Authors | Date |
|----------|---|---------|------------|
| 0.8.0 | <ul style="list-style-type: none"> • Add support for aperiodic variable service: <ul style="list-style-type: none"> ◦ <code>pwrfig_varidlist_aper_request()</code> ◦ <code>pwrfig_varlist_aper_request()</code> ◦ <code>pwrfig_var_aper_channel_purge()</code> • Add SM-MPS variables support: (note: internally managed by the library) <ul style="list-style-type: none"> ◦ Identification (0x10XY) ◦ Report (0x11XY) ◦ Presence (0x14XY) ◦ Presence Check (0x9002) ◦ BA Synchronization (0x9003) • Add new structure: <code>struct pwrfig_node_ident_cfg</code> • Add <code>.priority</code> field to <code>struct pwrfig_node_ba_cfg</code> • Add <code>.ident</code> field to <code>struct pwrfig_node_cfg</code> • Add <code>.pwrfig_ba_sync_handler</code> field to <code>struct pwrfig_node_cfg</code> • Add <code>.user_ctx</code> field to <code>struct pwrfig_var_cfg</code> and <code>struct pwrfig_var</code> • Add new errors to <code>enum pwrfig_error_code</code>: <ul style="list-style-type: none"> ◦ <code>PWRFIG_ERR_DEV_DIAG_TASK_STARTED</code> ◦ <code>PWRFIG_ERR_DEV_DIAG_TASK_STOPPED</code> ◦ <code>PWRFIG_ERR_NODE_IDENT_PARAM</code> ◦ <code>PWRFIG_ERR_NODE_IDENT_LEN</code> | MC | 2021-10-19 |
| 0.7.2 | <ul style="list-style-type: none"> • Mailboxes processing inside the driver (Windows) • High thread priority for internal library thread • Add <code>.index</code> field to <code>struct pwrfig_dev_infos</code> | MC | 2021-09-21 |
| 0.7.1 | Windows 7/8/10 OS support | MC | 2021-08-04 |
| 0.7.0 | First version (Linux OS) | MC | 2021-07-05 |