Power Quality Meter

Serial Communication Protocol

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Table of Contents

Table of Figures

Introduction

This document describes the Serial Communication Protocol designed to control operation and read measured data form Power Quality Meter device.

0.1 General guidelines

Serial Communication Protocol (SCP) is designed to control Power Quality Meter (PQM) device and to read measured data from it in real time. SCP also supports downloading boot image to device, reading diagnostics and other housekeeping information.

SCP is host slave protocol; all transactions are initiated by host (PC or ARM board). Transaction consists from command message from host and reply message form PQM device. Host must not send next command until it has got reply on previous command. PQM sends reply when it has completed action, required by the command. In case of failure, reply specifies failure reason code.

SCP is binary byte-oriented protocol. All messages consist from integer number of bytes. SCP is designed to communicate over error-free communication media, like USB. No error detection algorithm is implemented.

0.2 Command and reply code

Command message consists from command code field and body field. Body structure is specified in command description. SCP command codes are specified in Table 1 Command codes.

Command code	Description	Paragraph
0x00	Get device version	1.1.1
0x01	Set absolute clock time	1.1.2
0x02	Get absolute clock time	1.1.3
0x03	Get debug text message	1.1.4
0x04	Run self-test	1.1.5
0x05	Get measurement value	1.2.1
0x06	Get event	1.2.2
0x07	Get waveform capture frame	1.2.3
0x08	Set Calibration and CT-compensation parameters	1.3.1
0x09	Get Calibration and CT-compensation parameters	1.3.2
0x0A	Set Measurement configuration parameters	1.3.3
0x0B	Get Measurement configuration parameters	1.3.4
0x0C	Set Event configuration parameters	1.3.5
0x0D	Get Event configuration parameters	1.3.6
0x0E	Set Event configuration parameters	1.3.7

Table 1 Command codes.

Replay message consist from reply code and body field. Successful reply body structure depends on command code; it is specified in command description. SCP reply codes are specified in Table 2 Reply codes. Error reply does not include body.

Reply code	Description
0x00	Command successfully processed
0x10	Empty queue for debug message, event, waveform capture frame
0x80	Unknown command code
0x81	Command length is less than required
0x90	Wrong Absolute clock time in Set absolute clock time command
0x91	Wrong Test number in Run self-test command
0x92	Wrong Start address or Length in Get measurement command
0x93	Incorrect data in Configuration and software update commands
0x94	Flash memory erase error in Configuration and software update commands

0x95	Flash memory write error in Configuration and software update commands
0x96	Wrong Packet number, Total packets or Length in Set Event configuration parameters command
0xA0	Wrong Password value in Configuration and software update commands

Table 2 Reply codes.

0.3 Message length and data alignment

For fixed length message, length is defined by command code (and reply code for reply). For variable length message, length is directly specified in message body. Error reply message is always single word message.

MSB of word value is transmitted first, MSW of long value is transmitted first.

1 Command Set

1.1 General purpose command

1.1.1 Get device version

Description:

This command gets PQM device hardware and software version. Version is returned in the form of ASCII character string of specified length (not null-terminated) similar to:

```
SW 2.3 HW 1.1
```

Supported command set and particular format command depends on PQM device version.

Command format:

Command code	1 word	0x00
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Replay length (string length + 2)	1 word	
ASCII string (without null character)	1-128 bytes	

1.1.2 Set absolute clock time

Description:

This command sets absolute clock time. Absolute clock time is used in time stamping of all events, detected by PQM. Absolute clock time is specified as two value: number of seconds passed since 00:00:00 1 Jan 2000 and number of milliseconds passed from beginning of current second.

Command format:

Command code	1 word	0x01
Command length	1 word	5
Seconds since 00:00:00 1 Jan 2000	1 dword	
Milliseconds since beginning of second	1 word	

Reply format:

Reply code	1 word	0x00

Replay length	1 word	2

1.1.3 Get absolute clock time

Description:

This command gets absolute clock time. Absolute clock time is used in time stamping of all events, detected by PQM. Absolute clock time is specified as two value: number of seconds passed since 00:00:00 1 Jan 2000 and number of milliseconds passed from beginning of current second.

Command format:

Command code	1 word	0x02
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Replay length	1 word	5
Seconds since 00:00:00 1 Jan 2000	1 dword	
Milliseconds since beginning of second	1 word	

1.1.4 Get debug text message

Description:

This command gets text debug message. Text debug message is the arbitrary ASCII character string of specified length (not null-terminated).

In debug mode, host periodically polls PQM, to get messages and display it to user. Polling interval is about 100 ms, host should get all messages until PQM replies with empty debug message.

Command format:

Command code	1 word	0x03
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Replay length (string length + 2)	1 word	
ASCII string (without null character)	1-128 bytes	

1.1.5 Run self-test

Description:

This command run specified internal self test and return test results. Result message is the arbitrary ASCII character string of specified length (not null-terminated).

Command format:

Command code	1 word	0x04
Command length	1 word	3
Test number	1 word	Specified in Table 3

Test number	Description	Result

0x00	Read phase A voltage raw ADC value	-1000 to +1000 V DC input range correspond to value from -4096 to +4095
0x01	Read phase B voltage raw ADC value	
0x02	Read phase C voltage raw ADC value	
0x03	Read neutral voltage raw ADC value	
0x04	Read phase A current raw ADC value	-5 to +5 V DC input range correspond to value from -4096 to +4095
0x05	Read phase B current raw ADC value	
0x06	Read phase C current raw ADC value	
0x07	Read neutral current raw ADC value	
0x08	Read power supply voltage	Power supply voltage, 5000 mV
0x09	Read board temperature	Board temperature, accuracy 2 degrees Celsius
0x0A	Run external memory test	Ok / fault
0x0B	Run interrupt rate test	Number of interrupts per second, 320 000 +/- 100 ppm
0x0C	Force WDT reset	Reset DSP in 1.5 second

Table 3 Run self-test test number.

Reply format:

Reply code	1 word	0x00
Replay length (string length + 2)	1 word	
ASCII string (without null character)	1-128 bytes	

1.2 Get measurement results

1.2.1 Get measurement value

Description:

This command gets measurement results from Measurement Result structure `tENG_fullRes` see . This command accesses the structure as array of words, not as structure fields. Start address is index in array of first element to be got by the command. Length is number of elements (number of words) to be got by the command.

This access organization speed up bulk read of measurement results and maximize SCP throughput. But, host should derive address of reading fields by itself.

Host should periodically poll measurement results, to get them in.

Command format:

Command code	1 word	0x05
Command length	1 word	3
Start address	1 word	

Reply format:

Reply code	1 word	0x00
Reply length (array length + 2)	1 word	
Array	1-4095 words	

1.2.2 Get event

Description:

This command gets event from event queue. Event structure type is `tENG_evChar` see , reply length is constant. The structure consist from event type, start time and duration, event ID and other information, specific for particular event type. Unique event ID is designed to link waveform frames with its event. Special event type is reserved to designate empty event queue.

Host periodically polls Event queue, to avoid its overflow. Polling action consists from continuing requests until PQM replies with empty frame.

Command format:

Command code	1 word	0x06
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Reply length	1 word	XX+2
Structure `tENG_evFull`	XX words	

1.2.3 Get waveform capture frame

Description:

This command gets captured waveform frame from captured waveform queue. Entire waveform is divided to several frames with size less than 4096 words. Each frame is equipped with description data, its structure type is `tENG_wcDescr` see . The structure consist from event type, start time and duration, event ID and number of samples. Host uses this data to assemble frames in continues data flow and associates its to detected event. Number of samples specifies reply lenght.

Host periodically polls Waveform capture queue, to avoid its overflow. Polling action consists from continuing requests until PQM replies with empty frame.

Command format:

Command code	1 word	0x07
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Reply length (data length + structure `size + 2`)	1 word	
Structure `tENG_wcDescr`	XX word	
Captured data	1-4095 words	

1.3 Configuration and software update

1.3.1 Set Calibration and CT-compensation parameters

Description:

This command sets Calibration and CT-compensation parameters. Parameters are applied to running algorithm immediately after sending positive reply on this command. Parameters are saved to flash memory and will be used as start-up parameters after future rebooting device, until is will be overridden. Calibration and CT-compensation parameters structure type is `tENG_calPar` see . This command accesses the

structure as array of words, not as structure fields. Maximum parameters size is 4095 words. Password is the 32 integer to be compared with the defined value, if value is not correct current packet does not change internal data. After receiving 3 commands with incorrect password DSP hangs up.

Command format:

Command code	1 word	0x08
Command length	1 word	XX+4
Password	1 dword	
Structure `tENG_calPar`	XX words	

Reply format:

Reply code	1 word	0x00
Reply length	1 word	2

1.3.2 Get Calibration and CT-compensation parameters

Description:

This command gets current Calibration and CT-compensation parameters. Calibration and CT-compensation parameters structure type is `tENG_calPar` see . This command accesses the structure as array of words, not as structure fields. Maximum parameters size is 4095 words.

Command format:

Command code	1 word	0x09
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Reply length	1 word	XX+2
Structure `tENG_calPar`	XX words	

1.3.3 Set Measurement configuration parameters

Description:

This command sets Measurement configuration parameters. Parameters are applied to running algorithm immediately after sending positive reply on this command. Parameters are saved to flash memory and will be used as start-up parameters after future rebooting device, until is will be overridden. Configuration parameters structure type is `tENG_measCfg` see . This command accesses the structure as array of words, not as structure fields. Password is the 32 integer to be compared with the defined value, if value is not correct current packet does not change internal data. After receiving 3 commands with incorrect password DSP hangs up.

Command format:

Command code	1 word	0x0A
Command length	1 word	XX+4
Password	1 dword	
Structure `tENG_measCfg`	XX words	

Reply format:

Reply code	1 word	0x00

Reply length	1 word	2

1.3.4 Get Measurement configuration parameters

Description:

This command gets current Measurement configuration parameters. Parameters structure type is `tENG_measCfg` see . This command accesses the structure as array of words, not as structure fields.

Command format:

Command code	1 word	0x0B
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Reply length	1 word	XX+2
Structure `tENG_measCfg`	XX words	

1.3.5 Set Event configuration parameters

Description:

This command sets Event configuration parameters. Parameters are applied to running algorithm immediately after sending positive reply on this command. Parameters are saved to flash memory and will be used as start-up parameters after future rebooting device, until is will be overridden. Configuration parameters structure type is `tENG_evCfg` see . This command accesses the structure as array of words, not as structure fields. Password is the 32 integer to be compared with the defined value, if value is not correct current packet does not change internal data. After receiving 3 commands with incorrect password DSP hangs up.

Command format:

Command code	1 word	0x0C
Command length	1 word	XX+4
Password	1 dword	
Structure `tENG_evCfg`	XX words	

Reply format:

Reply code	1 word	0x00
Reply length	1 word	2

1.3.6 Get Event configuration parameters

Description:

This command gets current Event configuration parameters. Parameters structure type is `tENG_evCfg` see . This command accesses the structure as array of words, not as structure fields.

Command format:

Command code	1 word	0x0D
Command length	1 word	2

Reply format:

Reply code	1 word	0x00
Reply length	1 word	XX+2

Structure `tENG_evCfg`	XX words	

1.3.7 Software Update

Description:

This command updates Software image. To make update procedure more reliable, whole Software image is divided to multiple packets. Packet should be sent in ascending order by Packet number field, Total packets field should be the same for all packets. Length of all packets except last one should be 4096 words, last packet length is arbitrary. Bytes of load image are packed to image word data even address to lower byte. Password is the 32 integer to be compared with the defined value, if value is not correct current packet does not change internal data. After receiving 3 commands with incorrect password DSP restarts in a second.

Part of Image is stored to flash immediately after sending positive reply on current command. When complete image is programmed, PQM device reboots automatically in a second. If Software update procedure was failed in unknown state, it should be started from the first packet.

Command format:

Command code	1 word	0x0E
Command length (image length + 6)	1 word	7 - 4101
Password	1 dword	
Packet number	1 word	
Total packets	1 word	
Image	1 - 4095 words	

Reply format:

Reply code	1 word	0x00
Reply length	1 word	2

References

[1] Software Description, Version 0.2.
[2] DSP Engine Interface, Version 0.2.