Pundit Lab/Lab+ Remote Control Interface

Documentation

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Revision History

Rev	Date	Comments
1	02-March-2010	pre-released for review
2	12-April-2010	Detailed description of serial interface related issues, data structures and individual commands
3	20-July-2011	Fixed some inconsistencies in data structures and remote command descriptions. Additional probe frequency of 250kHz (>V1.2.4) Pundit Lab+: Data structure for conversion curves added (TConvCurve) Measurement and device setup data adapted accordingly. New probe gain levels for Pundit Lab+
4	24-October-2011	SET_DEVICE_SETUP: Description of command, response and example corrected and clarified (two responses, no CRC)
5	03-June-2014	Update of conversion curve structure, which has changed for firmware version ≥ V2.3.0.

Table of Contents

1. Introduction

1.1 Scope / intended use

This document describes the Pundit Lab/Lab+ remote control interface. It consists of a set of binary commands which allow the user to configure the Pundit Lab/Lab+ device, to trigger measurements and to collect measurement data using a remote PC.
The target audience is software engineers and Proceq customers who want to embed Pundit Lab/Lab+ remote functionality into their own PC applications.

1.2 Boundary conditions

This document relies on the Pundit Lab/Lab+ Firmware Version V2.4.0 but is also valid for older versions. For further conditions see [2.3 Requirements, prerequisites].

1.3 Abbreviations

Term	Description
USB	Universal serial bus
UART	Universal Asynchronous Receiver Transmitter
PL	Pundit Lab
PLP	Pundit Lab+

2. Overview

2.1 Purpose

The purpose of this document is to describe all necessary interface facts to enable customers to use the Pundit Lab/Lab+ device in a most flexible way according to their needs. Possible applications are:

- Integration of Pundit Lab/Lab+ into a (semi-) automated production line.
- Controlling Pundit Lab/Lab+ and collecting measurement data from the device using own software and databases to be further processed or stored without the need of the Pundit Link software and the overhead of unneeded manual work.
- Remote setup of Pundit Lab/Lab+ into a specific, well defined measurement mode with one click.

2.2 Notation

The different functions can be started through remote commands described later in this document. The description of the individual commands is based on the following rules:

Each command consists of a defined number of bytes. These bytes are always described in hexadecimal syntax (e.g. 0x12 = 18 decimal).

Variable byte-values within a command are described by replacements characters (e.g.: PP).

For number values with two bytes the low-order byte is presented by lower-case letters and the high-order byte by upper-case letters (e.g.: pp PP).

For number values with more than two bytes a number is added to the replacement characters. Numbering starts with 0, which represents the low-order byte (e.g.: ZZ0 ZZ1 ZZ2).

2.3 Requirements, prerequisites, limitations

To avoid problems during remote connection please take care of the following:

- Make sure the Pundit Lab/Lab+ is powered and connected to the PC
- Do not disconnect the Pundit Lab/Lab+ while communication with the PC is active
- Do not try to start/stop measurements locally by pressing any Pundit Lab/Lab+ button while measurements are being triggered remotely from a PC.

2.4 Suggestions, bugs, improvements

We hope that with this solution we can fulfill most customer needs regarding the matter of automation and remote control of Pundit Lab/Lab+.
Should there be any bugs, missing commands, questions and other suggestions regarding this add-on, please feel free to write an email to: *software@proceq.com*
We appreciate your feedback and we will gather any incoming information and try to help whenever possible.

3. Serial interface

3.1 Virtual COM port driver

The Pundit Lab/Lab+ offers a USB UART interface by which it can be remotely controlled from a PC. I.e. physically, the device appears like a normal USB device, but internally the Pundit Lab/Lab+ uses a UART, which is an asynchronous, serial interface (similar to RS232). A so called USB bridge device on the Pundit Lab/Lab+ makes the conversion from UART to USB signals and vice versa.

On the PC side it is necessary to install a virtual COM port driver, which causes the Pundit Lab/Lab+ to appear as if it was connected to a standard serial COM port to the PC. This allows application software running on the PC to access the Pundit Lab/Lab+ in the same way as it would access a standard COM port.

To install the virtual COM port driver you can either:
- Get and install Proceq's Pundit Link software. The virtual COM port driver is installed automatically.

or:
- Get the virtual COM port driver setup program from FTDI's home page (http://www.ftdichip.com/Drivers/VCP.htm)

Provided that the PC has an active internet connection, some newer versions of the Windows operating system (XP, Vista and 7) automatically get and install the needed driver when the USB device is connected.

3.2 Serial Interface parameters

To be able to communicate to the Pundit Lab/Lab+ device, the following serial interface parameters must be set:
- 115200 baud
- 8 data bit
- 1 stop bit
- No parity

3.3 Detect Pundit Lab/Lab+ device

When the Pundit Lab/Lab+ device is connected to a PC, the Windows operating system automatically assigns the next available COM port number. To find the correct COM port from within an application program, it is best to scan the COM ports starting at COM1, COM2, and so on. By sending the GET_DEVICE_INFO command (with sub-command 0x00 for device name and 0x04 for device signature) it's possible to see if the Pundit Lab/Lab+ is connected to that particular port.
Once connected, all of the remote commands described in this document can be sent to the Pundit Lab/Lab+.

4. Data structures

4.1 Data types

The following table lists the types used to characterize data exchanged between the Pundit Lab/Lab+ and a remote PC.

Type specifier	Description
INT8U	Unsigned integral type with a size of 1 byte
INT8S	Signed integral type with a size of 1 byte
INT16U	Unsigned integral type with a size of 2 bytes
INT16S	Signed integral type with a size of 2 bytes
INT32U	Unsigned integral type with a size of 4 bytes
INT32S	Signed integral type with a size of 4 bytes
INT64U	Unsigned integral type with a size of 8 bytes
INT64S	Signed integral type with a size of 8 bytes

4.2 Conversion curves data (TConvCurve)

Conversion curves for compressive strength calculation are only available for Pundit Lab+. The following table list the data bytes of such a conversion curve structure. It will be used in the measurement and device setup data structures described further down in this document.

Byte-Nr	Structure Element	Description	Units / Range
1	INT8U version	Structure version	0x10 (< V2.3.0) 0x21 (≥ V2.3.0)
2	INT8S curveType	Conversion curve type -1 undefined 0 polynomial $(a*v^3 + b*v^2 + c*v + d)$ 1 exponential $(a*e^{b*v})$ 2 SONREB $(a*v^b*R^c)$ v: Pulse velocity	
3…34	INT64S coeff[4]	Array of 4 coefficients (a, b, c, d in the above equations), each of type INT64S. <V2.3.0: The effective float value of the coefficients results by converting each INT64S array element to a float and dividing it by 10^{-12}. ≥ V2.3.0: Each INT64S array element represents a 32-bit float value according to IEEE 754.	
35..36	INT16S min	Lower limit of pulse velocity (v)	[m/s]
37..38	INT16S max	Upper limit of pulse velocity (v)	[m/s]
37..49	INT8S name[11]	Array of 11 characters specifying the name of the conversion curve. The 11th character is the string (null-) terminator.	

4.3 Measurement data

The following table lists the sequential data bytes sent by Pundit Lab/Lab+ when a remote measurement is triggered. They are described in the order they are received on the remote PC. Extensions valid only for Pundit Lab+ are gray shaded in the table and marked with PLP.
Structure size: Pundit Lab: 50 Bytes, Pundit Lab+: 109 Bytes

Byte-Nr	Structure Element	Description	Units / Range
1	INT8U version	Structure version	0x10 (≤ V1.2.5) 0x20 (≥ V2.0.4)
2	INT8U measType	Measurement type 0 undefined 1 direct measurement (default type in case of a remote controlled measurement) 2 surface measurement 3 crack measurement	
3…10	INT64U Reserved1	Reserved, always 0	
11…14	INT32U measId	Measurement object id	0…0xFFFFFFFF
15…16	INT16U corrFactor	Correction factor (temperature, moisture, etc...)	1/100 70…130 (0.7…1.3)
17…18	INT16U pulseLength	Pulse length of transmitter trigger impulse	1/10 [µs] 1…1000 (0.1…100.0µs)
19	INT8S pulseAmpl	Amplitude of transmitter trigger pulse -1 Undefined 0 125 V 1 250 V 2 350 V 3 500 V 4 AUTO (automatic amplitude setting)	[V]
20	INT8S probeFreq	Resonance frequency of connected probes -1 Undefined 0 24 kHz 1 37 kHz 2 54 kHz 3 82 kHz 4 150 kHz 5 200 kHz 6 220 kHz 7 500 kHz (≤V1.2.4) 7 250 kHz (>V1.2.4) 8 500 kHz (>V1.2.4)	[kHz]
21…24	INT32U measDistance	Distance between measurement probes (i.e. path length). If propSpeed is given this value will be calculated as result of the measurement.	1/100 [mm] 0…999999 (0…9.99999m)
25…28	INT32U crackDepth	Crack depth	[mm] 0…9999 (0…9.999m)
29…32	INT32U propTime1	Propagation time 1 as the result of a measurement	1/100 [µs] 0…999999 (0…9999.99µs)
33…36	INT32U propTime2	Propagation time 2 as result of a measurement. For direct measurement this time is always 0. For surface velocity and crack measurement the value will be different from 0.	1/100 [µs] 0…999999 (0…9999.99µs)
37…40	INT32U propSpeed	Propagation speed (pulse velocity) If measDistance is given this value will be calculated as result of the measurement	1/100 [m/s] 0…1000000 (0…10000.00m/s)

7

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Byte-Nr	Structure Element	Description	Units / Range
41	INT8S rxProbeGain	Receiver probe gain -1 Undefined 0 1 1 10 2 100 3 AUTO (automatic gain setting) Pundit Lab+: -1 Undefined 5 1 6 2 7 5 8 10 9 20 10 50 11 100 12 200 13 500 14 1000 15 AUTO (automatic gain setting)	
42	INT8U result	Type of calculated result 1 calculated result is measDistance 2 calculated result is propSpeed	
43…44	INT16S calibTimeOfs	Calibration time offset	
45…46	INT16U pulseAmplValue	Integral value of pulse amplitude (useful if pulseAmpl = AUTO)	125…500
47…48	INT16U rxProbeGainValue	Integral value of probe gain (useful if rxProbeGain = AUTO)	PL: 1…100 PLP: 1…1000
49…50	INT16U nrOfCurveSamples	Number of curve samples sent following this measurement data structure. Always 0 for measurements stored on Pundit Lab/Lab+. Possibly ≠ 0 for remotely triggered measurements (see command TRIGGER_MEASUREMENT).	0
51	INT8U reserved	PLP: Undefined	
52…53	INT16S ambientTemp	PLP: Ambient temperature (from temperature sensor of internal real-time-clock device)	1/10 [°C] -1280…+1278 (-128.0...127.8°C)
54…57	INT32U compStrength	PLP: Compressive strength	1/10 [MPa]
58…106	TConvCurve curve	PLP: Currently active conversion curve data structure according to TConvCurve.	
107…108	INT16U rebValue	PLP: Currently active rebound value corresponding to the currently active conversion curve. The value is only valid if the conversion curve is of type SONREB.	1/10 0…1000 (0…100.0)

4.4 Device setup data

The following table lists the sequential data bytes sent by Pundit Lab/Lab+ when it's setup is interrogated remotely. They are described in the order they are received on the remote PC. Extensions valid only for Pundit Lab+ are gray shaded in the table and marked with PLP.
Structure size: Pundit Lab: 59 Bytes, Pundit Lab+: 322 Bytes

Byte-Nr	Structure Element	Description / Range	Units / Range	Note
1	INT8U version	Structure version	0x10 (≤ V1.2.5) 0x20 (≥ V2.0.4)	4)
2	INT8U reserved	always 0	0	3)
3…6	INT32U measId	Current measurement object id. Incremented by Pundit Lab/Lab+ (see command TRIGGER_MEASUREMENT)		4)
7…10	INT32U nrOfStoredMeas	Number of measurements stored on Pundit Lab/Lab+		4)
11…14	INT32U reserved	Always 0	0	3)
15…18	INT32U presetMeasDistance	Preset measurement distance between probes for direct measurement	1/100 [mm]	1)
19…22	INT32U presetCrackDistance	Preset measurement distance between probes for crack measurement	1/100 [mm]	1)
23…26	INT32U presetSurfaceDistance	Preset measurement distance between probes for surface velocity measurement	1/100 [mm]	1)
27…28	INT16U corrFactor	Correction factor (temperature, moisture, etc.)	1/100 70…130 (0.7…1.3)	
29…32	INT32U calibTime	Target calibration time. Should be same as on the calibration calibration stick.	1/100 [µs]	1)
33…34	INT16S calibTimeOfs	Calibration time offset. Calculated during calibration, which is not possible to be done remotely.	1/100 [µs]	1)
35…36	INT16U pulseLength	Pulse length of transmitter trigger pulse	1/10 [µs]	
37…40	INT32U reserved	Always 0	0	3)
41	INT8U lenUnit	Length unit to be displayed on device 0 m 1 ft		2)
42	INT8S intRxProbeGain	Receiver probe gain -1 Undefined 0 1 1 10 2 100 3 AUTO (automatic gain setting) Pundit Lab+: -1 Undefined 5 1 6 2 7 5 8 10 9 20 10 50 11 100 12 200 13 500 14 1000 15 AUTO (automatic gain setting)		
43	INT8U reserved	always 0		3)

Byte-Nr	Structure Element	Description / Range	Units / Range	Note
44	INT8S pulseAmpl	Amplitude of transmitter trigger pulse -1 Undefined 0 125 V 1 250 V 2 350 V 3 500 V 4 AUTO (automatic ampl. setting)	[V]	
45	INT8S probeFreq	Resonance frequency of connected probes -1 Undefined 0 24 kHz 1 37 kHz 2 54 kHz 3 82 kHz 4 150 kHz 5 200 kHz 6 220 kHz 7 500 kHz (≤V1.2.4) 7 250 kHz (>V1.2.4) 8 500 kHz (>V1.2.4)	[kHz]	
46	INT8S measMode	Measurement mode -1 Undefined 0 Continuous Mode 1 Burst Mode		
47…50	INT32U measDistance	Distance between measurement probes If setup data is set by means of the appropriate remote command and if propSpeed is given, this value must be set to 0 and will then be calculated as result of the measurement.	1/100 [mm] 0…999999 (0…9.99999m)	
51…54	INT32U propSpeed	Propagation speed. If setup data is set by means of the appropriate remote command and if measDistance is given this value must be set to 0 and will be calculated as result of the measurement.	1/100 [m/s] 0…1000000 (0…10000m/s)	
55…56	INT16U reserved	Always 20	20	3)
57…58	INT16U samplingFreq	ADC sampling frequency. Always 2000.	[kHz] 2000	4)
59	INT8U reserved	Always 5	5	3)
60…61	INT16U zeroMeasValue	PLP: Zero value of the signal found during calibration. See chapter 4.5 "Curve data" for more details.	≈ 2048	4)
62…65	reserved	PLP: Undefined		3)
66	INT8U pressUnit	PLP: Compressive strength unit to be displayed on device 0 MPa 1 N/mm2 2 kg/cm2 3 psi		
67	INT8U convCurveIndex	PLP: Array index of the currently active conversion curve and currently active rebound value.	0…4	
68…312	TConvCurve curves[5]	PLP: Array of 5 conversion curves data structures according to TConvCurve.		
313…322	INT16U reb[5]	PLP: Array of 5 rebound values, each corresponding to one of the 5 conversion curves. The appropriate value is only valid if the corresponding curve is of type SONREB.	1/10 0…1000 (0…100.0)	

1) Of practical use only for setup operations executed directly on Pundit Lab/Lab+
2) Internally Pundit Lab/Lab+ always stores and uses [m] or [m/s] for distance or speed values
3) Reserved values are either for internal use of the device or for use with the Pundit Link PC tool. They always must be left unchanged. Otherwise correct operation of the Pundit Lab/Lab+ device is not guaranteed.
4) Read-only values

4.5 Curve data

The curve data is transmitted as a sequence of INT16U values. Each value represents a 12-bit data sample output by the analog-to-digital converter (ADC). An ADC value ranges from the lowest value of 0 to the maximum value of 4095 (0x0000 … 0x0FFF).

In this context an ADC value of 0 corresponds to the most negative curve value (-100%) and a value of 4095 corresponds to the most positive curve value (+100%).

Since the sampled signal is bipolar its zero ADC value in theory is 2048. But in practice the value is somewhere around 2048. In addition it is variable for different devices and different probes. The exact zero ADC value for a given device and for given probes gets determined during calibration. To be able to consider this fact the Pundit Lab+ transmits this value with the device setup data (zeroMeasValue).

The following image shows the relation:

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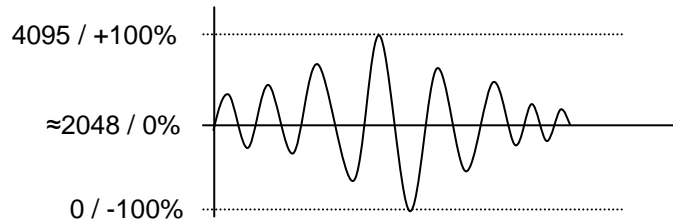
5. Remote commands description

5.1 Overview

Command	ID	Description
SOFTWARE_RESET	0x01	Perform a reset on the Pundit Lab/Lab+
TRIGGER_MEASUREMENT	0x05	Trigger measurement
GET_DEVICE_INFO	0x0A	Get device specific info
GET_DEVICE_SETUP	0x0C	Get device specific setup data
SET_DEVICE_INFO	0x0D	Set device specific setup data
GET_NR_MEASUREMENT	0x0E	Get number of stored measurements on Pundit Lab/Lab+
ERASE_ALL	0x10	Erase all measurements stored on Pundit Lab/Lab+
GET_ALL_MEASUREMENTS	0x11	Download all measurements stored on Pundit Lab/Lab+

5.2 Individual remote commands

5.2.1 Software-Reset

SOFTWARE_RESET (ID 0x01)
Description: Performs a reset and makes the device firmware restart.
Command Syntax: 0xC0 0x01
Response: 0x00   ok

5.2.2 Trigger/stop measurement

TRIGGER_MEASUREMENT (ID 0x05)
Description: Triggers a new measurement or stops a currently running measurement.

Command Syntax: 0xC8 0x05 0x01 0xFFFF 0x02 nn NN MM 0x00
nn NN   Number of curve samples to return
       0x000   Return only measurement data without any curve samples
       0x0001…0x4E20   Return specified number of curve samples (=1….20000)
       0xFFFF   Return maximum number of curve samples (20000)
MM   0x00   do not increment measurement object ID on Pundit Lab
       0x01   increment measurement object ID on Pundit Lab

Response:
0xEF 0x00 ZZ0 ZZ1 ZZ2 yy YY GG HH II JJ KK …mm MM mm MM…. pp PP
0xEF 0x00   identifier for long data blocks
ZZ0 ZZ1 ZZ2 3 bytes overall length information (#bytes, measurement and curve data)
           including 2 Bytes checksum (*Len1*)
           0x000000…0xFFFFFF
yy YY   2 bytes length information (# bytes) of measurement data (*Len2*)
           0x0000 … 0xFFFF (0 … 65535)
           If *Len2 = Len1 – 2* →no curve data has been transmitted
GG HH II J… Measurement data as sequence of bytes ("Measurement Data" description)
mm MM…   curve data as a sequence of INT16U values
pp PP   checksum (CRC-16 over all measurement and curve data)

Response in case of an error:
0xFB   Execution error
0xFC   Transmission error (timeout)
0xFE   Error in command parameter

Example 1:
Command: Trigger measurement, return 1024 (0x400) curve samples
              0xC8 0x05 0x01 0xFF 0xFF 0x02 0x00 0x04 0x01 0x00

Response: 0xEF 0x00 0x36 0x08 0x00 0x32 0x00 0x00 0x00 0x00 0x03 0x06 0xAA …
                        ‿‿‿‿‿‿‿‿‿‿ ‿‿‿‿‿ ‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿
                              A   B   C

              …0x01 0x08 0x00 0x08 0x01 0x08 0x03 0x08 … 0x32 0x46
               ‿‿‿‿‿ ‿‿‿‿‿   ‿‿‿‿‿
                 D   E   F

A: Overall length information (0x000836 →2102 bytes)
B: Length information of measurement data (0x0032 → 50 bytes)
C: Measurement data (50 bytes)
D: Curve sample 1
E: Curve sample 2
F: Checksum

Example 2:
Command: Trigger measurement, return 16000 (0x3E80) curve samples
              0xC8 0x05 0x01 0xFF 0xFF 0x02 0x08 0x3E 0x01 0x00

Response: 0xEF 0x00 0xB6 0x3E 0x00 0x32 0x00 0x00 0x00 0x00 0x03 0x06 0xAA …
                        ‿‿‿‿‿‿‿‿‿‿ ‿‿‿‿‿ ‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿‿
                              A   B   C

              …0x00 0x08 0x00 0x08 0xFF 0x07 0x01 0x08 … 0x45 0x78
               ‿‿‿‿‿ ‿‿‿‿‿   ‿‿‿‿‿
                 D   E   F
A: Overall length information (0x007D36 →32054 bytes)
B: Length information of measurement data (0x0032 → 50 bytes)
C: Measurement data (50 bytes); D: Curve sample 1; E: Curve sample 2; F: Checksum

5.2.3 Query device information

GET_DEVICE_INFO (ID 0x0A)
Description: Query device specific information of Pundit Lab/Lab+.

Command Syntax: 0xC1 0x0A YY
YY   Device information to query
      0x00   Device name
      0x01   Device serial number
      0x02   Hardware serial number
      0x03   Hardware revision number
      0x04   Device signature (Pundit Lab/Lab+ : "09000000")
      0x05   Firmware version

Response: GG HH II JJ KK ... 0x00   Device specific information as a NULL-terminated string 0xFC   Transmission error (timeout) 0xFE   Error in command parameter

Example 1:
Command: Query device name (Pundit Lab)
           0xC1 0x0A 0x00
Response: 0x50 0x75 0x6E 0x64 0x69 0x74 0x20 0x4C 0x61 0x62 0x00
            P   u   n   d   i   t   L   a   b   <\0>
Example 2:
Command: Query device name (Pundit Lab+)
           0xC1 0x0A 0x00
Response: 0x50 0x75 0x6E 0x64 0x69 0x74 0x20 0x4C 0x61 0x62 0x2B 0x00
            P   u   n   d   i   t   L   a   b   +   <\0>
 	
Example 3:
Command: Query device serial number
           0xC1 0x0A 0x01
Response: 0x50 0x4C 0x30 0x31 0x2D 0x30 0x30 0x30 0x2D 0x30 0x30 0x30 0x30 0x00
            P   L   0   1   -   0   0   1   -   0   0   0   1   <\0>
Example 4:
Command: Query device signature (Pundit Lab/Lab+)
           0xC1 0x0A 0x04
Response: 0x30 0x39 0x30 0x30 0x30 0x30 0x30 0x30 0x00
            0   9   0   0   0   0   0   0   <\0>
Example 5:
Command: Query firmware version
           0xC1 0x0A 0x05
Response: 0x32 0x2E 0x30 0x2E 0x34 0x00
            2   .   0   .   4   <\0>

5.2.4 Query device setup data

GET_DEVICE_SETUP (ID 0x0C)
Description: Query device specific setup data of the Pundit Lab/Lab+.
Command Syntax: 0xC0 0x0C
Response: 0xEF 0x00 ZZ0 ZZ1 ZZ2 GG HH II JJ KK LL MM …… pp PP 0xEF 0x00   identifier for long data blocks ZZ0 ZZ1 ZZ2 3 bytes overall length information (# bytes) including the 2 Bytes of the   checksum. 0x000000…0xFFFFFF GG HH II…   Setup data as sequence of bytes (see "Device Setup Data" description) pp PP   checksum (CRC-16 over all setup data excluding length information) **Response in case of an error:** 0xF3   CRC error 0xFC   Transmission error (timeout) 0xFE   Error in command parameter

Example:
Command: Query device setup
               0xC0 0x0C
 	
Response: 0xEF 0x00 0x3D 0x00 0x00 0x10 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
 	
             A   B
             0x00 0x00 0x00 0x00 0x00 0x20 0x4E 0x00 0x00 0x3A 0x00 0x98 0x3A 0x00
             0x00 0x64 0x00 0xEC 0x00 0x00 0x00 0x00 0x5D 0x00 0x64 0x00 0x00 0x00
             0x00 0x00 0x00 0x00 0x02 0x00 0x20 0x4E 0x00 0x00 0x00 0x00 0x00 0x00
             0x14 0x00 0xD0 0x07 0x05 0xCA 0x6F
 	
             C   D
 	
A: Identifier for long data blocks
B: Overall length information
C: Device setup data
D: Checksum

5.2.5 Set device setup data

SET_DEVICE_SETUP (ID 0x0D)
Description: Sets device specific setup data on Pundit Lab/Lab+.
Command Syntax: 1. Pre-Command: 0xC2 0x0D xx XX xx XX   length information of the data sent in the following data command 2. Data-Command: GG HH II JJ KK GG HH II ….   Setup data as sequence of bytes (see "Device Setup Data" description)
Response: 0x00   ok 0xFC   Transmission error (timeout) 0xFE   Error in command parameter (command length mismatch, parameter out of range) **Important note!** After each command (pre-/data-command) the device returns a response containing one of the above codes. After reception of the pre-command's 'ok' response the application must send the data-command within **200ms**! Otherwise the device will respond with an error code.

Example: for Pundit Lab
Pre-Command:
       0xC2 0x0D 0x3B 0x00
 	
Response 1: 0x00
 	
Data-Command:
       0x20 0x00 0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
       0x00 0x20 0x4E 0x00 0x00 0x4E 0x98 0x3A 0x00 0x00 0x64 0x00 0xEC
       0x09 0x00 0x00 0x00 0x00 0x5D 0x00 0x64 0x00 0x00 0x00 0x00 0x01
       0x00 0x03 0x02 0x00 0x20 0x4E 0x00 0x00 0x00 0x00 0x00 0x00 0x14
       0x00 0xD0 0x07 0x05
 	
Response 2: 0x00

5.2.6 Get number of stored measurements

GET_NR_MEASUREMENT (ID 0x0E)
Description: Query number of stored measurements on Pundit Lab/Lab+.
Command Syntax: 0xC0 0x0E
Response: 0x02 zz ZZ   2 bytes response   zz ZZ   0x0000 … 0xFFFF   number of stored measurements 0xFC   Transmission error (timeout) 0xFE   Error in command parameter

5.2.7 Erase all measurements

ERASE_ALL (ID 0x10)
Description:
Erase all measurements stored on Pundit Lab/Lab+. All measurement data will be lost.
Command Syntax: 0xC1 0x10 SS
SS: Treatment of device setup on Pundit Lab/Lab+
0x00   Leave device setup data unchanged
0x01   Set default device setup
Response:
0x00   ok
0xFB   Execution error
0xFC   Transmission error (timeout)
0xFE   Error in command parameter

5.2.8 Download all measurements

GET_ALL_MEASUREMENTS (ID 0x11)
Description:
Download all measurement data stored on Pundit Lab/Lab+.
Command Syntax: 0xC0 0x11

Response without measurement data:
0x00   No measurement data stored on Pundit Lab/Lab+
 	
Response with measurement data:
The message sent by the Pundit Lab/Lab+ consists of 3 parts:
1. **Message header:**
    0xEF 0x00 ZZ0 ZZ1 ZZ2…
       0xEF 0x00   Identifier for long data blocks
       ZZ0 ZZ1 ZZ2 3 bytes overall length information (# bytes) including 2 Bytes overall checksum, 0x000000…0xFFFFFF
2. **1 to n measurement data sets:**
    …0xEF 0x00 XX0 XX1 XX2 yy YY GG HH II JJ KK …mm MM mm MM…. pp PP…
       0xEF 0x00   Identifier for long data blocks
       XX0 XX1 XX2 3 bytes length information for one measurement including 2 bytes checksum, 0x000000…0xFFFFFF
       yy YY   2 bytes length information for measurement data, 0x0000…0xFFFF
       GG HH II J… Measurement data as sequence of bytes (see "Measurement Data" description)
       mm MM…   curve data as a sequence of INT16U values
       pp PP   checksum (CRC-16 over one measurement data set)
3. **Overall Checksum:**
    …. qqQQ   overall checksum (CRC-16 over all data)
 	
Response in case of error:
0xFC   Transmission error (timeout)
0xFE   Error in command parameter

Example: see example for TRIGGER_MEASUREMENT

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