USB

The Teensy 4.1 USB development board provides a native USB interface that can operate at up to 480 Mbit/sec. This interface is used by the P7001 USB+ Interface to communicate with a modern computer. No drivers are needed. The interface is automatically detected as a COM-port on Windows 7 or newer. Baud rate settings are ignored - data transfer is always done at maximum speed. Any terminal program can be used to interact with the P7001 USB+ Interface.

Commands are not case sensitive. TIME?, time? and TiMe? will be accepted. Numbers can be given in decimal (1024), hexadecimal (0x400) or octal (02000) notation. It's possible to change the notation from number to number - e.g.: READMEM 0x200, 01000

For the moment, all return values are in decimal notation.

The computer can talk to the P7001 in an SCPI like, but simpler command syntax. The P7001 also uses the interface as a terminal to display massages. There is an option to output debugging information over the interface.

SCPI

SCPI is a standard for syntax and commands to use in controlling programmable test and measurement devices. The P7001 USB+ Interface has some of the basic SCPI commands implemented. But most commands are newly created to match the specific design of the P7001.

?

Returns a list of all available commands with a short description.

*IDN?

Returns the device identification in the standard SCPI format.

Syntax: *IDN?

Example output:

```
Holger,P7001 USB+,04E9E50F4987,HW:1.0,FW:1.0,1KB
```

Explanation

<Manufacturer>, <Device Name>, <Serial Number>, <Hardware Revision>, <Firmware Revision>, <P7001 Memory Configuration>

ID?

Shows the extended hardware- & firmware information.

Syntax:

ID?

Example output:

```
P7001 USB+, HW:1.0, 04E9E50F4987
DPO: 1KB
Firmware: FW:1.0.0.2859 - 2023-01-16 20-10-59 UTC
COPYRIGHT 2021..2023 HOLGER LUEBBEN
```

DUMPMEM?

Dumps the complete RAM content of the P7001. For the moment, this call does not care about the available memory configuration. The content of the complete 4k address space is returned. Depending on the memory configuration, there might be overlapping address areas in the P7001. This command does not take this into account. All 4096 values are always transmitted. The values are returned as decimal numbers in the range 0...1023. The delimiter is always a comma. For non-existing addresses 1023 is returned.

Syntax:

DUMPMEM?

Example output:

```
53,252,807,1002,...,17,43
```

TIME?

Returns the actual system time of the P7001 in the local time zone.

The return format is:

yyyy-MM-dd HH:mm:ss

Explanation

yyyy	The year as a four-digit number.
MM	The month, from 01 through 12.
dd	The day of the month, from 01 through 31.
HH	The hour, using a 24-hour clock from 00 to 23.
mm	The minute, from 00 through 59.
ss	The second, from 00 through 59.

Syntax:

TIME?

Example output:

```
2023-02-26 16:22:04
```

JOKE?

Returns the actual joke of the day.

Syntax:

JOKE?

Example output:

See Joke of the day

RAMCONFIG?

Returns the RAM configuration of the P7001.

Syntax:

RAMCONFIG?

Possible return values are:

```
1kB with readout
1kB no readout
2kB with readout
2kB no readout
3kB
4kB
RAM config error
```

READMEM

Returns the RAM content of 'COUNT' number of cells, starting at a specific address.

Syntax:

READMEM ADR[,][COUNT]

Examples

READMEM 1024	returns the content of the single memory cell 1024
READMEM 1024 512	returns the 512 raw values of waveform memory C
READMEM 0x800,0120	returns the 80 raw values of readout memory A in Field 0
READMEM 015600	returns the content of the Front Panel Status register info: leading zero indicates octal number notation

The count and range of the return values depend on the selected address range. Up to address 4095 the return values are in the range 0…1023. For the status registers Front Panel (015600), Display Generator (16000), Readout Interface (016200), ADC (016400) and I/O Interface (016600) the return values are in the range 0…65535. When the start address is in the range 0…4095 the maximum count of returned values is limited by the upper bound of this range. When a Status register is selected only a single value will be returned.

On systems with installed Hardware Signal Averager module the valid ranges are automatically extended to 4096…5119 for the HSA memory contents and (015400) as the HSA Control Status register.

Further checks are not done. Example: On systems with removed readout interface card (1k no readout or 2k no readout) its still possible to read the non-existent Status register at address (016200). The P7001 will return the value 65535 in this case.

Ranges of READMEM command

Address range decimal	**Address range octal**	**Content**	**Data range**
0...2047	0...03777	Waveforms A...D	0...1023
2048...4095	04000...07777	Scale factors & messages	0...1023
4096...5119	010000...011777	HSA Waveforms	0...1023
6912	015400	HSA Control Register	0...65535
7040	015600	Front Panel Status Register	0...65535
7168	016000	Display Gen. Status Register	0...65535
7296	016200	Readout Int. Status Register	0...65535
7424	016400	ADC Status Register	0...65535

WRITEMEM

Writes one or more values to an address range of the P7001 starting with the given start address.

Syntax:

WRITEMEM ADR[,] VALUE1[,] VALUE2[,]...

Examples

WRITEMEM 1024,0	clears the content of memory cell 1024
WRITEMEM 1024 512 73	writes the value 512 to memory cell 1024 and 73 to 1025
WRITEMEM 1024, 512, 73	same as above, with different delimiter
WRITEMEM 015600 520	writes the value 520 to the Front Panel status register. info: leading zero indicates octal number notation

Ranges of WRITEMEM command

Address range decimal	**Address range octal**	**Content**	**Data range**
0...2047	0...03777	Waveforms A...D	0...1023
2048...4095	04000...07777	Scale factors & messages	0...1023
4096...5119	010000...011777	HSA Waveforms	0...1023

Address range decimal	Address range octal	Content	Data range
6912	015400	HSA Control Register	0...65535
7040	015600	Front Panel Status Register	0...65535
7168	016000	Display Gen. Status Register	0...65535
7296	016200	Readout Int. Status Register	0...65535
7424	016400	ADC Status Register	0...65535

MEMSET

Writes a specific values to an address range of the P7001 starting with the given start address.

Syntax:

MEMSET ADR[,]VALUE1[,][COUNT]

Examples

MEMSET 1024,0	clears the content of memory cell 1024
MEMSET 0,0,4096	clears the content of the entire 4k of memory
MEMSET 512,128,512	inits the content of waveform memory B with the value 128

READWFMX

Returns a string with waveform information. It contains a preamble section with scaling information followed by an array of curve data in floating point format. The syntax of the returned string is based on the Tektronix 7854 waveform data format. It's extended by some parameters, but it should be possible to import the waveform data in any program with a proper 7854 waveform data importer.

Syntax:

READWFMA, READWFMB, READWFWC or READWFMD

Example output:

```
WFMPRE ENCDG:ASC,NR.PT:512,PT.FMT:Y,XZERO:0,XINCR:3.906e-06,XUNIT:S,
YZERO:0, YMULT:1,YUNIT:V,MEMORY:A,LABEL:"COMMENT",PLUGIN.V:LEFT.CH1,
PLUGIN.H:A.CH1,DIG.MODE:AVG_COUNT, DIG.PARAMS:"min:50,max:100,t:100",
TIME:2023-02-24 16:52:24, TIME.ZONE:UTC+00:00,TIME.MODE:TRANSFER;
CURVE 1.026,1.026,1.026,1.026,...,-3.001,-3.001,1.026
```

Waveform format Description

Key	Description
WFMPRE	Preamble header identifier
ENCDG:ASC	Curve data encoded as ASCII data

Key	Description
NR.PT:512	Number of points per waveform
PT.FMT:Y	Point format - Curve data returned in y/t mode
XZERO:0	Horizontal offset
XINCR:[10*HSCL/512]	horizontal increment between points
XUNIT:S	Horizontal scale factor units
YZERO:0	Vertical offset from center graticule in divisions. Range: +/-5 Divisions
YMULT:1	Vertical Scale Factor
YUNIT:V	Vertical scale factor units
MEMORY:[A...D]	Memory location on the P7001
LABEL:”COMMENT”	Label given to the waveform under program control
PLUGIN.V:LEFT.CH1	Detected Vertical compartment and channel of the waveform
PLUGIN.H:A.CH1	Detected Horizontal compartment and channel of the waveform
DIG.MODE:AVG_COUNT	Detected digitizing mode
DIG.PARAMS:”min:50,max:100,t:100”	Additional prameters used by the digitizing process
TIME:2023-02-24 16:52:24	Date & Time of digitizing the waveform
TIME.ZONE:UTC+00:00	Time zone of the Date & time above
TIME.MODE:[TRANSFER, DIGITIZE]	DIGITIZE: Timestamp was taken at start of digitizing process. TRANSFER: Timestamp was taken when data was transferred to the controller
CURVE	Curve data header identifier
1.026,0.9873,...,-3.001	512 values of vertical point data in floating point format, relative to graticule center.

MEMX?

Same as READWFM, see above

Syntax:

MEMA?, MEMB?, MEMC? or MEMD?

Example:

Same as READWFM, see above

WFMX?

Same as READWFM, see above

Syntax:

WFMA?, WFMB?, WFMC? or WFMD?

Example:

Same as READWFM, see above

Terminal

The USB connection will be used by the Interface as an Output Terminal for messages and debug information. One example is the Pulse Parameters Program which prints some Measurement results when the Program Call Buttons 3 or 11 are pressed. Debug Information is sent during firmware development.

The following two pictures are a comparison between the original terminal output vs the modern recreation.

PULSE PARAMETERS
JULY 29,1974

VOLTAGE MEASUREMENTS

MEAN = 9EMV
RMS = 143MV

PEAK TO PEAK = 372MV
AMPLITUDE = 213MV

0 % VALUE = 10MV
10 % VALUE = 31MV
50 % VALUE = 116MV
90 % VALUE = 201MV
100 % VALUE = 223MV

TIME MEASUREMENTS

RISETIME = 6US
DELAY = 144US
DURATION = 198US
FALLTIME = 6US

PROXIMAL-DISTAL TIMES

TIME, P-P = 205US
TIME, D-D = 193US
TIME, P-D = 199US
TIME, D-P = 199US

LINEAR PULSE 10% & 90% MATCH		GAUSSIAN PULSE 10% & 50% MATCH		NYQUIST PULSE 50% & 90% MATCH	
TOTAL DEVIATIONS		TOTAL DEVIATIONS		TOTAL DEVIATIONS	
FLAT WITHIN	38.1%	FLAT WITHIN	38.1%	FLAT WITHIN	38.1%
AND	-36.6%	AND	-36.6%	AND	-36.6%
TOTAL OF	74.7%	TOTAL OF	74.7%	TOTAL OF	74.7%
EXCLUDING TRANSITIONS		EXCLUDING TRANSITIONS		EXCLUDING TRANSITIONS	
FLAT WITHIN	38.1%	FLAT WITHIN	38.1%	FLAT WITHIN	38.1%
AND	-36.6%	AND	-36.6%	AND	-36.6%
TOTAL OF	74.7%	TOTAL OF	74.7%	TOTAL OF	74.7%

1883-24

PULSE PARAMETERS
JULY 29,1974

VOLTAGE MEASUREMENTS

MEAN = -1.411mV
RMS = 181.6mV

PEAK TO PEAK = 506.4mV
AMPLITUDE = 505.9mV

0 % VALUE = -246.1mV
10 % VALUE = -195.5mV
50 % VALUE = 6.836mV
90 % VALUE = 209.2mV
100 % VALUE = 259.8mV

TIME MEASUREMENTS

RISETIME = 515.6uS
DELAY = 433.6uS
DURATION = 483.5uS
FALLTIME = 56.48uS

PROXIMAL-DISTAL TIMES

TIME, P-P = 769.4uS
TIME, D-D = 197.3uS
TIME, P-D = 712.9uS
TIME, D-P = 253.8uS

LINEAR PULSE 10% & 90% MATCH		GAUSSIAN PULSE 10% & 90% MATCH		NYQUIST PULSE 10% & 90% MATCH	
TOTAL DEVIATIONS		TOTAL DEVIATIONS		TOTAL DEVIATIONS	
FLAT WITHIN	4.01%	FLAT WITHIN	3.783%	FLAT WITHIN	918.6m%
AND	-4.008%	AND	-1.724%	AND	-698.2m%
TOTAL OF	8.018%	TOTAL OF	5.507%	TOTAL OF	1.617%
EXCLUDING TRANSITIONS		EXCLUDING TRANSITIONS		EXCLUDING TRANSITIONS	
FLAT WITHIN	532.2m%	FLAT WITHIN	533.5m%	FLAT WITHIN	532.2m%
AND	0%	AND	-145.3m%	AND	0%
TOTAL OF	532.2m%	TOTAL OF	678.8m%	TOTAL OF	532.2m%