APG7400A　USB-MCA4

Command Manual

Version 1.5

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1 Safety Precautions / Disclaimer

Thank you very much for purchasing this product from TechnoAP Co., Ltd. Before using this product, please read this "Safety Precautions and Disclaimer" and be sure to observe the contents and use the product properly.

We are not responsible for any damage caused by abnormality of device, detector, connected device, application, damage to failure, other secondary damage, even if accident caused by using this device.

Prohibited matter

- Cannot be used for applications requiring special quality and reliability related to human life or accidents.
- Cannot be used in environments with high temperature, high humidity, or strong vibration.
- Do not apply strong impact or vibration.
- Do not disassemble or modify.
- Do not expose to water or condensation. Do not operate with wet hands.
- If heat generation, deformation, discoloration, or abnormal odor is observed, stop use immediately and contact our company.

Note

- Use this device within the room temperature range and ensure that no condensation occurs.
- If smoke or abnormal heat generation occurs, turn off the power immediately.
- This device is a high-precision electronic instrument. Be careful of static electricity.
- Do not store this device in dusty locations or in high-temperature or high-humidity environments.
- Do not bring devices that emit strong radio waves, such as mobile phones or transceivers, close to this device.
- Malfunctions may occur in environments with high levels of electrical noise.
- The specifications of this device and the contents of this document and related materials are subject to change without notice.

2 Overview

2.1 Overview

This device can be connected to a PC via a USB cable, and measurement and control can be performed by sending and receiving commands from Microsoft Visual Studio, National Instruments LabVIEW, Linux environments, and others.
This document explains the handling of measurement and control commands for this device.

※ The contents of this document are subject to change without notice.

2.2 Revision History

July 31, 2017	Version 1.0	First edition
August 10, 2017	Version 1.1	Correction of typographical errors
November 12, 2019	Version 1.2	Correction of typographical errors in STUW and HIXX commands
December 07, 2020	Version 1.3	Addition and correction of commands
July 10, 2022	Version 1.4	Addition of list mode procedures, correction of typographical errors
March 16, 2024	Version 1.5	Change of maximum values such as ADC gain, correction of dead time units in status

2.3 Environment

The following environment is assumed to be in place.

(1) FTDI D2XX Drivers are installed.
(2) Our sample programs can be executed.

3 Command

3.1 Overview

Settings and data acquisition for this device are performed via USB communication.
The types of commands are broadly classified into settings, status, histogram, and list. Details of each type are described below.

(1) Setting Commands

For setting commands, when 8 bytes are transmitted from the PC, the device returns an 8-byte response. After transmitting the 8 bytes, it is necessary to immediately read the 8 bytes.

Example: Setting the histogram mode

PC →This device	Command section (4 bytes) ASCII character string 4D4F4457 (MODW)	Parameter section (4 bytes) Binary 0x00000000
This device →PC	Command section (4 bytes) ASCII character string 4D4F4457 (MODW)	Parameter section (4 bytes) Binary 0x00000000

[Settings from the PC]
The “command section” is 4 bytes and consists of an ASCII character string. For example, in the case of mode setting, it is “MODW”, which corresponds to “4D4F4457” when represented as an ASCII character string.
The “parameter section” is 4 bytes in binary format (big-endian, network byte order, MSB first) and contains the value to be set.

[Response from the device]
If the setting is executed correctly, a response is returned with the same content as the setting. By comparing the setting content with the response content, it is possible to confirm whether the setting command was executed normally.

(2) Status Commands

For status commands, when 4 bytes are transmitted from the PC, the device returns a 94-byte response. After transmitting the 4 bytes, it is necessary to immediately read the 94 bytes.

PC →This device	Command section (4 bytes) ASCII character string 53545557 (STUW)	Parameter section (4 bytes) Binary 0x00000000
This device →PC	Data section (94 bytes) Binary Realtime, CH1–CH4 Throughput rate, Throughput rate, Input rate	

[Settings from the PC]
The “command section” is 4 bytes and consists of an ASCII character string. It is “STUW”, which corresponds to “53545557” when represented as an ASCII character string. The “parameter section” is 4 bytes in binary format, and 0 is set.

[Response from the device]

If the setting is executed correctly, the following data can be received: real time, CH1 throughput rate, throughput count, input rate, and similarly the throughput rate, throughput count, and input rate for CH2 through CH4.

(3) Histogram Commands

The following processing should be performed after starting measurement in histogram mode using the previously described setting commands.

Histogram data is up to a maximum of 65,536 bytes per channel (65,536 bytes = 16,384 channels × 4 bytes per channel), but since it is read in units of one block (2,048 bytes), it is necessary to read the data in segments while specifying the block number to be read.

When the PC sends a histogram read command (8 bytes including block number information), the device returns a 2,048-byte response. After sending the read command, it is necessary to immediately read the 2,048 bytes.

The 2,048-byte response here does not include a header and consists only of the histogram data for the specified one block. Each block corresponds to 512 channels (512 = 2,048 bytes / 4 bytes). To acquire up to 16,384 channels, it is necessary to execute the operation 32 times (32 = 16,384 channels / 512 channels)

Example: Acquiring 16,384 channels of histogram data for CH1

Histogram CH setting

PC →This device	Command section (4 bytes) ASCII character string 48434857 (HCHW)	Parameter section (4 bytes) Binary 0x00000000
This device →PC	Command section (4 bytes) ASCII character string 48434857 (HCHW)	Parameter section (4 bytes) Binary 0x00000000

Reading histogram data

PC →This device	Command section (4 bytes) ASCII character string 48493030 (HI00) Block number 0	Parameter section (4 bytes) Binary 0x00000000
This device →PC	Data section (2048 bytes) Binary Histogram data for channels 0 to 511	

*Subsequently, execute block numbers 1 to 31 in the same manner.

PC →This device	Command section (4 bytes) ASCII character string 48493146 (HI1F) Block number 0	Parameter section (4 bytes) Binary 0x00000000
This device →PC	Data section (2048 bytes) Binary Histogram data for channels 15872 to 16383	

[CH Number Setting from the PC]
First, set the CH number to be read using the “HCHW” command. The “command section” is 4 bytes and is an ASCII character string, which is “48434857”.
The “parameter section” is 4 bytes in binary format (big-endian, network byte order, MSB first). Set it to 0 for CH1 and to 3 for CH4.

[Response to CH Number Setting from the Device]
If the setting is executed correctly, a response is returned with the same content as the setting. By comparing the setting content with the response content, it is possible to confirm whether the setting command was executed normally.

[Histogram Readout and Block Number Setting from the PC]
The “command section” is 4 bytes, and the block number to be read is set as an ASCII character string in the “HIXX” format. “XX” is a hexadecimal block number: to acquire channels 0 to 512, the ASCII character string is “HI00”, and to acquire channels 15872 to 16383, it is “HI1F”.
The “parameter section” is 4 bytes in binary format, and 0 is set. Histogram data for the specified channel range of the specified CH, amounting to 2048 bytes (512 channels), is sent from the device.

Similarly, read out the required number of channels while specifying the ranges.

(1) List Commands
The following processing should be performed after starting measurement in list mode using the previously described setting commands.

With list commands, when the PC sends a list read start request, the device returns an 8-byte response. The parameter section of the 8-byte response contains the number of list events stored in the device, so it is necessary to immediately read list data corresponding to that number of events. Since one event is 8 bytes, the size of the list data to be read is the number of events × 8 bytes.

List read start

	Command section (4 bytes) ASCII character string 4C495352 (LISR)	Parameter section (4 bytes) Binary 0x00000000		
PC →This device				
This device →PC			Command section (4 bytes) ASCII character string 4C495341 (LISA)	Parameter section (4 bytes) Binary n

Reading list data

(After receiving LISA, subsequently read list data for the number of events)

	Data section (n × 8 bytes) Binary List data for n events
This device →PC	

[Read Start from the PC]

Using the “LISR” command, instruct the device to start reading list data.

The “command section” is 4 bytes and is an ASCII character string, which is “4C495352”.

The “parameter section” is 4 bytes in binary format, and 0 is always set.

[Response from the Device]

In response to the list read start request, there is an 8-byte response.

In the response content, the “command section” is a 4-byte ASCII character string, which is “4C495341”.

The “parameter section” is 4 bytes in binary format (big-endian, network byte order, MSB first) and indicates the number of list events stored in the device.

[List Data Read from the PC]

After receiving the response, immediately read the list data. Since the list data is 8 bytes per event, it is necessary to read all data amounting to the number of events × 8 bytes. Note that the list data is also in binary format (big-endian, network byte order, MSB first).

3.2 Command List

No.	Command				Description	Remarks
	Category		Abbreviation	ASCII		
1	Register setting	CH1(ch.0)	ADGW	41444757	CH1ADC Gain	
2			ADG0	41444730	CH1ADC Gain	*Planned for implementation
3			THRW	54485257	CH1 Threshold	
4			THR0	54485230	CH1 Threshold	*Planned for implementation
5			LLDW	4C4C4457	CH1LLD	
6			LLD0	4C4C4430	CH1LLD	*Planned for implementation
7			ULDW	554C4457	CH1ULD	
8			ULD0	554C4430	CH1ULD	*Planned for implementation
9			OFSW	4F465357	CH1Offset	
10			OFS0	4F465330	CH1Offset	*Planned for implementation
11		CH2(ch.1)	ADG1	41444731	CH2ADC Gain	
12			THR1	54485231	CH2 Threshold	
13			LLD1	4C4C4431	CH2LLD	
14			ULD1	554C4431	CH2ULD	
15			OFS1	4F465331	CH2Offset	
18		CH3(ch.2)	ADG2	41444732	CH3ADC Gain	
19			THR2	54485232	CH3 Threshold	
20			LLD2	4C4C4432	CH3LLD	
21			ULD2	554C4432	CH3ULD	
22			OFS2	4F465332	CH3Offset	
25		CH4(ch.3)	ADG3	41444733	CH4ADC Gain	
26			THR3	54485233	CH4 Threshold	
27			LLD3	4C4C4433	CH4LLD	
28			ULD3	554C4433	CH4ULD	
29			OFS3	4F465333	CH4Offset	
32		Common	MODW	4D4F4457	Mode	0: Histogram, 1: List, 2: Coincidence, 3: MCS
33			MMDW	4D4D4457	Measurement Mode	0：Realtime, 1：Livetime
34			MT0W	4D543057	Measurement Time	Upper 12bit
35			MT1W	4D543157		Lower 32bit
36			PDSW	50445357	Peak Detection Mode	
37			AQSW	41515357	Start Measurement	
38			AQEW	41514557	Stop Measurement	
39			CLRW	434C5257	Clear	
40			HCHW	48434857	Histogram Request CH	
41			LISR	4C495352	List Data Read Start	
42			COCH	434F4348	Coincidence Target CH	0:CH1&CH2
43			COWD	434F5744	Coincidence Time	
44			COD0	434F4430	CH1Coincidence Delay Time	
45			COD1	434F4431	CH2 Coincidence Delay Time	
46			DWLT	44574C54	Dwell Time	
47	Status		STUW	53545557	Status	Real time, CH1～4Live time,Dead time, TCR, TCT, ICR
48	Histogram		HI00	48493030	Histogram memory read Read in units of 512 points × 4 bytes	0～511 channels
49			HI01	48493031		512～1023 channels
50			HI02	48493032		1024～1535 channels
51			HI03	48493033		1536～2047 channels
52			HI04	48493034		2048～2559 channels
53			HI05	48493035		2560～3071 channels
54			HI06	48493036		3072～3583 channels

55		HI07	48493037		3584～4095 channels
56		HI08	48493038		4096～4607 channels
57		HI09	48493039		4608～5119 channels
58		HI0A	48493041		5120～5631 channels
59		HI0B	48493042		5632～6143 channels
60		HI0C	48493043		6144～6655 channels
61		HI0D	48493044		6656～7167 channels
62		HI0E	48493045		7168～7679 channels
63		HI0F	48493046		7680～8191 channels
64		HI10	48493130		8192～8703 channels
65		HI11	48493131		8704～9215 channels
66		HI12	48493132		9216～9727 channels
67		HI13	48493133		9728～10239 channels
68		HI14	48493134		10240～10751 channels
69		HI15	48493135		10752～11263 channels
70		HI16	48493136		11264～11775 channels
71		HI17	48493137		11776～12287 channels
72		HI18	48493138		12288～12799 channels
73		HI19	48493139		12800～13311 channels
74		HI1A	48493141		13312～13823 channels
75		HI1B	48493142		13824～14335 channels
76		HI1C	48493143		14336～14847 channels
77		HI1D	48493144		14848～15359 channels
78		HI1E	48493145		15360～15871 channels
47		HI1F	48493146		15872～16383 channels

3.3 Command Descriptions

※ For details of each setting, please refer to the “USB-MCA4 Instruction Manual” included with this device.

(1) ADC Gain

Description: ADC gain and number of channels.

Range: 2: 4096 channels, 3: 2048 channels, 4: 1024 channels,
5: 512 channels

(2) Threshold

Description: Threshold for the timing to start waveform acquisition. Set to a value equal to or less than the LLD.

Range: 0 to 4095

(3) LLD

Description: Energy LLD (Lower Level Discriminator). Unit: ch. Set to a value greater than or equal to the threshold and less than the ULD.

Range: 0 to 4095

(4) ULD

Description: Energy ULD (Upper Level Discriminator). Unit: ch. Set to a value greater than the LLD.

Range: 0 to 4095

(5) Offset

Description: Positive-direction offset. Unit: ch.

Range: 0 to 2047

(6) Mode

Description: Mode setting.

Range: 0: Histogram, 1: List, 2: Coincidence, 3: MCS

(7) Measurement Time

Description: Measurement time setting. Since this device operates with an internal clock of 25 MHz, the value set is the measurement time (seconds) multiplied by 25,000,000. As the upper limit per setting is 32 bits, the value is set in two operations: the upper register (12 bits) and the lower register (32 bits).

Range: Maximum 192 hours. In this case,
60 seconds × 60 minutes × 192 hours × 25,000,000 = 17,280,000,000,000 (0xFB750430000), so set 0xFB7 to the upper register and 0x50430000 to the lower register.

(8) Selection of Peak (Maximum Pulse Height) Detection Method
Description: Selects the detection method for the peak (maximum pulse height).
Range: 0: abs, 1: fast

(9) Start Measurement
Description: Sets the start of measurement.
Range: 1: Start

(10) Stop Measurement
Description: Sets the stop of measurement.
Range: 1: Stop

(11) Clear
Description: Reset of measurement time and clearing of measurement data.
Range: 0: Clear

(12) Histogram Request CH
Description: Sets the target CH number before reading histogram data.
Range: 0: CH1, 1: CH2, 2: CH3, 3: CH4

(13) List Data Read Start
Description: Starts reading list data.
Range: Fixed at 0

(14) Coincidence Target CH
Description: Selects the target CH in coincidence mode.
Range: 0: CH1 & CH2

(15) Coincidence Time
Description: Time range for determining coincidence counting in coincidence mode.
Range: From 40 ns to 10,000 ns in units of 40 ns. When setting, specify the value divided by 40.
Example: For 1,000 ns, set 25.

(16) CH Coincidence Delay Time
Description: Coincidence counting delay time in coincidence mode. Adjusts the signal transmission delay between channels.
Range: From 0 ns to 10,000 ns in units of 40 ns. When setting, specify the value divided by 40.
Example: For 1,000 ns, set 25.

(17) Dwell Time
Description: Time width per channel in MCS mode.
Range: From 40 ns to 10 s. The setting value is calculated as (time width per channel / 40 ns) − 1.

Representative examples are shown in the table below.

bin	Setting value
40ns	0
80ns	1
120ns	2
160ns	3
200ns	4
240ns	5
280ns	6
320ns	7
360ns	8
400ns	9
440ns	10
480ns	11
520ns	12
560ns	13
600ns	14
640ns	15
680ns	16
720ns	17
760ns	18
800ns	19
840ns	20
880ns	21
920ns	22
960ns	23
1μs	24
2μs	49
5μs	124
10μs	249
20μs	499
50μs	1,249
100μs	2,499
200μs	4,999
500μs	12,499
1ms	24,999
2ms	49,999
5ms	124,999
10ms	249,999
20ms	499,999
50ms	1,249,999
100ms	2,499,999
200ms	4,999,999
500ms	12,499,999
1s	24,999,999
2s	49,999,999
5s	124,999,999
10s	249,999,999
20s	499,999,999
50s	1,249,999,999
100s	2,499,999,999

(18) Status

Description: Acquires the values shown in the table below.

No.	Item	Size (Byte)
1	Real time (40 ns/count)	6
2	CH1 live time (40 ns/count)	6
3	CH1 dead time (40 ns/count)	6
4	CH1 throughput count rate	3
5	CH1 throughput total count	4
6	CH1 input count rate	3
7	CH2 live time (40 ns/count)	6
8	CH2 dead time (40 ns/count)	6
9	CH2 throughput count rate	3
10	CH2 throughput total count	4
11	CH2 input count rate	3
12	CH3 live time (40 ns/count)	6
13	CH3 dead time (40 ns/count)	6
14	CH3 throughput count rate	3
15	CH3 throughput total count	4
16	CH3 input count rate	3
17	CH4 live time (40 ns/count)	6
18	CH4 dead time (40 ns/count)	6
19	CH4 throughput count rate	3
20	CH4 throughput total count	4
21	CH4 input count rate	3
Total		94