IM-A-1024B August 2023

KYOWA

INSTRUCTION MANUAL
PCD-400 Series
SENSOR INTERFACE
(FOR CONTROL COMMAND)

Thank you for purchasing KYOWA's product PCD-400A Series Sensor Interface.
Read this Instruction Manual carefully in order to make full use of the high performance capabilities of the product.
Do not use the product in methods other than described in this Manual.

This Manual only describes Control Command of the PCD-400 Series.
For hardware, see the "PCD-400A Instruction Manual (For hardware)", "PCD-430A Instruction Manual (For hardware)" and "PCD-400B/430B Instruction Manual (For hardware)."
For software operation, see the "DCS-100A Instruction Manual (For PCD-400 Series operation)."

- CONTENTS -

NOTATIONS USED IN THE INSTRUCTION MANUAL

This Instruction Manual is written based on the assumption that customers fully understand basic knowledge of softwares including PCs and programming languages.
For details of programming, refer to commercially available textbooks, etc.

QUOTATIONS

- Related and reference items are enclosed with bracket quotation marks “ “. In addition, header No. and header character string may be adopted.
  "PCD-400A Instruction Manual (FOR HARDWARE),” “FOR CONTROL COMMAND” etc.)
- PCD-400A /B and PCD-430A/B are denoted as the "PCD."
- The input channel may be denoted as the "CH."
- The CH No. is denoted as the "CH1, CH2, , CH16."
- Low pass filter may be simply denoted as “LPF,” and High pass filter, as “HPF.”
- Unless otherwise specified, prefix that is expressing the size is described as follows.
  "K" (Kilo) = 1,024 and "M" (Mega) = 1,048,576.
  (1K byte = 1,024 byte, 1M byte = 1,048,576 byte)

INFORMATIONAL NOTES

Certain notations are used as necessary to attract your attention to information that requires special care when handing the product, and to information provided for reference purposes.

Examples of Notations

NOTE

Essential precautions required when handling the PCD.

MEMO

Reference items required when handling the PCD.

1 OUTLINE

This Instruction Manual is to define Communication Command through USB interface between the PCD and the PC.
The PCD and the PC is connected via USB, thereby enabling the PC to control the PCD with the Communication Command.
This Instruction Manual is written based on the assumption that customers fully understand basic knowledge of the USB.
For details, refer to commercially available textbooks, etc.
In addition, for how to connect the PCD and the PC and for details of units, see the "PCD-400A Instruction Manual (FOR HARDWARE)" ," PCD-430A Instruction Manual (FOR HARDWARE)",
"PCD-400B/430B Instruction Manual (FOR HARDWARE)" when required.

NOTE

- The USB interface is applicable only on Windows OS.

When control command data (hereinafter referred to as the command packet) is sent to the PCD from the PC, the PCD executes the specified operation and processing and then, returns the response data (hereinafter referred to as the response packet) to the PC.

The PC communicates with the PCD through the specified device driver that controls the PCD.
The PC sends the command packet to the PCD using data transfer function of the device driver and receives the response packet from the PCD using data receiving function.

2 TYPES OF VARIABLES

This chapter is to define various types of variables used in command packet and response packet.

*Assignment of variables with more than 2 bytes is in little endian format.

MEMO

- Notation "0x****" on and after then denotes a hexadecimal value.

Types of variables	The number of bytes	Notation	Supplement
signed char	1	char	8-bit variable with sign
unsigned char	1	BYTE	8-bit variable without sign
signed short	2	short	16-bit variable with sign
unsigned short	2	WORD	16-bit variable without sign
signed long	4	long	32-bit variable with sign
unsigned long	4	DWORD	32-bit variable without sign
signed int64	8	INT64	64-bit variable with sign
unsigned int64	8	UINT64	64-bit variable without sign
Float	4	float	Single precision floating decimal point variable
Double	8	double	Double precision floating decimal point variable

3 COMMUNICATION VIA USB INTERFACE

When controlling the PCD through the USB interface, the application program makes a demand to the PCD for control command send/receive request through KYOWA's USB communication API library (PCD400.DLL) function dedicated for the PCD

NOTE

- The USB interface is applicable only on Windows OS. (Excluding Windows RT.)
- When connecting the PCD the PC with USB interface, installing a device driver may be required. At this time, install the device driver according to instructions in the "PCD-400A Instruction Manual (FOR USB DRIVER SET-UP)."

3-1 ESSENTIAL FILES

The following files are essential for creating and executing an application program.

(1) PCD400.H — API defined file (Required when creating the program)
Should be included in the API using source file.

(2) PCD4000.LIB — API import library (Required when creating the program)
Should be linked to the library when creating the program.

(3) PCD400.DLL — API library main body (Required when executing the program)
Should be copied to the same folder with the application program.

Every file has 32-bit version and 64-bit version. The files are saved in the following folder in the installation DVD.
\PCD-400A\USBLIB

3-2 API FUNCTION

3-2-1 List of API functions

Function	Function Name
USB library start processing	PCD400_UsbOpen()
USB library end processing	PCD400_UsbClose()
Receive time-out time	PCD400_UsbSetTimeOut()
Connection check	PCD400_UsbConnectCheck()
Send command	PCD400_UsbSendCmd()
Receive command	PCD400_UsbReceiveCmd()
Target reset	PCD400_UsbTargetReset()

3-2-2 List of return value of API functions

Return value of the API function is described in the following table.

Return value	Results
0	Normally ended
Numerical value of 1 and more	The number of received bytes (only PCD400_UsbReceiveCmd())
-1	Unable to open the DLL.
-2	Argument is faulty
-3	The other process is using the resource.
-100	Unable to check the PCD.
-101	Communication error or timeout error
-102	Internal DLL error

3-2-3 Details of API functions

(1) PCD400_UsbOpen

Function	Initialization process of USB library
Definition	int PCD400_UsbOpen(void)
Return value	See the "List of return value of API functions".
Memo	Do not forget to execute initialization process when starting the application program. By activating this function, initialization process of the DLL and PCD contact monitoring process are executed inside the PC.

(2) PCD400_UsbClose

Function	End process of the USB library
Definition	int PCD400_UsbClose(void)
Return value	See the "List of return value of API functions".
Memo	Do not forget to execute end process when ending the application program. By activating this function, DLL using resource is released.

(3) PCD400_UsbTimeOut

Function	Set receive timeout time
Definition	int PCD400_UsbSetTimeOut(WORD wTimeOut)
Argument	wTimeOut Timeout time (0 to 60[sec], Default: 15)
Return value	See the "List of return value of API functions".

(4) PCD400_UsbConnectCheck

Function	Returns status of the stacking PCD units.
Definition	int PCD400_UsbConnectCheck(WORD* pwConnect)
Argument	pwConnect Folder destination of the PCD status
Return value	See the "List of return value of API functions".
Memo	Returns status of the stacking PCD units. 0: Not connected. 1: Connected.

(5) PCD400_UsbSendCmd

Function	Sends command packet
Definition	int PCD400_UsbSendCmd(DWORD dwSendByte, const void *pSendCmd)
Argument	dwSendByte: Size of the command packet to be sent (byte). pSendCmd: Folder destination for the command packet to be sent
Return value	See the "List of return value of API functions".
Memo	To be error when the send-destination PCD is not connected. Before using this function, check whether the send-destination PCD is connected by using the PCD400_UsbConnectCheck() function.

(6) PCD400_UsbReceiveCmd

Function	Receives Command Response Packet
Definition	int PCD400_UsbReceiveCmd(void *pReceiveCmd, DWORD dwReceiveSize)
Argument	pReceiveCmd: Folder destination for the received Command Response Packet. dwReceiveSize: Size of the folder destination for the Command Response Packet (byte).
Return value	See the "List of return value of API functions".
Memo	To be error when the receive-destination PCD is not connected. Before using this function, check whether the receive-destination PCD is connected by using the PCD400_UsbConnectCheck() function. Size of the folder destination for storing the command response packet varies with the command. Prepare a folder with a size that can sufficiently save the response data of the commands.

(7) PCD400_UsbTargetReset

Function	After disconnecting the USB wiring of the PCD, reconnect the USB.
Definition	int PCD400_UsbTargetReset()
Argument	None
Return value	See the "List of return value of API functions".
Memo	To be error when the PCD is not connected. Before using this function, check whether the PCD is connected by using the PCD400_UsbConnectCheck() function.

3-3 OUTLINE OF COMMUNICATION PROCEDURES

To send/receive the command and response packets, use API (Function) of the USB communication API library.
For formats of the command and response packets, see "4 CONTROL COMMAND SEND/RECEIVE PROTOCOL" and after.

Outline of USB communication procedures is described in the following.
(1) Call PCD400_UsbOpen() function and execute initialization process of the USB library.
(2) Call PCD400_UsbConnect Check() function and check the connected status of the PCD.
(3) Call PCD400_UsbSendCmd() function and send the command packet to the PCD.
(4) Call PCD400_UsbReceiveCmd() function and receive the response packet from the PCD.
(5) Repeat procedures from items (3) to (4) when necessary.
(6) Call PCD400_UsbClose() function and execute end process of the USB library.

4 CONTROL COMMAND SEND/RECEIVE PROTOCOL

4-1 COMMAND PACKET (PC → PCD)

This section describes format used for sending command packet to the PCD from the PC.

The command packet is composed of fixed length header section, fixed length command identifier, and variable length parameter section.

According to the respective control commands, after constructing an appropriate command packet, the command packet is sent to the PCD from the PC.

Header section (64 bytes fixed)	Command identifier (3 bytes fixed)	Parameter section (Variable length)

Description of Items

- Header — Always add the following format header at the head of the control command.

No.	Item name	Types of variables	The number of bytes	Contents
1	Model	char	20	Fixed character string of the "PCD-400A" (" " is not included.) *
2	The number of transferred bytes	DWORD	4	Command identifier + The number of parameter bytes
3	Reserved	char	40	Reserved
Total			64	

* Enter "PCD-400A" for the model name of the header even when communicating with PCD-400B or PCD-430A/B.

- Command identifier — Character string of ASCII code (3 uppercase characters)

- Parameter: — When parameters are required for the command, additionally mention it just after the command.

NOTE

- When defining the structure variable, take care to the data packing.
- When constructing a header section on the PC, after initializing the entire header section with "0x00," set the required items.

4-2 RESPONSE PACKET (PCD → PC)

After sending the command packet from the PC to the PCD, since the PCD returns the response packet to the PC, the PC must receive the response packet from the PCD.

The response packet is composed of fixed length header section and variable length response data section.

The size and format of the response data section depends on the command that is sent to the PCD from the PC just before.

Format of the response packet from the PCD to the PC is described in the following.

Header section (64 bytes fixed)	Response data section (Variable length)

Description of Items

- Header Always add the following format header at the head of the response packet.

No.	Item name	Types of variables	The number of bytes	Contents
1	Model	char	20	Fixed character string of the "PCD-400A" (" " is not included.) *
2	The number of response data bytes	DWORD	4	Size of response data section. 0: Only header section with no response data section.
3	PCD status	DWORD	4	PCD status For details, see "4-3 PCD STATUS."
4	PCD error status	DWORD	4	PCD error generating status For details, see "4-4 PCD ERROR STATUS."
5	Sampling frequency	DWORD	4	1 to 10000 Hz
6	Measuring channel bit	DWORD	4	In binary digit (0: Not measure, 1: Measure) Examples are described in the following. The CH to be measured (Meas ON) is CH1 only: 0x00000001 The CH to be measured (Meas ON) are CH1 and CH2: 0x00000003
7	The number of channels	WORD	2	1 to 16
8	Reserved 1	char	1	Reserved
9	The number of stacking PCD units	BYTE	1	Returns the number of stacking PCD units
10	Reserved 2	char	20	Reserved
Total			64	

*Even when communicating with PCD-400B or PCD-430A/B, "PCD-400A" is returned as the model name of the header.

- Response data section

The response data section is variable length data. The contents and data size vary with the control commands.

For details, see "6-3 DETAILS INFORMATION OF CONTROL COMMANDS."

NOTE

- The size of the response packet is maximum 1MB + 64Byte (1,048,640 bytes).
  Prepare a folder with a size that can sufficiently save the response packet.

4-3 PCD STATUS

The PCD status is stored in the header section of response packet.

The PCD status is in 32-bit (4-byte) numeric value and can be checked by this status.

Although bits are independently set, they may be set together at the same time.

Depending on the PCD status, there may be a limit when executing the command.

See also "6-2 WHETHER CONTROL COMMAND IS ENABLED OR DISABLED."

Bit Value	Contents
0x00000001	AD conversion start available To set: ● When no error occur in the measuring-condition-checking of the stacking PCD units. ● When no error occur in the measuring-condition-checking while setting measuring conditions by using the MES command.. ● When the INI command is properly ended. To clear: ● When an error occurs in the measuring-condition-checking of the stacking PCD units. ● When an error occurs in the measuring-condition-checking while setting measuring conditions by using the MES command.. ● When a fatal error occurs.
0x00000002	During the AD conversion (measurements) To set: ● When the STA command is properly ended. To clear: ● When the STP command is properly ended. ● When a fatal error occurs.
0x00010000	Executing the command (executing the balance adjustment or loading/writing the TEDS information) To set: ● When receiving a command from the PC. To clear: ● When the response data to be sent becomes available after executing the command. ● When the balance adjustment or loading/writing the TEDS information completed.
0x08000000	AD data is discretely data. To set: ● When the internal FIFO memory becomes full. To clear: ● When the header section (PCD status) is sent.
0x80000000	Error occurred status (1 = Error occurring, 0 = No error) To set: ● When a fatal error occurs. To clear: ● When turning ON the PCD. (For details, see "4-4 PCD ERROR STATUS.")

The other than the above mentioned bits are reserved.

MEMO

AD conversion status and PCD status are described in the following.

- AD conversion start available status: 0x00000001 is set.
- During AD conversions: 0x00000003 is set.

4-4 PCD ERROR STATUS

The PCD status is described in 32-bit numeric values. When hardware related error occurred in the PCD, the following bit is set. Details of error contents can be checked with these error statuses.

When fatal error occurred, it can be cleared by restoring the PCD power. However, if error is not cleared or if the error still occurs, contact KYOWA or our representative for repair.

Bit value	Contents
0x00000001	Hardware: Error (*1) ● The left bit will be set when an error occurs during the self diagnosis when starting the PCD.
0x00000002	EEPROM: Error (*1) ● The left bit will be set when an EEPROM error occurs.
0x00000004	External SRAM: Error (*1) ● The left bit will be set when an External SRAM error occurs when starting the PCD.
0x00000008	FPGA: Error (*1) ● The left bit will be set when an FPGA error occurs when starting the PCD.
0x00000100	The number of stacking PCD units: Error ● The left bit will be set when stacking 5 or more PCD units.
0x00000200	Slave units are OFF..: Error ● The left bit will be set when a POWER-OFF PCD exists.

The other than the above mentioned bits are reserved.

(*1) The Hardware error status is cleared when turning ON the power.

5 ERROR CODE

Error code is indicated with 1 byte of the char type.

If it is stated as 'Standard type' in response data of control commands, the response data is considered as the error code. In addition, if error occurred during control command process, this error code is returned without returning the response data stated in the control commands. The list of error codes is described in the following.

Error code No.	Error contents
0	Normally ended
-1	Unknown command
-2	Parameter: Error
-3	No channel to be measured
-4	Failed to execute the command.
-5	The number of stacking PCD units: Error
-6	Slave units are OFF.

When the PCD receives an unavailable command during executing the command (executing balance adjustment or loading/writing the TEDS information), the parameter error (-2) is returned.

6 CONTROL COMMANDS

6-1 LIST OF CONTROL COMMANDS

PCD control available commands are listed in the following table.

Type	Contents	Command	Ref. Page
Measuring condition	Initialize measuring condition	INI	12
	Set/load measuring condition	MES	13
Execute	Start AD conversion	STA	15
	Stop AD conversion	STP	15
	Obtain AD data	GMD	16
	Execute balance adjustment.	BAL	17
	Load PCD status	-----	18
	Write TEDS information.	TEW	22
	Load TEDS information.	TER	24
System	Load system information	SYS	19
	Load/write the user data	URW	20

6-2 WHETHER CONTROL COMMAND IS ENABLED OR DISABLED

Depending on the PCD status, there may be a limit when executing the command.

Whether executing control commands is enabled or disabled are listed in the following table

For the PCD status, see "4-3 PCD STATUS."

Command	Stopping AD conversion (AD conversion start available status)	AD converting	Executing the command (Executing the balance adjustment or executing the self diagnosis.)
INI	✔		
MES	✔	△	
STA	✔		
STP	✔	✔	
GMD	✔	✔	
BAL	✔		
-----	✔	✔	✔
TEW	✔		
TER	✔		
SYS	✔	✔	
URW	✔	△	

✔: Enabled. △: Loading only

6-3 DETAILS INFORMATION OF CONTROL COMMANDS

This section describes detailed information for every control command.
When sending the control command from the PC to the PCD, construct a command packet with header (64-byte fixed length), command identifier (3-byte fixed length), and parameter (variable length).
The number of transferred bytes in the header section includes the total number of bytes of the command identifier and parameter.
The PC receives the response data packet, with header section (64-byte fixed length) at the head, from the PCD.
The size of response data, succeeding the header section, is written in the number of response data bytes in the header. The PC can receive the entire response data packet from the PCD.
For the command packet and response data packet, see "4 CONTROL COMMAND SEND/RECEIVE PROTOCOL."

MEMO

- Although the number of response data bytes is originally 2 bytes or more, only 1 byte is returned in some cases. At this time, error occurred and the PCD is returning error codes different from the original response data.
  For error codes, see "5 ERROR CODE."
- Depending on the PCD status, some commands are unavailable.
  For details, see "6-2 WHETHER CONTROL COMMAND IS ENABLED OR DISABLED."

6-3-1 Initialize measuring condition (INI)

Initializes the pre-set measuring conditions in the PCD to the factory default.

- Command INI
- The number of transferred bytes 4 bytes
- Parameter None

<table>
<tr><th>No.</th><th>Name</th><th>Contents</th><th>Types of variables</th><th>The number of bytes</th></tr>
<tr><td>1</td><td>Command</td><td>INI</td><td>char</td><td>3</td></tr>
<tr><td>2</td><td>Parameter 1</td><td>Specify the target PCD to initialize the conditions.
Example
<table><tr><th>Setting values</th><th>To be initialized</th></tr><tr><td>0x01</td><td>Master unit only</td></tr><tr><td>0x03</td><td>Master unit and 1st slave unit</td></tr><tr><td>0x0A</td><td>Master unit and 3rd slave unit</td></tr><tr><td>0xFF</td><td>Initialize all the stacking PCD units.</td></tr></table></td><td>BYTE</td><td>1</td></tr>
<tr><td colspan="4">Total number of transferred bytes</td><td>4</td></tr>
</table>

- Response data Standard type (1 byte)

- Remarks After sending the INI command, the PCD is in the following status.

Measuring condition

Sampling frequency:	1kHz
The number of recording channels:	easure all the recording available channels.
Channel conditions:	Default value of every unit (*1)

(*1) For details, see “7-1 SETTING VALUES OF THE PCD-400A/PCD-430A”

6-3-2 Set/load measuring condition (MES)

Sets and loads measuring conditions together at the same time.

- Command MES

◆◆◆ When setting ◆◆◆

- The number of transferred bytes 1604 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	MES	char	3
2	Parameter 1	Parameter mode (0x00: Load, 0x01: Set) Set 0x01.	BYTE	1
3	Parameter 2	Measuring conditions to be set in the PCD	----	1600
Total number of transferred bytes				1604

- Response data 4 bytes

Result of measuring-condition-checking

The result of measuring-condition-checking is in 32-bit numeric value and is defined as follows.

When the result is not 0x00000000, you cannot start the AD conversion.

Result (bit)	Contents
0x00000000	Passed, AD conversion can be started
0x00000001	Channel condition error
0x00000002	Undefined (system reserved)
0x00000004	Undefined (system reserved)
0x00000008	Undefined (system reserved)
0x00000010	Undefined (system reserved)
0x00000020	Undefined (system reserved)
0x00000040	Undefined (system reserved)
0x00000080	Undefined (system reserved)
0x00000100	Undefined (system reserved)
0x00000200	Sampling frequency error
0x00000400	Undefined (system reserved)
0x00000800	Undefined (system reserved)
0x00001000	Undefined (system reserved)
0x00002000	Undefined (system reserved)
0x00004000	Undefined (system reserved)
0x00008000	No channel to be measured
0x00010000	Undefined (system reserved)
0x00020000	Undefined (system reserved)
0x00040000	General information error
0x00080000	Measuring condition error
0x10000000	Balance adjustment conditions error
0x20000000	Undefined (system reserved)
0x40000000	Undefined (system reserved)
0x80000000	Undefined (system reserved)

* Note that the undefined (system reserved) result is 0.

◆◆◆ When loading ◆◆◆

- The number of transferred bytes 4 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	MES	char	3
2	Parameter 1	Parameter mode (0x00: Load, 0x01: Set) Set 0x00.	BYTE	1
Total number of transferred bytes				4

- Response data 1600 bytes

No.	Name	Contents	Types of variables	The number of bytes
1	Response data 1	Measuring conditions pre-set in the PCD.	----	1600
Total number of response data bytes				1600

MEMO

- For the parameter 2 for setting conditions, see "6-4-1 DETAILS OF MEASURING CONDITION FORMAT."
- For the response data 1 for loading data, see "6-4-1 DETAILS OF MEASURING CONDITION FORMAT."

6-3-3 Start AD conversion (STA)

Starts AD conversion.

- Command STA

- The number of transferred bytes 3 bytes
- Parameter None

No.	Name	Contents	Types of variables	The number of bytes
1	Command	STA	char	3
Total number of transferred bytes				3

- Response data Standard type (1 byte)

MEMO

- To execute this command, the PCD status should be AD conversion start available status.

6-3-4 Stop AD conversion (STP)

Stops AD conversion.

- Command STP

- The number of transferred bytes 3 bytes
- Parameter None

No.	Name	Contents	Types of variables	The number of bytes
1	Command	STP	char	3
Total number of transferred bytes				3

- Response data Standard type (1 byte)

6-3-5 Obtain AD data (GMD)

Obtains AD data.

Be sure to execute the command during the AD conversion.

- Command GMD

- The number of transferred bytes 3 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	GMD	char	3
Total number of transferred bytes				3

- Response data AD data
  (The number of bytes vary with the number of measuring channels and execution timing of commands.)

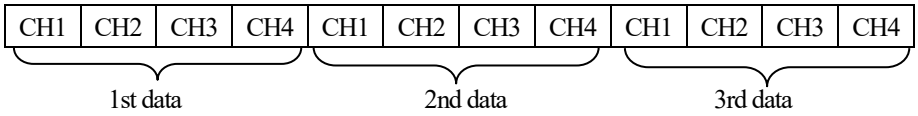
■ AD data assignment

The AD data is 4 bytes per CH.

The AD data of one sampling is assigned in due order from CH1, CH2, and CH3.

[Example]

Suppose the CH1-data, CH2-data, CH3-data, and CH4-data are measured for 3 times



■ The PCD is in 'AD data is discretely data' status when receiving AD data

If the GMD command is executed in the above status, only the header section (the number of response data bytes: 0) is returned.

After sending the 'AD data is discretely data' status to the PC, the PCD clears the status.

■ About A/D data

The data, obtained by using the GMD command, is AD data. Note that you will need to convert the AD data into range value.

For details, see "8 REFERENCE DATA."

MEMO

- AD data of the PCD is sent to the PC through internal the FIFO memory.
  To obtain the continuous data by the PC, continuously obtain the A/D data by using the GMD command before the internal FIFO memory becomes full. If the internal FIFO memory becomes full, the PCD status 'AD data is discretely data' is set to have the A/D data in discontinuous status.
- With the 'AD data is discretely data' status set in the PCD, no new AD data is stored in the FIFO memory. If the 'AD data is discretely data' status is cleared, data in the FIFO memory is also cleared to newly store the A/D data.
- During the AD conversion, be sure to call the command periodically every 100 msec to 1 sec.

6-3-6 Execute the balance adjustment/load the balance adjustment result (BAL)

Executes the balance adjustment and obtains the results.

To execute the command, set the target channel in advance.

To set the target channels to be balanced, use the MES command.

- Command BAL

◆◆◆ When executing ◆◆◆

- The number of transferred bytes 4 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	BAL	char	3
2	Parameter 1	Balance executing mode (0x00: Load the balance adjustment result, 0x01: Execute) Set 0x01.	BYTE	1
Total number of transferred bytes				4

- Response data Standard type (1 byte)

- Remarks After executing the BAL command, use the status load command to check the PCD status.
  After checking that the status is not in "Executing the command (Busy)" status, load the checked results.

◆◆◆ When loading the results ◆◆◆

- The number of transferred bytes 4 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	BAL	char	3
2	Parameter 1	Balance executing mode (0x00: Load the balance adjustment result, 0x01: Execute) Set 0x00.	BYTE	1
Total number of transferred bytes				4

- Response data 32 bytes

No.	Name	Contents	Types of variables	The number of bytes
1	Response data 1	Balance adjustment 1 byte × 16 channels ＝ 16 bytes -1: No unit, no function, no target channel 0: Passed 1: Error 2: OFF 3: Connection error	char	16
2	Response data 2	Reserved	char	16
Total number of response data bytes				32

6-3-7 Load PCD status

Generally, since the PCD status is stored in the header section of the response packet, the PCD status can be obtained by executing any command and by referring the header section of the response packet.

However, the PCD status may be required before issuing the command to the PCD or may be required when the next command cannot be issued unless after checking whether or not the processing, requiring a certain time in the PCD, is surely finished.

In the above cases, send only the header section of the command packet (addition data size: 0) to the PCD. The response packet, only storing the header section, is returned. After checking the status of the response packet header section, the PCD status can be obtained.

- Command None
- The number of transferred bytes bytes
- Parameter None
- Response data 0 byte

6-3-8 Load system information (SYS)

Loads the system information of the PCD.

- Command SYS
- The number of transferred bytes 3 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	SYS	char	3
Total number of transferred bytes				3

- Response data 1600 bytes

No.	Name	Contents	Types of variables	The number of bytes
1	Response data 1	Model	char	32
2	Response data 2	Firmware version	char	32
3	Response data 3	FPGA version	char	32
4	Response data 4	USB device driver version	char	32
5	Response data 5	SERIAL No.	char	32
6	Response data 6	Reserved	char	32
7	Response data 7	Model For details, see *6 in the "6-4-1 DETAILS OF MEASURING CONDITION FORMAT."	BYTE	1
8	Response data 8	Reserved	char	7
Total number of bytes 4 PCD units × 200 bytes (total of response data 1 to 8) = 800 bytes				800
9	Response data 9	Reserved		800
Total number of transferred bytes				1600

MEMO

- All the response data 1 to 5 is character string.
  Note that display contents may be changed without prior notice.

6-3-9 Load/write the user data (URW)

Loads and writes arbitrary user data.

- Command URW

◆◆◆ When setting ◆◆◆

- The number of transferred bytes 264 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	URW	char	3
2	Parameter 1	Parameter mode (0x00: Load, 0x01: Set) Set 0x01.	BYTE	1
3	Parameter 2	Writing No. (0 to 1)	BYTE	1
4	Parameter 3	Target PCD to be written (in binary digit) [Example] Suppose the target PCD is PCD-1, PCD-2, and PCD-4. Set 0x0A.	BYTE	1
5	Parameter 4	Reserved	char	2
6	Parameter 5	User data of the PCD-1 (master unit)	BYTE	32
		・ ・		
9	Parameter 8	User data of the PCD-4	BYTE	32
10	Parameter 9	Reserved	char	128
Total number of transferred bytes				264

- Response data Standard type (1 byte)

◆◆◆ When loading ◆◆◆

- The number of transferred bytes 5 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	URW	char	3
2	Parameter 1	Parameter mode (0x00: Load, 0x01: Set) Set 0x00.	BYTE	1
3	Parameter 2	Loading No. (0 to 1)	BYTE	1
Total number of transferred bytes				5

- Response data 256 bytes

No.	Name	Contents	Types of variables	The number of bytes
1	Response data 1	User data	BYTE	32
Total number of response data bytes (single unit)				32
Total number of response data bytes 4 PCD units × 32 bytes = 128 bytes				128
2	Response data 2	Reserved	char	128
Total number of transferred bytes				256

MEMO

- When the target PCD does not exists, a blank space is returned.
  Note that an error is not returned.

6-3-10 Write TEDS information (TEW)

Writes the TEDS information of 16 channels at the same time.

- Command TEW

◆◆◆ When setting ◆◆◆

- The number of transferred bytes 1032 bytes
- Parameter See the table below.

No.	Name	Contents		Types of variables	The number of bytes
1	Command	TEW		char	3
2	Parameter 1	Parameter mode (0x00: Load, 0x01: Write) Set 0x01.		BYTE	1
3	Parameter 2	Target channel to be written (in binary digit) [Example] Suppose the target CH is CH1, CH2, and CH16. Set 0x00008003.		DWORD	4
4	Parameter 3	Character strings to be written in the user data 1 (for 16 channels). Maximum 28 characters/CH +NULL code	CH1 data to be written	char	32
			CH2 data to be written	char	32
			CH3 data to be written	char	32
			.	.	.
			CH16 data to be written	char	32
5	Parameter 4	Reserved		char	512
Total number of transferred bytes					1032

- Response data Standard type (1 byte)
- Remarks After executing the TEW command, use the status load command to check the PCD status. After checking that the status is not in "Executing the command (Busy)" status, load the checked results.

◆◆◆ When loading the results ◆◆◆

- The number of transferred bytes: 4 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	TEW	char	3
2	Parameter 1	Parameter mode (0x00: Load, 0x01: Write) Set 0x00.	BYTE	1
Total number of transferred bytes				4

● Response data 32 bytes

No.	Name	Contents	Types of variables	The number of bytes
1	Response data 1	Results of writing the TEDS information 1 byte × 16 channels ＝ 16 bytes -1: No target channel 0: Passed 1: Error 2: OFF	BYTE	16
2	Response data 2	Reserved	char	16
Total number of transferred bytes				32

6-3-11 Load TEDS information (TER)

Loads the TEDS information of 16 channels at the same time.

MEMO

- For details of TEDS, see IEEE1451.4 standard.

◆◆◆ When loading ◆◆◆

- The number of transferred bytes: 4 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	TER	char	3
2	Parameter 1	Parameter mode (0x00: Load the results, 0x01: Read run) Set 0x01.	BYTE	1
Total number of transferred bytes				4

- Response data Standard type (1 byte)

- Remarks After executing the TER command, use the status load command to check the PCD status. After checking that the status is not in "Executing the command (Busy)" status, load the checked results.

◆◆◆ When loading the results ◆◆◆

- The number of transferred bytes 4 bytes
- Parameter See the table below.

No.	Name	Contents	Types of variables	The number of bytes
1	Command	TER	char	3
2	Parameter 1	Parameter mode (0x00: Load the results, 0x01: Read run) Set 0x00.	BYTE	1
Total number of transferred bytes				4

- Response data 21120 bytes

No.	Name	Contents		Types of variables	The number of bytes
1	Response data 1	Template ID No. (*1)		BYTE	1
		Validity of Template ID No. (0: Invalid, 1: Valid)		BYTE	1
		Reserved		char	2
		Basic information (*3)	Unique Registration Number	INT64	8
			Manufacture ID	WORD	2
			Model Number	WORD	2
			Version Letter	char	2
			Version Number	WORD	2
			Serial Number	DWORD	4
		Standard information (*4)		char	100
		User data	User data 1	char	32
			User data 2	char	480
			Available size of the user data 2	DWORD	4
		Reserved	Mode No.	BYTE	1
			RANGE No.	BYTE	1
			Low pass filter No.	BYTE	1
			Unit No.	BYTE	1
			CAL coefficient	float	4
			Strain mode	BYTE	1
			Editable or non-editable user data 1 (*5) (0: Non-editable, 1: Editable)	BYTE	1
			Reserved	char	10
		Total number of CH1 TEDS information			660
		.			.
		Total number of CH16 TEDS information			660
2	Response data 2	Reserved			10560
Total number of response data bytes					21120

(*1) Template ID No.

- Template ID No. and Sub ID are identification numbers originally defined for the PCD. (See the following table.)
- The following Standard Template IDs are the Template IDs defined by the IEEE1451.4 standard.

Template ID No.	Contents
0	no TEDS information
1	Not applicable TEDS information
6	Standard Template ID= 30, Sub ID=0
7	Standard Template ID= 30, Sub ID=1
8	Standard Template ID= 33, Sub ID=0

(*2) Template ID No.

Flag to indicate whether the standard information is valid or invalid.

(*3) Basic information

Valid only when the template ID No. is 2 or more.

(*4) Standard information

Contents and the number of bytes vary with the template ID No.

(Valid only when the template ID No. is 2 or more.)

The standard information of every template ID No. is described in the following table.

(The contents are based on the IEEE1451.4 standard.)

(*5) Editable or non-editable user data 1

Flag to indicate whether the user data 1 is editable or non-editable (1: Editable).

Template ID No.	Contents	Types of variables	The number of bytes
6	Standard Template ID	BYTE	1
	Physical Measurand	BYTE	1
	Transducer Electrical Signal Type (0: Voltage sensor)	BYTE	1
	Full-Scale Electrical Value Precision	BYTE	1
	Mapping Method(0: Linear)	BYTE	1
	AC or DC coupling (0:DC, 1:AC)	BYTE	1
	Reserved	char	2
	Minimum physical value	float	4
	Maximum physical value	float	4
	Minimum voltage output [V]	float	4
	Maximum voltage output [V]	float	4
	Sensor output impedance [ohms]	float	4
	Response Time [sec]	float	4
	Calibration Date (e.g. "2005/01/01")	char	16
	Calibration Initials (Max 3chrs. e.g. "TK ")	char	4
	Calibration period [days]	WORD	2
	Measurement location ID (0 to 2047)	WORD	2
	Total number of template ID No. 6		56

Template ID No.	Contents	Types of variables	The number of bytes
7	Standard Template ID	BYTE	1
	Physical Measurand	BYTE	1
	Power-supply type (0: DC, 1: Bipolar DC, 2: AC (rms))	BYTE	1
	Transducer Electrical Signal Type(0: Voltage Sensor)	BYTE	1
	Full-Scale Electrical Value Precision	BYTE	1
	Mapping Method(0: Linear)	BYTE	1
	AC or DC coupling (0:DC, 1:AC)	BYTE	1
	Reserved	char	1
	Minimum physical value	float	4
	Maximum physical value	float	4
	Minimum voltage output [V]	float	4
	Maximum voltage output [V]	float	4
	Sensor output impedance [ohms]	float	4
	Response Time [sec]	float	4
	Power-supply level,nominal [V]	float	4
	Power-supply level,min [V]	float	4
	Power-supply level,max [V]	float	4
	Max current at nominal power level [A]	float	4
	Calibration Date (e.g. "2005/01/01")	char	16
	Calibration Initials (Max 3chrs. e.g. "TK ")	char	4
	Calibration period [days]	WORD	2
	Measurement location ID (0 to 2047)	WORD	2
	Total number of template ID No. 7		72
8	Standard Template ID	BYTE	1
	Physical Measurand	BYTE	1
	Transducer Electrical Signal Type (3: Bridge Sensor)	BYTE	1
	Full-Scale Electrical Value Precision	BYTE	1
	Mapping Method(0: Linear)	BYTE	1
	Bridge Type (0:QUARTER,1:HALF,2:FULL)	BYTE	1
	Reserved	char	2
	Minimum physical value	float	4
	Maximum physical value	float	4
	Minimum electrical output [V/V]	float	4
	Maximum electrical output [V/V]	float	4
	Bridge element impedance [ohms]	float	4
	Response Time [sec]	float	4
	Excitation level,nominal [V]	float	4
	Excitation level,min [V]	float	4
	Excitation level,max [V]	float	4
	Calibration Date (e.g. "2005/01/01")	char	16
	Calibration Initials (Max 3chrs. e.g. "TK ")	char	4
	Calibration period [days]	WORD	2
	Measurement location ID (0 to 2047)	WORD	2
	Total number of template ID No. 8		68

MEMO

Effectiveness of basic information, standard information, and user data information

(1) When the template ID No. = 0

- The template ID No. is always 0 (Invalid).
- The Basic information is invalid.
- The standard information is invalid.
- The user data information is invalid.

(2) When the template ID No. = 1

- The template ID No. is always 0 (Invalid).
- The basic information is valid.
- The standard information is invalid.
- The user data information is invalid.

(3) When the template ID No. >= 5

- The basic information is valid.
- When the template ID No. is 1 (valid), the standard information is correct data.
- When the template ID No. is 0 (invalid), the standard information is incorrect data or the current sensor does not match the current conditioner card.
- The user data information is valid only when the basic information's Manufacture ID is 58 (KYOWA).

6-4 MEASURING CONDITION FORMAT

Measuring condition format, between the PC and PCD, by executing the set/load measuring condition (MES) command.
Details of the measuring condition format are described in the following.

6-4-1 DETAILS OF MEASURING CONDITION FORMAT

The whole size 1600 bytes

No.	Classification	Contents and range	Types of variables	The number of bytes
1	General Information 80 bytes	Device ID ("PCD-400A" fixed, " " is not included.)*	char	20
		Parameter format version (1 fixed)	WORD	2
		Reserved	char	2
		Model 1 to 4 (*6)	BYTE	8
		Reserved (all 0)	char	48
2	Measuring Condition 32 bytes	Sampling frequency: (1 to 10000)	DWORD	4
		The number of channels to be recorded (0 to 16) The number of channels to be measured (Meas ON)	WORD	2
		Reserved (all 0)	BYTE	26
3	Channel Conditions 32 bytes × 16 channels = 512 bytes	Measurement ON/OFF -1: No unit or no target CH 0: Not measure 1: Measure	char	1
		Mode(*7) Fixed to 0 for PCD-400 A/B	BYTE	1
		RANGE No. (*8)	BYTE	1
		Strain mode No. (*9)	BYTE	1
		LPF No. (*10)	BYTE	1
		HPF No.(*11)	BYTE	1
		BAL ON/OFF (0: OFF, 1: ON)	BYTE	1
		Reserved (all 0)	char	25
4	System reserved		char	976

* Enter "PCD-400A" for the Device ID even when communicating with PCD-400B or PCD-430A/B.

MEMO

- Initialize the area indicated as 'Reserved' or unused area with '0.'

(*6) Model of the PCD-400A series

Parameter	Model	Measuring target	Description
0	NONE	NONE	No PCD
1	UNKNOWN		Unknown PCD
2	PCD-400A/B	Strain	
6	PCD-430A/B	Strain + Voltage	

(*7) Mode(PCD-430A/B Only)

Parameter	Measuring target
0	Strain
1	Voltage

(*8) RANGE No.

Parameter	Strain	Voltage
0	200 μm/m	1V
1	500 μm/m	2V
2	1000 μm/m	5V
3	2000 μm/m	10V
4	5000 μm/m	20V
5	10000 μm/m	50V
6	20000 μm/m	

(*9) Strain mode No.

Parameter	Setting contents
0	1G2W
1	1G3W
2	2G
3	4G

(*10) LPF No.

Parameter	Strain	Voltage
0	FLAT	FLAT
1	100 Hz	300Hz
2	30 Hz	100Hz
3	10 Hz	30Hz
4		10Hz

(*11) HPF No.(Mode Voltage Only)

Parameter	Setting contents
0	OFF
1	0.2Hz

6-5 GUIDE LINE FOR SETTING MEASURING CONDITIONS

Since the measuring condition may become error when it does not match with the PCD status, it is essential to match the measuring condition with the PCD status to be measured.

When creating a new measuring condition, it is recommended to read the current measuring condition of the PCD to the PC by the MES command, edit the required items, and create the new measuring condition. In this method, since the actual unit structure is properly reflected on the PC, the measuring condition can be created by editing various setting contents such as RANGE, LPF, sampling frequency, etc.

For newly creating a measuring condition, see the following procedures.

(1) Prepare a structure variable based on the measuring condition file format and 0 clear the entire structure variable.
(2) Set the general information based on the actual stacking PCD units.
(3) Set the CH conditions for 32 channels.
(4) Set the measuring conditions.

- Set the total number of channels, which are set to 'Meas ON' in item (4), to the number of channels to be recorded.
- Set the sampling frequency.

(5) Send the created structure variable to the PCD with the MES command.

MEMO

- When setting measuring conditions, set all the unrelated items '0.'

7 UNIT TYPE NO. AND SETTING VALUE OF UNITS

7-1 SETTING VALUES OF THE PCD-400A/PCD-430A

Setting values of PCD-400A/PCD-430A are listed in the following table.
(Shaded portions are initial values set by INI command.)

	PCD-400A/B	PCD-430A/B
Mode	0: Strain	0: Strain 1: Voltage
Strain mode	0 : 1G2W 1 : 1G3W 2 : 2G 3 : 4G	0 : 1G2W 1 : 1G3W 2 : 2G 3 : 4G
RANGE(Strain)	0 : 200 μm/m 1 : 500 μm/m 2 : 1000 μm/m 3 : 2000 μm/m 4 : 5000 μm/m 5 : 10000 μm/m 6 : 20000 μm/m 7 : OFF	0 : 200 μm/m 1 : 500 μm/m 2 :1000 μm/m 3 :2000 μm/m 4 :5000 μm/m 5 :10000 μm/m 6 :20000 μm/m 7 : OFF
RANGE(Voltage)	----------	0 : 1V 1 : 2V 2 : 5V 3 : 10V 4 : 20V 5 : 50V
LPF	0: FLAT 1: 100 Hz 2: 30 Hz 3: 10 Hz	0 : FLAT 1 : 300 Hz(Mode Voltage Only) 2 : 100 Hz 3 : 30 Hz 4 : 10 Hz
HPF	----------	0 : OFF 1 : 0.2 Hz
BAL	0: OFF 1: ON	0: OFF 1: ON

8 REFERENCE DATA

8-1 TO CONVERT AD VALUE INTO RANGE VALUES(Strain/Voltage common)

This section describes how to convert AD values, obtained by using the GMD command, into the range values described as follows.
When converting AD values, make sure the RANGE matches the full scale value of the measuring range.

$$\text{RANGE Value} = \frac{\text{AD value}}{8200000} \times \text{RANGE}$$

AD value: AD data obtained by using the GMD command
RANGE: Full scale value of the measuring range

● Examples
(The A/D values are some examples.)

Measuring condition
Measuring unit: PCD-400A
RANGE: 5000 μm/m

① Obtain the AD value by using the GMD command.
AD value: 3084200

② Convert the AD value by using the above expression.

$$\frac{3084200}{8200000} \times 5000 = 1881 \qquad [\mu m / m]$$

When the PCD-400A/PCD-430A is "strain mode (1G2W or 1G3W)", compensate the nonlinearity and gage factor by referring "8-2 WHEN THE STRAIN MODE IS 1G2W or 1G3W."

8-2 WHEN THE STRAIN MODE IS 1G2W or 1G3W

When the strain mode is 1G2W or 1G3W, compensate the nonlinearity and gage factor.

(1) To compensate the nonlinearity
When the strain mode is 1G2W or 1G3W, you are required to compensate the nonlinearity due to nonlinearity error.

$$\varepsilon 1 = \left(\frac{\varepsilon 0}{1 - \varepsilon 0} \right) \times (10^{-6})$$

ε0: Measured strain
ε1: Strain after compensating the nonlinearity

(2) To compensate the gage factor

The PCD measures data by using the gage factor 2.00.

When the gage factor of the target gage is not 2.00, you are required to compensate the gage factor.

$$\varepsilon 2 = \frac{2.00}{Ks} \times \varepsilon 1$$

ε1: Strain after compensating the nonlinearity

ε2: True strain

Ks: Gage factor of the strain gage