GP2Z0001AU1

Optical Pointing Device

■ Features

1. Easy operation thanks to adoption of optical system and slide system
2. High reliability due to elimination of the contact wear with the optical system
3. Compact and thin type
4. Adoption of specific serial interface
   (* PS/2 interface is also available.)

■ Applications

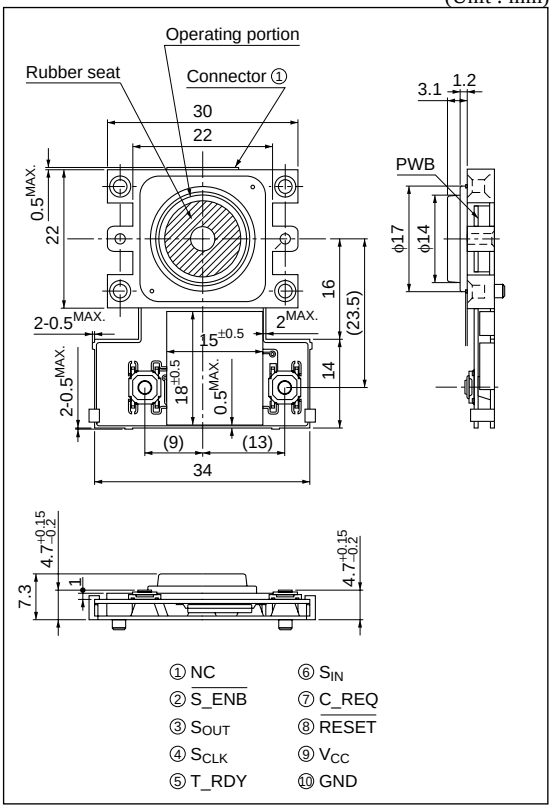
1. Notebook type PCs
2. Personal information tools

■ Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	−0.3 to +7	V
Input voltage	V_{IN}	−0.3 to V_{CC} +0.3	V
Output voltage	V_{OUT}	−0.3 to V_{CC} +0.3	V
Maximum output current	I_{OH}	*1 4	mA
	I_{OL0}	*2 30	mA
	I_{OL1}	*3 4	mA
Operating temperature	T_{opr}	0 to +60	°C
Storage temperature	T_{stg}	−10 to +70	°C

*1 Applicable terminal of high level:All input-output terminals
*2 Applicable terminal of low level:T_RDY, C_REQ
*3 Applicable terminal of low level:S_{OUT}, $\overline{S\_ENB}$, $\overline{RESET}$, S_{IN}, S_{CLK}

■ Outline Dimensions (Unit : mm)



■ Recommended Operating Conditions

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{CC}	Ta=0 to 60˚C	3	3.3	3.6	V

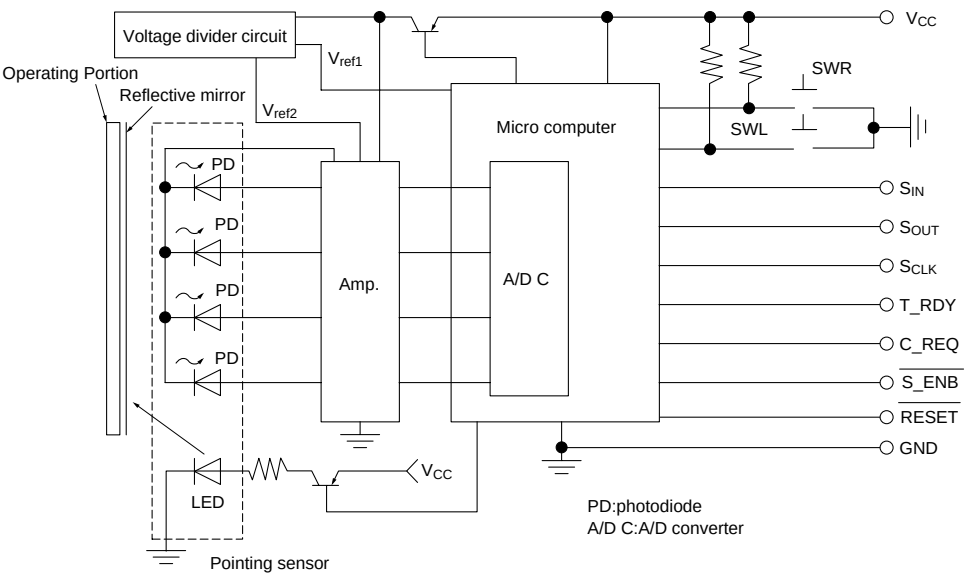
■ Electro-optical Characteristics

(Ta=25°C, Vcc=12V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input voltage	V_{IH1}	*4	0.8×V_{CC}	–	V_{CC}	V
	V_{IL1}		0	–	0.2×V_{CC}	
	V_{IH2}	*5	0.9×V_{CC}	–	V_{CC}	V
	V_{IL2}		0	–	0.1×V_{CC}	
Input current	I_{IL1}	*6 V_{IN}=0V, V_{CC}=3.3V	5	50	130	μA
	I_{IH1}	*6 V_{IN}=V_{CC}	–	–	2	
Output current	I_{OL1}	*7 V_O=1V	3	15	–	mA
	I_{OH1}	*7 V_O=V_{CC}–0.5	0.2	1.5	–	
	I_{OL2}	*8 V_O=0.5V	70	600	–	μA
	I_{OH2}	*8 V_O=V_{CC}–0.5	200	2 000	–	
Mean consumption current	I_{CC}	*9 At normal operation	–	3.5	7.5	mA
	I_{STBY}	*9 At stand-by	–	0.5	1	

*4 Applicable terminal:T_RDY, C_REQ, $\overline{S\_ENB}$, S_{OUT}
*5 Applicable terminal:S_{IN}, S_{CLK}, $\overline{RESET}$
*6 Applicable terminal:T_RDY, C_REQ, $\overline{S\_ENB}$, S_{OUT}, S_{IN}, S_{CLK}, $\overline{RESET}$
*7 Applicable terminal:T_RDY, C_REQ
*8 Applicable terminal: $\overline{S\_ENB}$, S_{IN}, S_{OUT}, S_{CLK}
*9 This value shall be fluctuated by data transmission mode and time to HALT mode of microcomputer
Average consumption current at stand-by is a value when data transmission mode is set "SET ALWAYS SEND MODE" and time to HALT mode of microcomputer is 520ms

Fig.1 Electric Circuit Constitution Diagram



■ Communication Method and function

Communication method

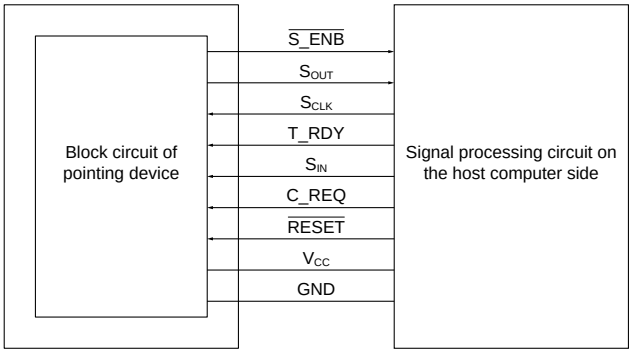
1. Communication method

Clock synchronous type 8bit serial interface (8bit signal is transmitted synchronized with clock (to 750kHz) input by host computer side.)

Half duplex type

2. Composition of the interface

The composition of the interface between host computer and pointing device shall be shown below.



3. Signal (Signal line)

Pin No.	Symbol	State	Signal wire name
1	–	NC	*10 –
2	S_ENB	Output	*11 Signal enable line
3	SOUT	Output	Data output line
4	SCLK	Input	Clock input line
5	T_RDY	Input	Transmission control line
6	SIN	Input	Data input line
7	C_REQ	Input	Command request line
8	RESET	Input	*11 Reset line
9	VCC	–	Power supply
10	GND	–	Ground

Note) Each state indicates input and output on the Pointing device side

*10 Pin No.1 is not connected to internal circuit of pointing device electrically. Therefore, don't connect Pin No.1 of host side to internal circuit of host side

*11 Active low

• Definition of each signal

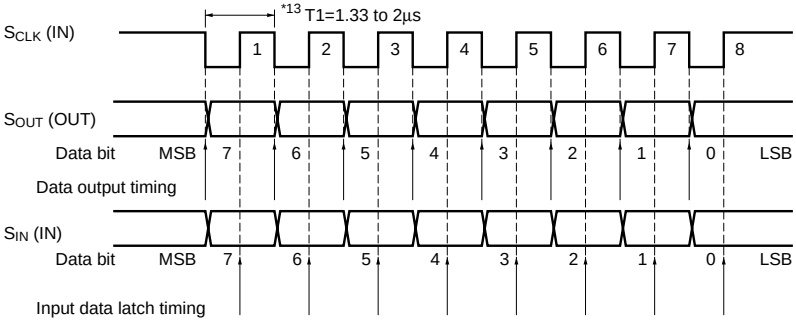
Symbol	Definition
SIN	Data input line. Host inputs data to resister of microcomputer in pointing device synchronized with the rising edge of the external input clock
SOUT	Data output line. Pointing device outputs data to host synchronized with the fall of the external input clock
SCLK	Clock input line. Pointing device inputs clock transmitted by Host
S_ENB	*12 Pointing device forces S_ENB from "H" to "L", then pointing device enables host to communicate
T_RDY	Host controls T_RDY to enable to communication by switching the state of T_RDY. ("H":enable, "L":disable)
C_REQ	Host controls the sequence of communication between pointing device and host ("H":from host to pointing device, "L":from pointing device to host)
RESET	Hardware reset line. If host put RESET "L", microcomputer inside of pointing device should be initialized

*12 When designing the control of transmission and reception, detect the falling edge of S_ENB

Control of transmission and reception

C_REQ	T_RDY	Contents
L	L	No communication
L	H	Data request. Host can transmit to pointing device
H	L	No communication
H	H	Command request. Pointing device can transmit to host.

Fig.2 The Timing Chart of Clock and Data Input/Output of Pointing Device



*13 T1 shows period of S_{CLK}. Duration of T1 is between 1.33µs and 2µs

4. Transmission method

The Pointing device generates the count data on X, Y direction and on/off status of Left and Right Switch as 3byte data. Output data is transmitted from S_{OUT} port. The composition of the output data shall be shown in the following list.

Byte	Bit	Contents
3rd	7 to 0	Y count (BIT0=LSB)
2nd	7 to 0	X count (BIT0=LSB)
1st	7	"0" (Fixed)
	6	"0" (Fixed)
	5	Direction of Y data (1:Minus, 0:Plus)
	4	Direction of X data (1:Minus, 0:Plus)
	3	"1" (Fixed)
	2	"0" (Fixed)
	1	Right key switch:ON="1", OFF="0"
	0	Left key switch:ON="1", OFF="0"

X, Y count data shall be composed of 9 bits including direction codes and stands by the binary number with the symbol. Therefore, value of X, Y count data have from +255 to –256.

• Data transmission methods from pointing device to host

① Host forces C_REQ to "L". (T_RDY is "H".)

② Pointing device forces $\overline{\text{S\_ENB}}$ from "H" to "L" if pointing device confirms T_RDY state is "H" and C_REQ state is "L".

③ Host transmits clock signal to pointing device using the interrupt function after host detects the falling edge of $\overline{\text{S\_ENB}}$ ("H"→"L") transmitted by pointing device.
(Host must transmit clock signal within 10ms after detecting the falling edge of $\overline{\text{S\_ENB}}$.)

④ Pointing device transmits the data to host synchronized with the falling edge of the clock signal which is sent by host.

⑤ After transmitting the data (1byte), pointing device pull $\overline{\text{S\_ENB}}$ "H".

⑥ Following the set up of the 2nd byte data, pointing device lowers $\overline{\text{S\_ENB}}$ "L" if pointing device confirms T_RDY state is "H" and C_REQ state is "L".

⑦ Step ③, ④ and ⑤ shall be then repeated.

⑧ Following the set up of the 3rd byte data, pointing device lowers $\overline{\text{S\_ENB}}$ "L" if pointing device confirms T_RDY is "H" and C_REQ is "L".

⑨ Step ③, ④ and ⑤ shall be then repeated.

⑩ After transmitting the data, pointing device pulls $\overline{\text{S\_ENB}}$ "H".

• Notes

① The state of T_RDY after transmitting data from pointing device isn't relevant.

② Pointing device monitors the state of T_RDY after $\overline{\text{S\_ENB}}$ is forced from "H" to "L".
The following process shall be shown below.

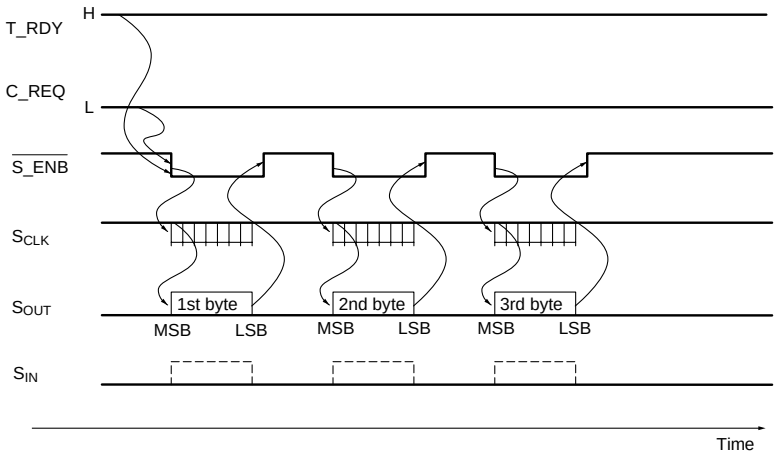
(1) In case of "L" state of T_RDY or not inputting of clock signal for 10ms, pointing device will cancel transmission process. Also, after cancel transmission, the rest of transmission data is cancelled completely and recturn normal operation.

(2) Pointing device continues to communicate if host transmits clock signal to pointing device within 10ms (Pointing device isn't in time out mode.).

③ Pointing device will stop transmitting the data if host forces C_REQ from "L" to "H" when pointing device is in the middle of a transmission.

④ When transmitting data of three byte, duration from the rising edge to the falling of $\overline{\text{S\_ENB}}$ is between 110μs and 220μs.

Fig.3 The Timing Chart of Data Transmission



5. Reception method

• Reception data

The received data format from host to pointing device is composed by 1byte.

The reception data shows as follows.

(e.g. reception data "11111000"→ hexadecimal indication "F8")

• Data transmission process from host to pointing device

① Host forces C_REQ line to "H". (T_RDY is "H".)

② Pointing devices lowers $\overline{\text{S\_ENB}}$ "L" if pointing device confirms T_RDY state is "H" and C_REQ state is "H".

③ Host transmits clock signal and the data to pointing device using the interrupt function after detecting the falling edge of $\overline{\text{S\_ENB}}$ transmitted by pointing device. (Host must transmit clock signal within 10ms after detecting the falling edge of $\overline{\text{S\_ENB}}$.)

④ Pointing device receives the data from host synchronized with the rising edge of the clock signal sent by the host.

⑤ Host forces C_REQ to "L" at the same time when host transmits the clock signal.

⑥ Pointing device pulls $\overline{\text{S\_ENB}}$ "H", after receives data from host.

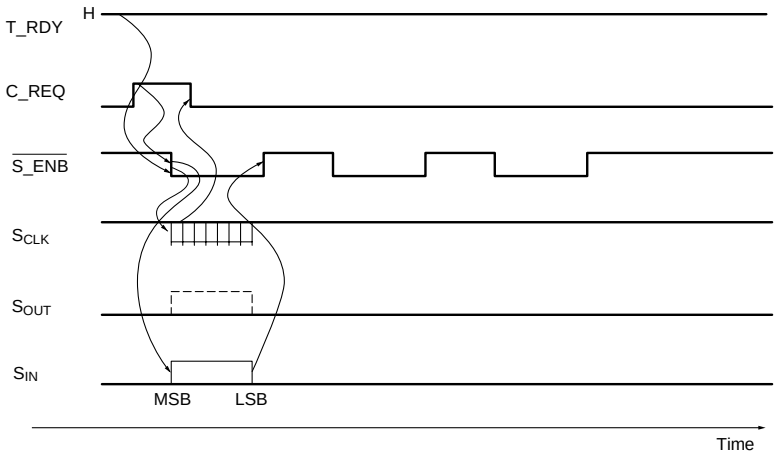
Notes)

① The state of T_RDY after transmitting data isn't relevant.

② When host changes count data table, host has to stop the transmission data from pointing device by using "F5" command (DISABLE).

③ When detecting T_RDY and C_REQ "H", pointing device switches $\overline{\text{S\_ENB}}$ to "L" within 50ms.

Fig.4 The Timing Chart of Data Transmission



6. Notes in communication

(1) Neither of ACK and NACK aren't controlled by pointing device and host in communication.

(2) Both of pointing device and host ignore insignificant data at their receive port.

(3) Host has to transmit clock signal within 10ms after receiving the falling edge of $\overline{S\_ENB}$.

(4) When pointing device is supplied V_{CC}, host has to force $\overline{RESET}$ to "L".

Command

1. Control command

Command	Order	Define
FF	RESET	Pointing device is transferred to RESET Mode
F9	STOP	Pointing device is transferred to STOP mode
F8	STAND-BY	Pointing device is transferred to STAND-BY mode
F5	DISABLE	Stop data transmission
F4	ENABLE	Permit data transmission
F2	SET STREAM MODE	Transmit data in case of pushed L/R SW and shifted X, Y data
F0	SET ALWAYS SEND MODE	Transmit data in any case

*14 The condition and the operation to change to RESET mode, STOP mode and STAND-BY mode is shown below

Condition

Mode	Order	Define
RESET mode	Power on supplying On receiving RESET command ("FF ")	Following to change to RESET mode, pointing device initializes itself. Under RESET mode, pointing device stop communicating to host. And pointing device recovers the default value set by initializing pointing device.
STOP mode	On receiving STOP command ("F9 ")	Host changes pointing device condition to STOP mode, pointing device stop to work completely. Pointing device stops to communicate, so pointing device doesn't accept the command request from host.
STAND-BY mode	On receiving STAND-BY command ("F8")	Host changes pointing device condition to STAND-BY mode. Even if when pointing device operates in the middle of HALT mode, pointing device accepts to receive command request from host. Pointing device transmits the data to host if pointing device is pushed L/R SW and pointing device is operated to change count data.

2. Switch command of count data table

Command	Set value	Contents
*40	TBL0	Switch count data table
41	TBL1	
42	TBL2	

For note, refer to Fig.14

3. Control command 1

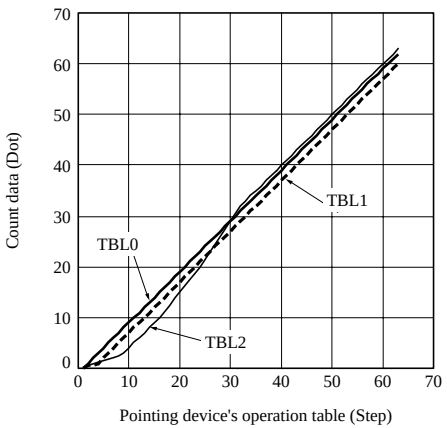
Command	Set value	Contents
*80	10	(Unit:s)
81	5	Determine a time taken to shift to STAND-BY mode when pointing device has no command and no operation.
82	30	
83	60	
*90	520	(Unit:ms)
91	90	In the STAND-BY mode, determine the interval of detection process which detects a change of SW or count data.
92	130	
93	170	
94	220	
95	260	
96	300	
97	350	
98	390	
99	440	
9A	480	
9B	570	
9C	610	
9D	650	
9E	700	
9F	740	

4. Control command 2

Command	Set value	Contents
*50	STBL0	Switch cursor stop judgement zone
#51	STBL1	
52	STBL2	
53	STBL3	
*60	0.25	Determine a scale of pointer's moving distance on displacement of operating portion
#61	0.30	
62	0.35	
63	0.20	
*70	(0.25)	Coefficient to fix cursor stop judgement zone corresponding to moving coefficient. Be sure to link stop coefficient to moving one. "e.g. 60-70, 61-71, 62-72, 63-73"
#71	(0.30)	
72	(0.35)	
73	(0.20)	
*A0	5	(Unit:s) In the time of set value, zero point shall be reset when data in judged values of correction is transmitted automatically
A1	4	
A2	3	
A3	2	
*B0	±2	(Unit:DOT) Determine a judged value of zero point correction automatically
B1	±3	
B2	±4	
B3	±5	
*C0	20	(Unit:%) Correct the output in the oblique direction.
C1	15	
C2	0	
C3	25	

Note) (1) *: default, #: recommended value
(2) The relation between count data and X, Y count data is shown in the below figure
(3) Host has to transmit initialized set command before host transmits "F4" command to pointing device when pointing device is supplied that pointing device condition is DISABLE
(4) If host doesn't transmit the command, pointing device operates at default condition
(5) Don't use initialized set command except on the supply V_{CC}, on the hardware reset and on the command reset
(6) Pointing device operates at default condition if pointing device receives reset command "FF" (RESET) from host
(7) Don't use control command 2 except below case
Power ON, Hardware reset, Software reset by receiving "FF"
Also, use the recommended value of 5x, 6x and 7x of control command 2

Fig.5 Relation between Pointing Device's Operation Table and Count Data



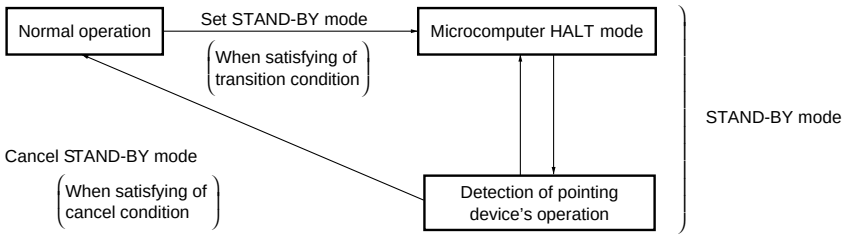
Switching operation mode of microcomputer reduces consumption power.

Fig.6 State Transition Diagram

Function

1. Low power function

(a) STAND-BY mode



• Transition condition

① Set time for no operation to pointing device. (Set time has 4 patterns with command 8x (0 to 3)

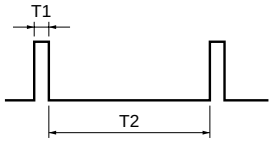
② Command transmission from host computer. (Command "F8")

• Cancel condition

① Pointing device operation. (Change of L/R SW, change of X, Y count data)

② Hardware reset

Fig.7 Timing Chart in STAND-BY mode



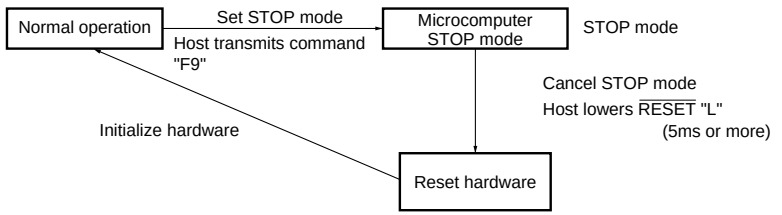
T1:Detection time of pointing device's operation
T2:Time to HALT mode of microcomputer.
It is able to be set by command.

(b) STOP mode

Shifting the operation mode of microcomputer in the pointing device shall reduce dissipation power. Consumption current is less than that of STAND-BY mode.

However, canceling STOP mode, it is necessary to reset hardware.

Fig.8 State Transmition diagram



2. Switching of count data table

Output ratio of count data on pointing device's operation shall be selected by transmitting command. (Three kinds of table)

• Control method

① Make pointing device "DISABLE" status by transmitting command "F5"

② Transmit command count data table for switching "4x" (x=0, 1, 2)

③ Make pointing device "ENABLE" status by transmitting command "F4".

• Relation between each pointing device's operation table and count data table

Refer to Fig.5

Note)

Be sure to switch after confining "DISABLE" status.

3. TEST mode

• Function

By transmitting command signal, pointing device generates the output of sensor taken by A/D converter as serial data of three byte.

• Output format

	First byte	Second byte	Third byte
TEST mode 1	Reference Voltage	AD1	AD0
TEST mode 2	Reference Voltage	AD3	AD2

• Control method

① Transmit command "F0" (SET ALWAYS SEND MODE).

② Transmit command "F4" (ENABLE).

③ Transmit command TEST mode 1 or TEST mode 2.

• TEST mode command

Transmit a series of command shown below.

TEST mode 1

"D0" "D1" "D2" "D3" "D4"

TEST mode 2

"D0" "D1" "D2" "D3" "D4" "D5"

This mode shall be used for process test on producer side.

Design it in not to become TEST mode when end customer uses the equipment.

Initial settings

In case of turning on power supply and reset hardware, the following processing shall be enforced.

• Processing flow when turning on power supply and reset hardware

① Turn on power supply and reset hardware

② Wait about 100ms

③ Host transmits command "F2" (STREAM MODE) or "F0" (SET ALWAYS SEND MODE).

④ Host transmits miscellaneous control commands. In case of transmitting control command, pointing device moves default settings. (Default settings have value composed of zero in lower 4bits.)

⑤ Host transmits command "F4" (ENABLE).

⑥ Host puts T_RDY "H" and C_REQ "L" (Data request).

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