

## CMOS 8-Bit Microcontroller TMP87PS39N/F

The TMP87PS39 is a One-Time PROM microcontroller with low-power 543 Kbits (a 60 Kbytes program memory and a 256 characters OSD font memory) electrically programmable read only memory for the TMP87CS39 system evaluation. The TMP87PS39 is pin compatible with the TMP87CS39. The operations possible with the TMP87CS39 can be performed by writing programs and OSD character data to PROM. The TMP87PS39 can write and verify in the same way as the TC571000 using an adaptor socket BM11118/BM11138 and an EPROM programmer.

Part No.	OTP	RAM	Package	Adaptor Socket
TMP87PS39N	60 Kbytes + 14 × 18 × 256 bits	2 Kbytes	P-SDIP64-750-1.78	BM11118
TMP87PS39F			P-QFP64-1420-1.00A	BM11138

030519EBP1

- The information contained herein is subject to change without notice.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.  
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- TOSHIBA products should not be embedded to the downstream products which are prohibited to be produced and sold, under any law and regulations.
- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance/Handling Precautions.



Purchase of TOSHIBA I<sup>2</sup>C components conveys a license under the Philips I<sup>2</sup>C Patent Rights to use these components in an I<sup>2</sup>C system, provided that the system conforms to the I<sup>2</sup>C Standard Specification as defined by Philips.



## Pin Function

The TMP87PS39 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the TMP87PS39 is pin compatible with the TMP87CS39 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A16	Input	PROM address inputs	P30
A15 to A8			P67 to P60
A7 to A0			P57 to P50
D7 to D0	I/O	PROM data input/outputs	P07 to P00
$\overline{CE}$	Input	Chip enable signal input (active low)	P13
$\overline{OE}$		Output enable signal input (active low)	P14
$\overline{PGM}$	Input	Program mode signal input (active low)	P15
VPP	Power supply	+12.5V/5V (Program supply voltage)	TEST
VCC		+5V	VDD
GND		0 V	VSS
P47 to 40	Input	Pull-up with resistance for input processing	PROM mode setting pin. Be fixed at high level.
P12			
P74 to P70			
P36 to P32			
P11		PROM mode setting pin. Be fixed at low level.	
P21			
P31			
P17, P16, P10			
P22, P20			
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
OSC1	Input	Non connection	
OSC2	Output		

## Operational Description

The following explains the TMP87PS39 hardware configuration and operation. The configuration and functions of the TMP87PS39 are the same as those of the TMP87CS39, except in that a one-time PROM is used instead of an on-chip mask ROM.

The TMP87PS39 is placed in the single-clock mode during reset. To use the dual-clock mode, the low-frequency oscillator should be turned on by executing [SET (SYSCR2). XTEN] instruction at the beginning of the program.

### 1. Operating Mode

The TMP87PS39 has two modes: MCU and PROM.

#### 1.1 MCU Mode

The MCU mode is activated by fixing the TEST/VPP pin at low level.

In the MCU mode, operation is the same as with the TMP87CS39 (the TEST/VPP pin cannot be used open because it has no built-in pull-down resistance).

##### 1.1.1 Program Memory and OSD Character Font Memory

The TMP87PS39 has a 60 K × 8-bit (addresses 1100H to FFFFH in the MCU mode, addresses 11100H to 1FFFFH in the PROM mode) of program memory and a 14 × 18 × 256 bits (addresses 04000H to 07FFFH in the PROM mode) of OSD character font memory.

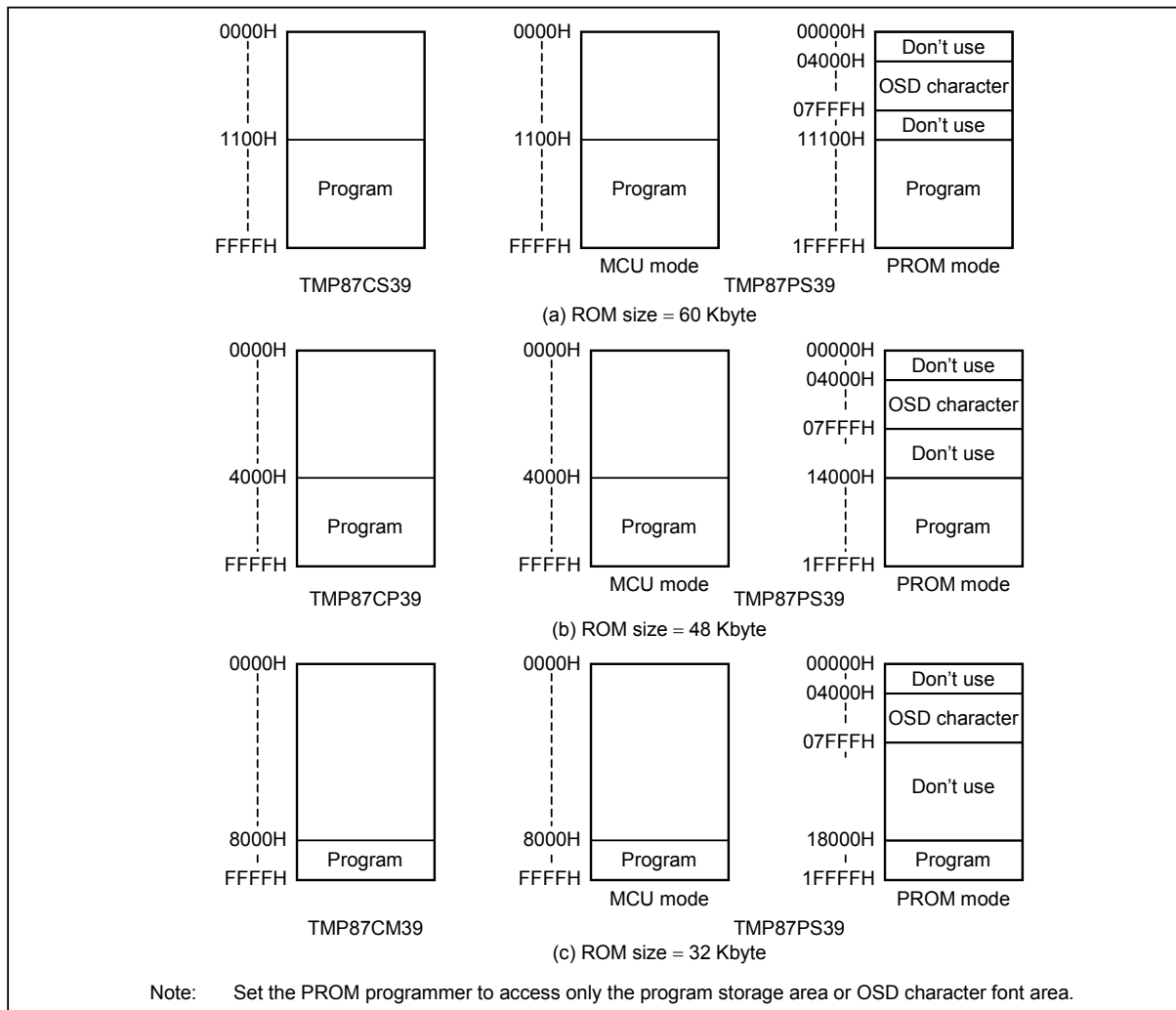


Figure 1.1.1 Program Memory Area

## Electrical Characteristics

## Absolute Maximum Ratings

(V<sub>SS</sub> = 0 V)

Parameter	Symbol	Pins	Ratings	Unit
Supply voltage	V <sub>DD</sub>		-0.3 to 6.5	V
Program voltage	V <sub>PP</sub>	TEST/VPP	-0.3 to 13.0	
Input voltage	V <sub>IN</sub>		-0.3 to V <sub>DD</sub> + 0.3	
Output voltage	V <sub>OUT1</sub>		-0.3 to V <sub>DD</sub> + 0.3	
Output current (Per 1 pin)	I <sub>OUT1</sub>	Ports P0, P1, P2, P3, P4, P5, P64 to P67, P7	3.2	mA
	I <sub>OUT2</sub>	Ports P60 to P63	30	
Output current (Total)	Σ I <sub>OUT1</sub>	Ports P0, P1, P2, P3, P4, P5, P64 to P67, P7	120	
	Σ I <sub>OUT2</sub>	Ports P60 to P63	120	
Power dissipation [T <sub>opr</sub> = 70°C]	P <sub>D</sub>		600	mW
Soldering temperature (time)	T <sub>sld</sub>		260 (10 s)	°C
Storage temperature	T <sub>stg</sub>		-55 to 125	
Operating temperature	T <sub>opr</sub>		-30 to 70	

Note: The absolute maximum ratings are rated values which must not be exceeded during operation, even for an instant. Any one of the ratings must not be exceeded. If any absolute maximum rating is exceeded, a device may break down or its performance may be degraded, causing it to catch fire or explode resulting in injury to the user. Thus, when designing products which include this device, ensure that no absolute maximum rating value will ever be exceeded.

## Recommended Operating Conditions

(V<sub>SS</sub> = 0 V, T<sub>opr</sub> = -30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply voltage	V <sub>DD</sub>		fc = 8 MHz	NORMAL1	4.5	5.5
				IDLE1, 2 modes		
			fc = 32.768 kHz	SLOW mode	2.7	
				SLEEP mode		
	STOP mode	2.0				
Input high voltage	V <sub>IH1</sub>	Except hysteresis input	V <sub>DD</sub> ≥ 4.5 V	V <sub>DD</sub> × 0.70	V <sub>DD</sub>	V
	V <sub>IH2</sub>	Hysteresis input		V <sub>DD</sub> × 0.75		
	V <sub>IH3</sub>			V <sub>DD</sub> < 4.5 V		
Input low voltage	V <sub>IL1</sub>	Except hysteresis input	V <sub>DD</sub> ≥ 4.5 V	0	V <sub>DD</sub> × 0.30	
	V <sub>IL2</sub>	Hysteresis input			V <sub>DD</sub> × 0.25	
	V <sub>IL3</sub>				V <sub>DD</sub> < 4.5 V	
Clock frequency	fc	XIN, XOUT	V <sub>DD</sub> = 4.5 to 5.5 V	4.0	8.0	MHz
	f <sub>OSC</sub>	OSC1, OSC2	Normal frequency mode (FORS = 0, V <sub>DD</sub> = 4.5 to 5.5 V)	4.0	f <sub>OSC</sub> ≤ fc × 1.2 ≤ 8.0	
			Doublet frequency mode (FORS = 1, V <sub>DD</sub> = 4.5 to 5.5 V)	2.0	f <sub>OSC</sub> ≤ fc × 0.6 ≤ 4.0	
	fs	XTIN, XTOUT		30.0	34.0	

Note 1: The recommended operating conditions for a device are operating conditions under which it can be guaranteed that the device will operate as specified. If the device is used under operating conditions other than the recommended operating conditions (supply voltage, operating temperature range, specified AC/DC values etc.), malfunction may occur. Thus, when designing products which include this device, ensure that the recommended operating conditions for the device are always adhered to.

Note 2: Clock frequency fc; Supply voltage range is specified in NORMAL 1/2 mode and IDLE 1/2 mode.

Note 3: When using test video signal circuit, high frequency must be 8 MHz.

Note 4: When the OSD circuit is used, the supply voltage must be from 4.5 V to 5.5 V.

## DC Characteristics

(V<sub>SS</sub> = 0 V, T<sub>opr</sub> = -30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis voltage	V <sub>HS</sub>	Hysteresis inputs		-	0.9	-	V
Input current	I <sub>IN1</sub>	TEST	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V/0 V	-	-	±2	μA
	I <sub>IN2</sub>	Open drain ports	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V/0 V	-	-	±2	
	I <sub>IN3</sub>	Tri-state ports	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V/0 V	-	-	±2	
	I <sub>IN4</sub>	RESET, STOP	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V/0 V	-	-	±2	
Input resistance	R <sub>IN2</sub>	RESET		100	220	450	kΩ
Output leakage current	I <sub>LO1</sub>	Sink open drain ports	V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V	-	-	2	μA
	I <sub>LO2</sub>	Tri-state ports	V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V/0 V	-	-	±2	
Output high voltage	V <sub>OH2</sub>	Tri-state ports	V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = -0.7 mA	4.1	-	-	V
Output low voltage	V <sub>OL</sub>	Except XOUT, OSC2 and ports P63 to P60	V <sub>DD</sub> = 4.5 V, I <sub>OL</sub> = 1.6 mA	-	-	0.4	
Output low current	I <sub>OL3</sub>	Ports P63 to P60	V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V	-	20	-	mA
Supply current in NORMAL 1, 2 modes	I <sub>DD</sub>		V <sub>DD</sub> = 5.5 V f <sub>c</sub> = 8 MHz	-	13	20	
Supply current in IDLE 1, 2 modes			V <sub>DD</sub> = 5.5 V f <sub>s</sub> = 32.768 kHz V <sub>IN</sub> = 5.3 V/0.2 V	-	6.5	10	
Supply current in SLOW mode			V <sub>DD</sub> = 3.0 V f <sub>s</sub> = 32.768 kHz	-	30	70	
Supply current in SLEEP mode			V <sub>DD</sub> = 3.0 V V <sub>IN</sub> = 2.8 V/0.2 V	-	15	35	
Supply current in STOP mode			V <sub>DD</sub> = 5.5 V V <sub>IN</sub> = 5.3 V/0.2 V	-	0.5	10	

Note 1: Typical values show those at T<sub>opr</sub> = 25°C, V<sub>DD</sub> = 5 V.

Note 2: Input Current I<sub>IN3</sub>; The current through pull-up resistor is not included.

Note 3: Supply Current I<sub>DD</sub>; The current (Typ. 0.5 mA) through ladder resistors of ADC is included in NORMAL mode and IDLE mode.

## AD Conversion Characteristics

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 5.5 V, T<sub>opr</sub> = -30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog reference voltage	V <sub>DD</sub>	Supplied from V <sub>DD</sub> pin	-	V <sub>DD</sub>	-	V
	V <sub>SS</sub>	Supplied from V <sub>SS</sub> pin	-	0	0	
Analog reference voltage range	ΔV <sub>AREF</sub>	= V <sub>DD</sub> - V <sub>SS</sub>	-	V <sub>DD</sub>	-	
Analog input voltage	V <sub>AIN</sub>		V <sub>SS</sub>	-	V <sub>DD</sub>	
Nonlinearity error		V <sub>DD</sub> = 4.5 to 5.5V	-	-	±1	LSB
Zero point error			-	-	±2	
Full scale error			-	-	±2	
Total error			-	-	±3	

AC Characteristics

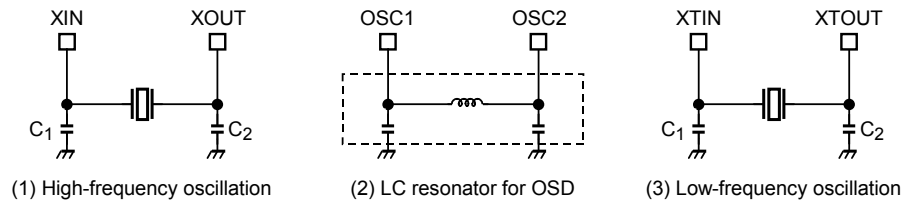
(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 5.5 V, Topr = -30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine cycle time	t <sub>cy</sub>	In NORMAL1, 2 modes	0.5	-	1.0	μs
		In IDLE1, 2 modes				
		In SLOW mode	117.6	-	133.3	
		In SLEEP mode				
High level clock pulse width	t <sub>WCH</sub>	For external clock operation (XIN input), fc = 8 MHz	50	-	-	ns
Low level clock pulse width	t <sub>WCL</sub>					
High level clock pulse width	t <sub>WSH</sub>	For external clock operation (XTIN input), fs = 32.768kHz	14.7	-	-	μs
Low level clock pulse width	t <sub>WSL</sub>					

Recommended Oscillating Conditions

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 5.5 V, Topr = -30 to 70°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator	Recommended Constant	
				C <sub>1</sub>	C <sub>2</sub>
High-frequency oscillation	Ceramic resonator	8 MHz	KYOCERA KBR8.0M	30 pF	30 pF
		4 MHz	KYOCERA KBR4.0MS MURATA CSA4.00MG		
	Crystal oscillator	8 MHz	TOYOCOM 210B 8.0000	20 pF	20 pF
		4 MHz	TOYOCOM 204B 4.0000		
OSD	LC resonator	8 MHz	TOKO A285TNIS-11695	-	-
		7 MHz	TOKO TBEKSES-30375FBY		
Low-frequency oscillation	Crystal oscillator	32.768 kHz	NDK MX-38T	15 pF	15 pF



Note 1: On our OSD circuit, the horizontal display start position is determined by counting the clock from LC oscillator. So, the unstable start of oscillation after the rising edge of Horizontal Sync. Signal will be cause the OSD distortion.

Generally, smaller C and larger L make clearer wave form at the beginning of oscillation.

We recommend that the value of LC oscillator should be equal and bigger than 33 μH.

Note 2: To keep reliable operation, shield the device electrically with the metal plate on its package mold surface against the high electric field, for example, be CRT (Cathode Ray Tube).

Note 3: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change.

For up-to-date information, please refer to the following URL:

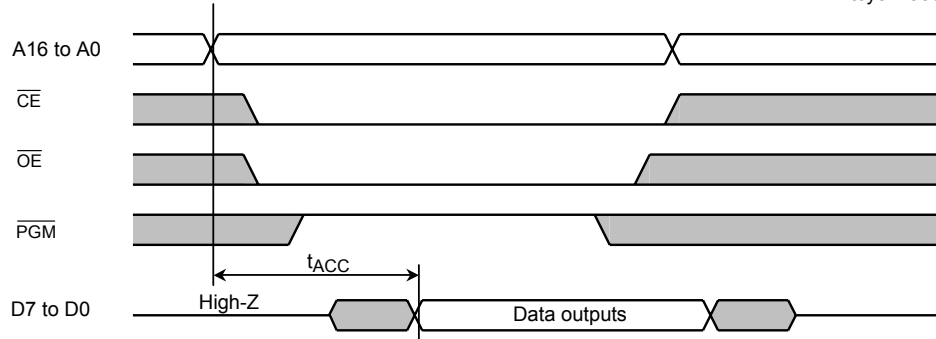
<http://www.murata.co.jp/search/index.html>

DC/AC Characteristics (PROM mode) (V<sub>SS</sub> = 0 V)

(1) Read Operation

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input high voltage	V <sub>IH4</sub>		V <sub>CC</sub> × 0.7	–	V <sub>CC</sub>	V
Input low voltage	V <sub>IL4</sub>		0	–	V <sub>CC</sub> × 0.12	
Power supply voltage	V <sub>CC</sub>					
Program power supply voltage	V <sub>PP</sub>		4.75	5.0	5.25	
Address access time	t <sub>ACC</sub>	V <sub>CC</sub> = 5.0 ± 0.25 V	–	1.5t <sub>cy</sub> + 300	–	ns

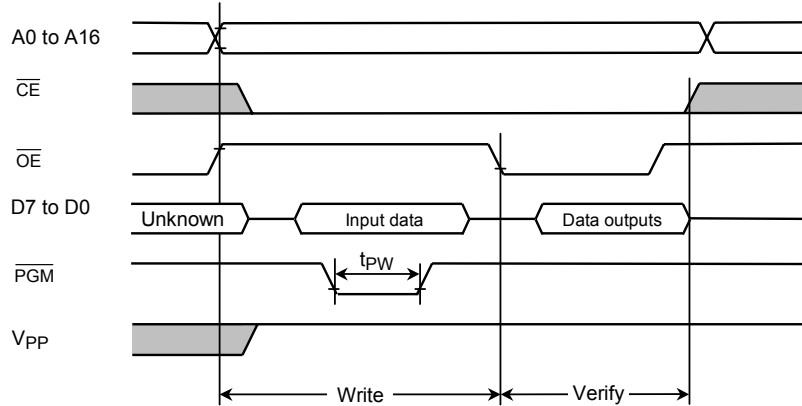
t<sub>cy</sub> = 500 ns at 8 MHz



(2) High-Speed Programming Operation

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input high voltage	V <sub>IH4</sub>		V <sub>CC</sub> × 0.7	–	V <sub>CC</sub>	V
Input low voltage	V <sub>IL4</sub>		0	–	V <sub>CC</sub> × 0.12	
Power supply voltage	V <sub>CC</sub>		6.0	6.25	6.5	
Program power supply voltage	V <sub>PP</sub>		12.5	12.75	13.0	
Initial program pulse width	t <sub>PW</sub>	V <sub>CC</sub> = 6.0 V	0.095	0.1	0.105	ms

High-speed programming timing



Note1: When V<sub>CC</sub> power supply is turned on or after, V<sub>PP</sub> must be increased.  
 When V<sub>CC</sub> power supply is turned off or before, V<sub>PP</sub> must be increased.

Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.75 V ± 0.25 V = V) to the V<sub>PP</sub> pin as the device is damaged.

Note3: Be sure to execute the recommended programming mode with the recommended programming adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.