TENTATIVE

Control IC Product Specifications

					TITLE	
					Control IC Product Specifications	
					DRAW. NO.	CUST
					Tech Bes F&T-I0603	
EDIT	DATE	DESIG.	CHECK	DESCRIPTION	Fujitsu Component Limited	SHEET 1 / 39
DESIG.	20050502K.Yoshifusa	CHECK	T.Nakajima	APPR. K.Nishimura		

TENTATIVE

Contents

Control IC Product Specifications

1. Scope

This specifications applies to the control IC of FCL Touch-panel (Corresponds to PnP ID).

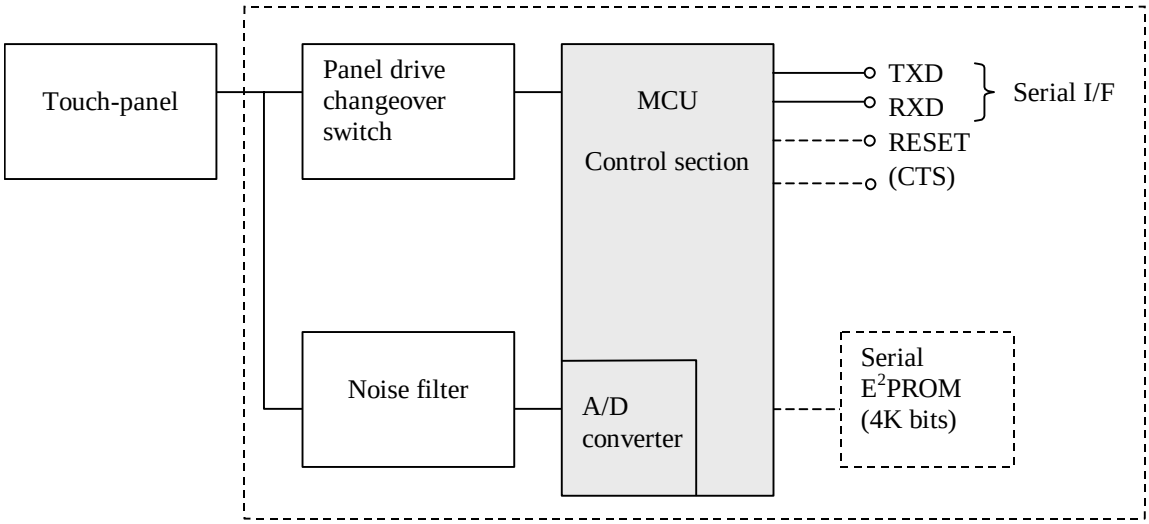
[Drawing No.] Control IC: N010-0559-V034 (Lead Free of N010-0559-V032)

2. Summary

The control IC and the FCL Touch-panel converts pen or finger pressure on a specific location into coordinate axis values and outputs them as serial data.

The shaded part in the following block diagram is the control IC (MCU control section, and converter).

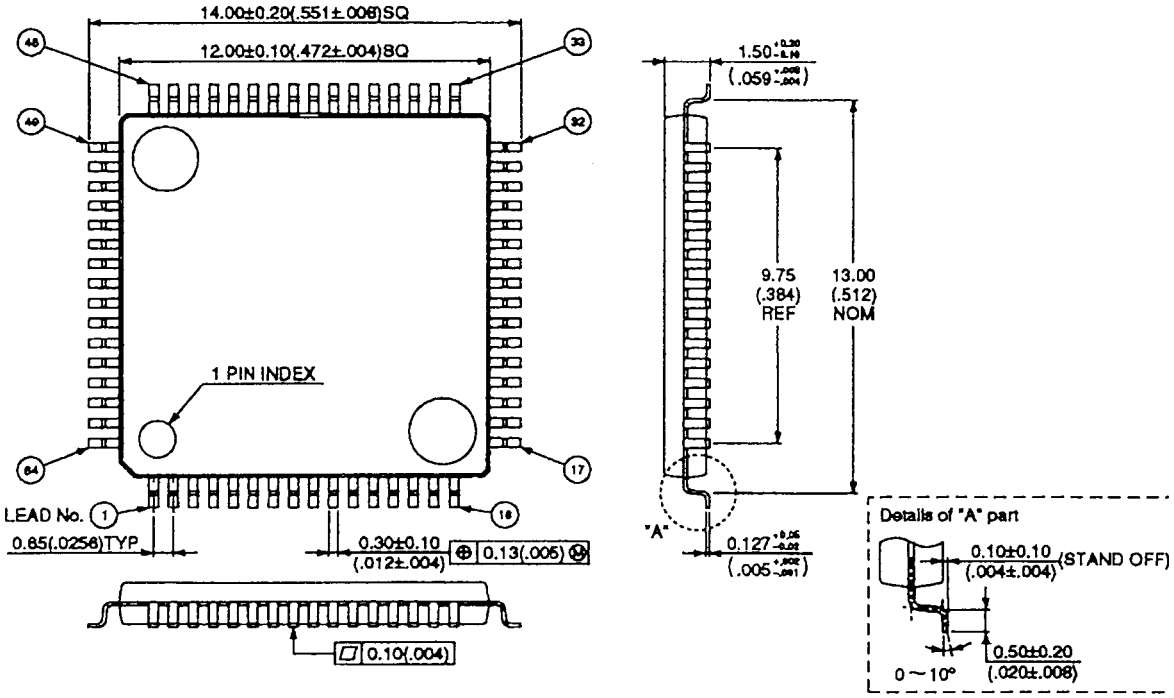
[Block diagram]



- E^2PROM contains correction data for each Touch-panel.
- Operation without using E^2PROM is possible, however, it should be used to minimize memory volatility.
- Connect the RESET signal if necessary. (Built-in power-on reset)]
- When wearing PnP ID is used, Host's RTS signal is connected with (CTS). Moreover, (CTS) differs from an original usage as CTS.

3. External Diagram

Plastic QFP, 64 pins
(FPT-64P-M09)



4. Coordinate System

(1) Initial coordinate system

The initial coordinate status presents the external panel. One corner of the panel is the origin point and a corner of the diagonal line becomes the maximum (X = 4095 and Y = 4095).

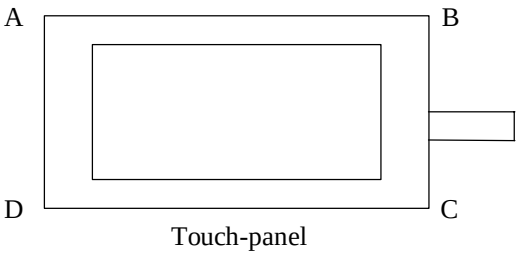
Therefore, the minimum value of the input area is 0(zero) or more and the maximum value is 4095 or less.

(2) Coordinate system after correction

The origin point (zero point) and the maximum point can be specified at an optional location in the input area using the correction command (CAL-In etc.), which will be described later. Additionally, a maximum value 4095 or less is possible.

(3) Setting origin point

The origin point can be specified at any corner using OS0 and OS1 pins.



Touch-panel

OS1	OS0	Location of origin point
H	H	A
H	L	B
L	H	C
L	L	D

5. Electrical Characteristics

5.1 Absolute Maximum Ratings

(AVss = Vss = 0.0 V)

Item	Symbol	Rated value		Unit	Remarks
		Minimum	Maximum		
Power voltage	Vcc	Vss-0.3	Vss+7.0	V	*
	AVcc	Vss-0.3	Vss+7.0	V	*
A/D converter standard input voltage	AVR	Vss-0.3	Vss+7.0	V	Must not exceed AVcc+0.3
Input voltage	V_1	Vss-0.3	Vcc+0.3	V	Other than 1, 2, 63, or 64 pin
	V_{12}	Vss-0.3	Vss+7.0	V	1, 2, 63, or 64 pin
Output voltage	V_O	Vss-0.3	Vcc+0.3	V	Other than 1, 2, 63, or 64 pin
	V_{O2}	Vss-0.3	Vss+7.0	V	1, 2, 63, or 64 pin
L-level maximum output current	I_{OL}	-	20	mA	
L-level mean output current	I_{OLAV}	-	4	mA	Mean value (operating current × operation ratio)
L-level entire maximum output current	$\sum I_{OL}$	-	100	mA	
L-level entire mean output current	$\sum I_{OLAV1}$	-	40	mA	Mean value (operating current × operation ratio)
H-level maximum output current	I_{OH}	-	-20	mA	
H-level mean output current	I_{OHAV}	-	-4	mA	Mean value (operating current × operation ratio)
H-level entire maximum output current	$\sum I_{OH}$	-	-50	mA	
H-level entire mean output current	$\sum I_{OHAV1}$	-	-20	mA	Mean value (operating current × operation ratio)
Power consumption	Pd	-	500	mW	
Operating temperature	Ta	-40	+85	°C	MCU single unit
Storage temperature	Tstg	-55	+150	°C	MCU single unit

- Utilize the same potential at for AVcc and Vcc. Also, when switching on power supply, it is made for AVcc not to exceed Vcc.

<Note>

Applying voltages exceeding the absolute rated value will cause fatal damage to the LSI.

In normal operation, this device should only be used under recommended conditions. LSI reliability will be severely degraded if operated under other conditions.

5.2 Recommended Operating Conditions

(AVss = Vss = 0.0 V)

Item	Symbol	Rated value		Unit	Remarks
		Minimum	Maximum		
Power supply voltage	Vcc	3.0	6.0	V	
	AVcc	3.5	6.0	V	Range within analog precision guarantee
	AVR	3.0	AVcc	V	
Operating temperature	Ta	0	+45	°C	

5.3 DC Rating

(Ta = 0 to 45°C, AVcc = Vcc = 5.0 V, AVss = Vss = 0.0 V)

Item	Symbol	Condition	Rated value			Unit	Remarks
			Minimum	Standard	Maximum		
H-level input voltage	V_{IH1}	-	0.7 Vcc	-	Vcc+0.3	V	48 to 41, 40 to 33, 30, 29, 57, 53, 50, 61, or 59 pin
	V_{IH2}	-	0.7 Vcc	-	Vss+6.0	V	1, 63, or 64 pin
	V_{IHS1}	-	0.8 Vcc	-	Vcc+0.3	V	19, 20, 21, 58, 55, 54, 52, 51, 62, or 60 pin
	V_{IHS2}	-	0.8 Vcc	-	Vss+6.0	V	2, 17, or 18 pin
L-level input voltage	V_{IL}	-	Vss-0.3	-	0.3 Vcc	V	48 to 41, 40 to 33, 30, 29, 57, 53, 50, 61, or 59 pin
	V_{ILS}	-	Vss-0.3	-	0.2 Vcc	V	58, 55, 54, 52, 51, 62, 60, 2, 1, 63, 64, 18 to 14, 19, 20, or 21 pin
H-level output voltage	V_{OH}	I_{OH} = -2.0 mA	4.0	-	-	V	48 to 41, 40 to 33, 32 to 25, 58, 57, 55 to 50, or 62 to 59 pin
L-level output voltage	V_{OL}	I_{OL} = 4.0 mA	-	-	0.4	V	48 to 41, 40 to 33, 32 to 25, 58, 57, 55 to 50, 62 to 59, 1, 2, 63, 64, 3 to 10, or 19 pin

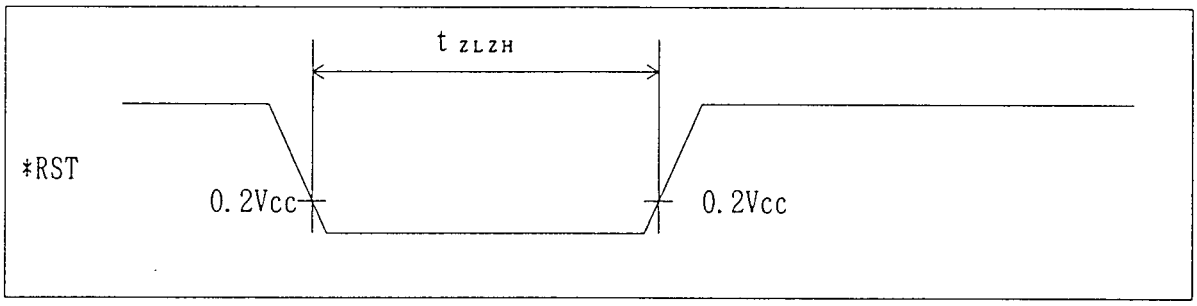
Item	Symbol	Condition	Rated value			Unit	Remarks
			Minimum	Standard	Maximum		
Input leak current (HI-Z output leak current)	I_{LI}	0.0 V < V_I < V_{CC}	-	-	±5	µA	48 to 41, 40 to 33, 32 to 25, 58, 57, 55 to 50, 62 to 59, 1, 2, 63, 64, 18 to 14, 21, or 20 pin
Vcc Power supply current	I_{CC}	F_C = 8 MHz	-	8	20	mA	MCU single unit at detection operation
	I_{CCH}	Ta = 25°C	-	-	1	µA	MCU single unit at sleep time
AVcc power supply current	I_A	F_C = 8 MHz	-	6	-	mA	MCU single unit when operating AD conversion
	I_{AH}	F_C = 8 MHz Ta = 25°C	-	-	1	µA	MCU single unit AD conversion stop
Input capacity	C_{IN}	f = 1 MHz	-	10	-	pF	Excluding AVcc, AVss, Vcc, and Vss
Pull-up resistor value	R_{PULL}	V_I = 0.0 V	25	50	100	kΩ	Terminal with pull-up

5.4 AC Rating

(1) Reset timing

(Ta = 0 to 45°C, Vcc = 5 V ±10%, AVss = Vss = 0 V)

Item	Symbol	Condition	Rated value		Unit	Remarks
			Minimum	Maximum		
*RST low width	t_{ZLZH}		$48t_{HCYL}$	-	ns	



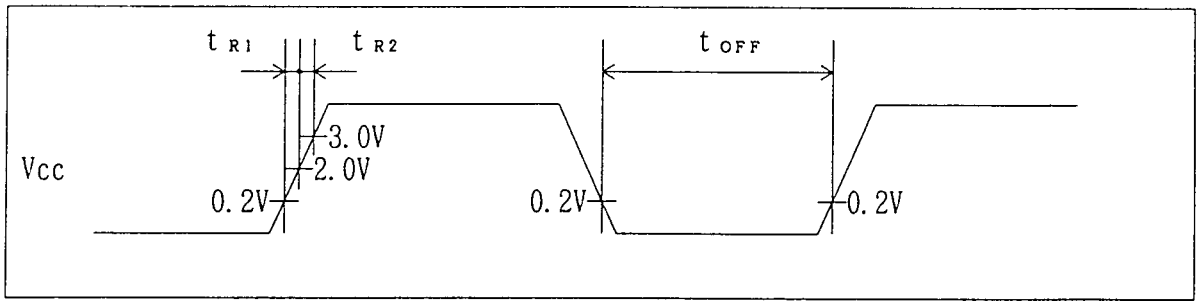
(2) Power-on reset

(Ta = 0 to 45°C, Vcc = 5.0 V)

Item	Symbol	Condition	Rated value		Unit	Remarks
			Minimum	Maximum		
Power supply start-up time	t_{R1}		-	50	ms	
	t_{R2}		-	20	ms	
Power supply disconnection time	t_{OFF}		1	-	ms	For repetition time

<Note>

If it is necessary to change power supply voltage while the device is operating, the change should be accomplished as smoothly as possible.

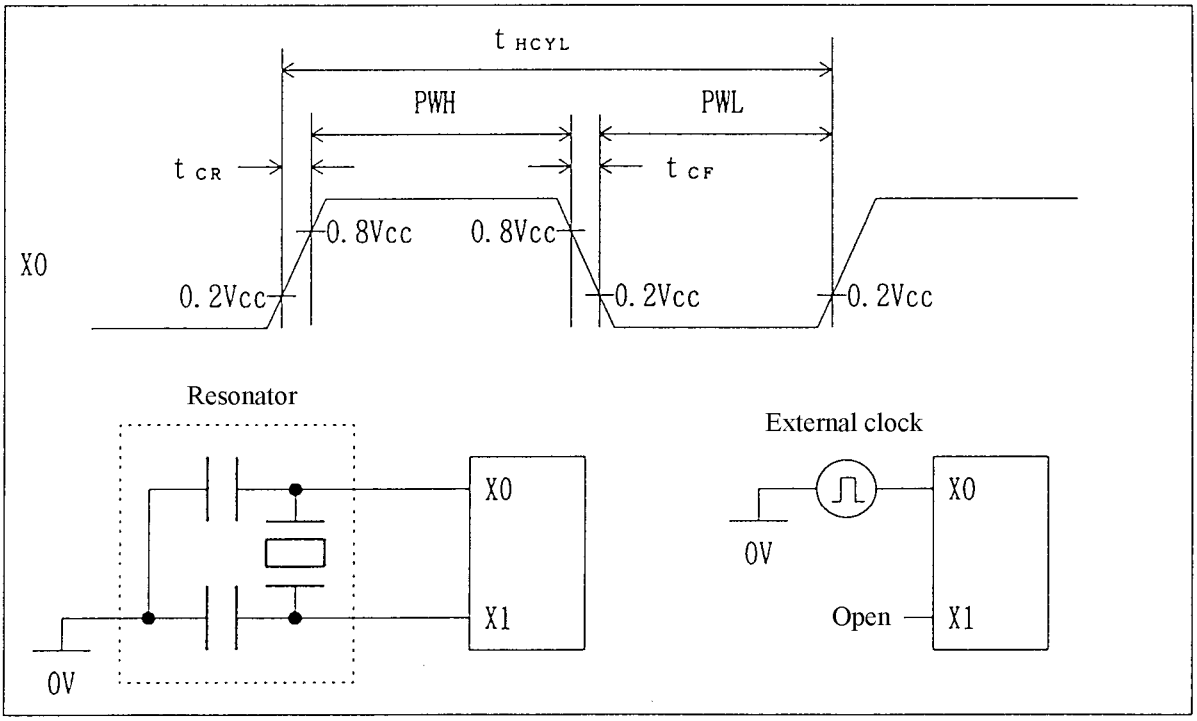


(3) Clock timing rate

(Ta = 0 to 45°C, AVss = Vss = 0 V)

Item	Symbol	Condition	Rated value		Unit	Remarks
			Minimum	Maximum		
Clock frequency	F_C		7.91	8.09	MHz	X0, X1
Input clock pulse width	PWH PWL		20	-	ns	X0 For external clock
Input clock raising/ falling time	t_{CR} t_{CF}		-	10	ns	X0 For external clock

Note) Always use an 8 MHz oscillation circuit for this system.



* Recommended resonator

Catalog number	Package	Frequency	Frequency deviation	Manufacturer
CSTCE8M00G55	CHIP	8 MHz	Within ±0.5% (initial)	Murata Manufacturing.

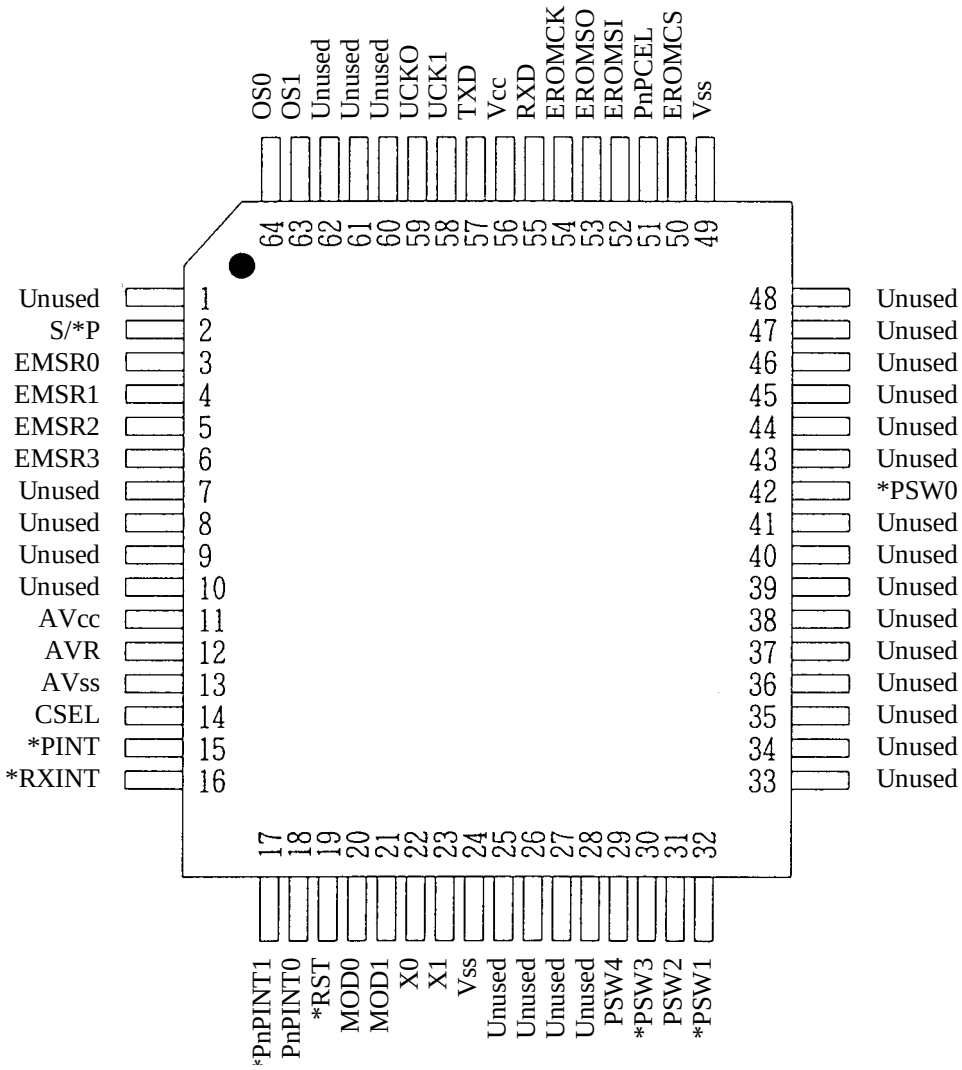
5.5 Electrical Characteristics of A/D Converter

(Ta = 0 to 45°C, AVcc = Vcc = 3.5 to 6.0 V, 8 MHz, AVss = Vss = 0.0 V)

Item	Symbol	Condition	Rated value		Unit	Remarks
			Minimum	Maximum		
Total precision	-	-	-	±3.0	LSB	When AVcc = Vcc

6. I-O Pins and Functions

(1) Pin allocation diagram



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DESIG.		CHECK		APPR.		

(2) I-O Pin list

(An "I" in the I/O column indicates that the signal is an input signal to the MCU; an "O" indicates that the signal is an output signal.)

Pin No.	Pin name	I/O	Function	Built-in pull-up
1	-	-	Unused (must be open)	None
2	S/*P	I	Internal status setting pin (must be directly connected to Vcc)	None
3	EMSR0	I	Panel voltage measuring pin	None
4	EMSR1	I	Panel voltage measuring pin	None
5	EMSR2	I	Panel voltage measuring pin	None
6	EMSR3	I	Panel voltage measuring pin	None
7	-	-	Unused (must be open)	None
8 to 10	-	-	Unused (must be open)	None
11	AVcc	-	A/D converter power supply pin	
12	AVR	-	A/D converter reference voltage input pin	
13	AVss	-	A/D converter power supply pin (must have the same voltage as Vss)	
14	CSEL	I	Clock selection pin for transferring data between main controllers	None
15	*PINT	I	Input pin for interrupt generated by pressing the panel	None
16	*RXINT	I	Reception interrupt input pin between main controllers	None
17	*PnPINT1	I	PnP signal input pin (Logic reverses at the same time as converting host side RTS at the TTL level, and connect with this terminal)	None
18	PnPINT0	I	PnP signal input pin (Logic reverses at the same time as converting host side RTS at the TTL level, and connect with this terminal)	None
19	*RST	I	Reset input pin (including power-on reset)	Available
20, 21	MOD0, 1	I	Operation mode input pin (must be connected to Vss)	None
22	X0	I	Input pin for oscillation (8 MHz)	None
23	X1	O	Input pin for oscillation (8 MHz)	
24	Vss	-	Digital power supply ground pin	
25 to 28	-	-	Unused (must be open)	None
29	PSW4	O	Panel drive switch control output pin	None
30	*PSW3	O	Panel drive switch control output pin	None
31	PSW2	O	Panel drive switch control output pin	None
32	*PSW1	O	Panel drive switch control output pin	None
33 to 40	-	-	Unused (must be open)	None
41	-	-	Unused (must be open)	None
42	*PSW0	O	Switch control output pin for panel pull-up	None

Pin No.	Pin name	I/O	Function	Built-in pull-up
43	-	-	Unused (must be open)	None
44 to 45	-	-	Unused (must be open)	None
46	-	-	Unused (must be open)	None
47	-	-	Unused (must be open)	None
48	-	-	Unused (must be open)	None
49	Vss	-	Digital power supply ground pin	
50	EROMCS	O	E^2PROM chip select output pin (open if no E^2PROM chips are used)	None
51	PnPCEL	I	PnP function selection pin	None
52	EROMSI	I	Data input pin for communication between E^2PROM chips (open if no E^2PROM chips are used)	Available
53	EROMSO	O	Data output pin for communication between E^2PROM chips (open if no E^2PROM chips are used)	None
54	EROMCK	O	E^2PROM shift clock output pin (open if no E^2PROM chips are used)	None
55	RXD	I	Data input pin for communication between main controllers	Available
56	Vcc	-	Digital power supply terminal	
57	TXD	O	Data output pin for communication between main controllers	None
58	UCKI	I	Clock input pin for transferring data between main controllers	None
59	UCKO	O	Clock output pin for transferring data between main controllers	None
60 to 62	-	-	Unused (must be open)	None
63	OS1	I	Panel origin selection pin	None
64	OS0	I	Panel origin selection pin	None

Note: Open pins must not be used for relaying signals.

(3) Detailed description of pin functions

1) S/*P

- Pin for setting the internal status. This pin is connected to Vcc.
- This controller recognizes the L level of this pin when the power is turned on and operation begins.

2) EMSR0 to EMSR3

- Pins for measuring the electrode voltage of the Touch-panel.
- Voltages applied to this pin are A/D converted in the controller to generate the coordinate reference. Therefore, pay attention to noise.

3) *PINT

- Pin for entering interrupt generated by pressing the panel. This pin is usually connected to the EMSR0 pin.
- When the signal of this pin changes to low, coordinate detection begins.

4) CSEL

- Pin for selecting a transfer clock for communication between main controllers. This pin is usually connected directly to Vcc.
- If the signal level of this pin is high, the controller generates a transfer clock for 9,600 bps and outputs that clock from the UCKO pin. If the signal level of this pin is low, an external transfer clock 16 times faster than the baud rate must be supplied (e.g., 307.2 kHz when the baud rate is 19,200 bps).

5) MOD0 and MOD1

- Pins for setting the reset vector fetch mode in the MCU. These pins are connected to Vss.

6) X0 and X1

- Pins for connecting a crystal oscillator or an external clock.

7) *RST

- Pin for resetting the MCU hardware.
- This controller contains a built-in power-on reset circuit to start operation when oscillation has stabilized, about 20 milliseconds after the power is turned on.
- If an external reset signal is supplied, input a "low" signal for at least 48 clock cycles (0.125 µs × 48 = 6 µs).

8) PSW1 to PSW4

- Pins for controlling the transistor that is used to apply voltage to the Touch-panel.

9) PSW0

- Pin for controlling the transistor that turns the pull-up resistor circuit on or off when the Touch-panel is ready to be pressed.

10) EROMCS

- Pin for selecting an E^2PROM chip. When the signal level is high, the E^2PROM chip is accessible.

11) EROMSI

- Pin for entering data from the E^2PROM chip. Serial data is transferred in synchronization with the clock.

12) EROMSO

- Pin for outputting data to the E^2PROM chip. Serial data is transferred in synchronization with the clock.

13) EROMCK

- Pin for outputting the clock data transferred from the E^2PROM chip. The clock frequency is 250 kHz.

Compatible with SEIKO Electronics S-29390AFJA

14) RXD

- Pin for entering serial data from the main controller.

15) TXD

- Pin for outputting serial data to the main controller.

16) UCKI

- Pin for entering a clock for serial transfer with the main controller. This pin is usually connected to the UCKO pin.

17) UCKO

- Pin for outputting the transfer clock.
- If the signal level of the CSEL pin is high, the transfer clock for 9,600 bps is output from this pin. If an external transfer clock is supplied, turn the CSEL signal low and open this pin.

18) OS0 and OS1

- Pins for determining the origin of the output coordinates.

19) PnPINT1,PnPINT0

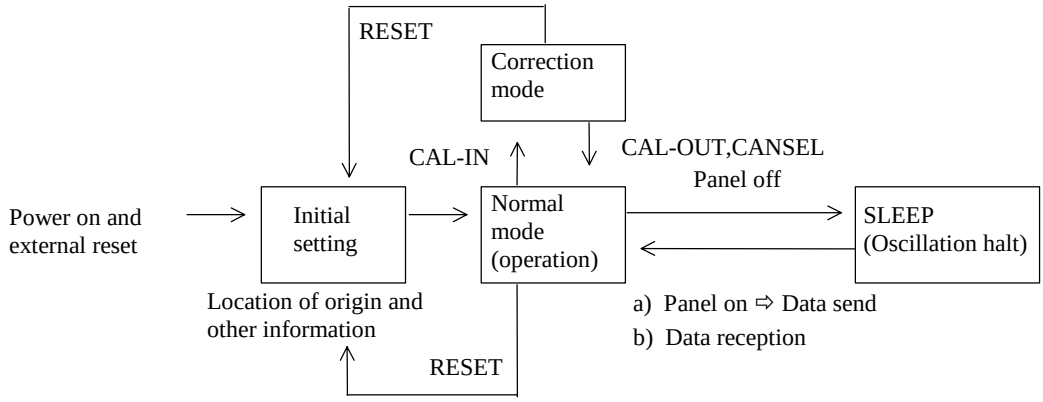
- Pin for PnP ID response.
- The PnP ID response starts by standing descending edge of PnPINT1.

20) PnPCEL

- The PnP ID response is effectively done by connecting Vss.

7. Interface Specifications

7.1 State Transition Diagram



7.2 Transfer Method

(1) Communication mode: Full-duplex, serial interface

(2) Transfer speed: 9,600 bps

The transfer speed can be changed to 19.2 kbps or lower by supplying an external transfer clock 16 times faster than the baud rate and by changing the setting of the CSEL pin.

Baud rate	CSEL	UCKI	UCKO
9600	H	Connected to SCKO	Connected to SCKI
Any rate	L	Connected to an external clock	Open

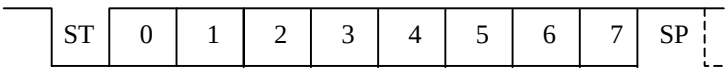
However, when the external clock is used, PnP ID operation is not applied.

(3) Data transfer method: Asynchronous start-stop synchronization

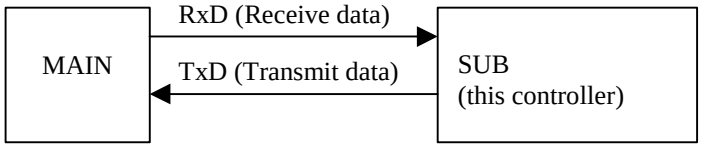
(4) Signal level: TTL level

(5) Data format: Binary

(6) Bit format: Start bit (1 bit) + data (8 bits) + stop bit (1 bit): A total of 10 bits
No parity bit included



(7) Interface signal

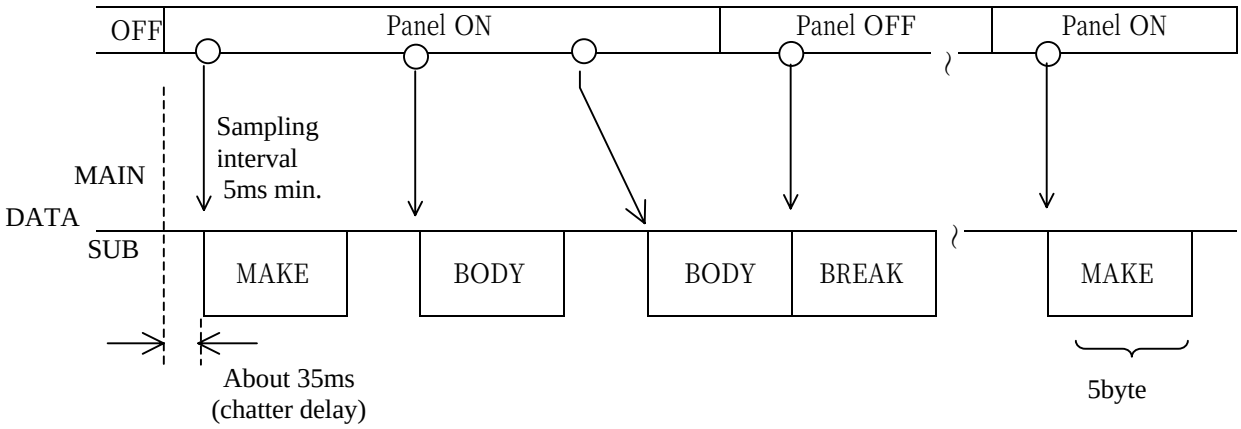


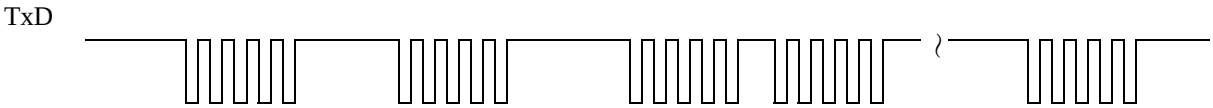
(8) Sampling rate
192 pps (max.) (changeable using the SET-RATE command)

[200 pps at maximum when the transfer speed is 19.2 kbps with an external transfer clock (307.2 kHz) supplied]

100 pps (max.) when an E^2PROM is used

(9) Coordinates output sequence



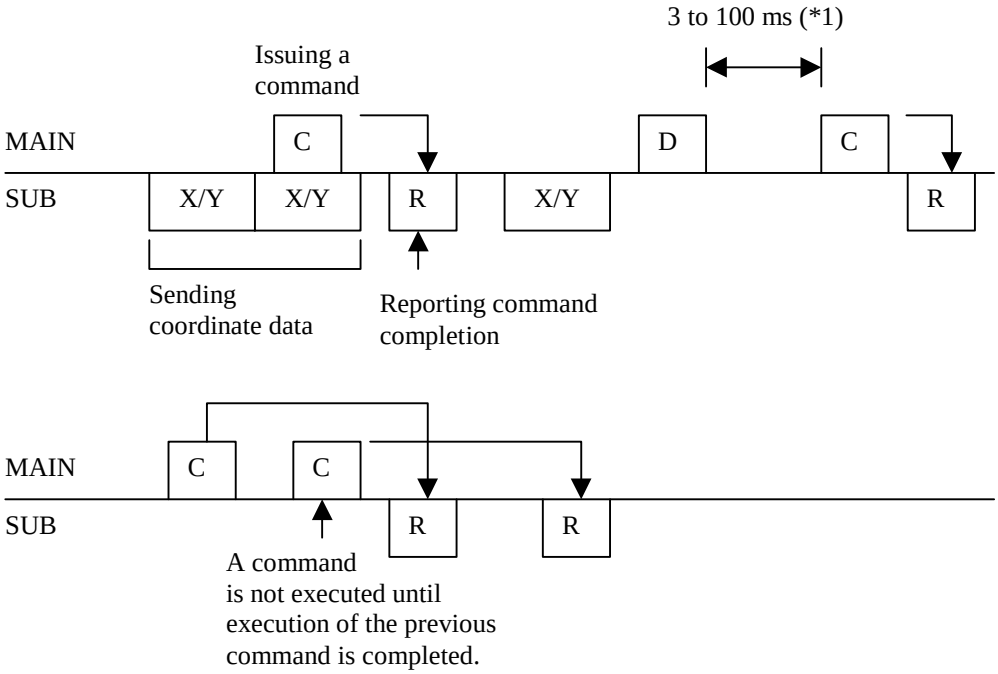


This controller's coordinates output sequence is a stream mode , and it does not have the control line to stop the coordinates output .

(10) The plug and play ID response is provided by another paragraph .

7.3 Relationships between Commands and Responses

C: Command data, R: Response data, X/Y: X and Y coordinate data, D: Dummy data



(1) While the panel is on, this controller outputs the coordinate data to the main controller.

(2) If this controller receives a command from the main controller during data transmission, it executes the command after it has completed data transmission. If this controller is not sending data when it receives a command from the main controller, it immediately executes the command.

(3) If this controller is not detecting coordinate data, the controller is in sleep mode. Therefore, the main controller must send one byte of dummy data (FF_H) and wait until oscillation (see (*1)) stabilizes before sending any command data.

(4) If a command is sent by the main controller before completion of the previous command, this controller stores the new command in a buffer (maximum size of 32 bytes), then reads the stored command when execution of the previous command is complete.

(5) Multi-byte commands of more than one byte may not be received correctly if the data interval exceeds 100 ms. Do not insert dummy data (FF_H) between multi-byte commands.

7.4 Command (MAIN → SUB)

(1) List of commands

Commands	Functions	Codes	Operation code byte	Response		
				End code	Coordi-nate code	Notifica-tion data
RESET	Initializing the controller	80_H	0	○	×	×
COLD-RST	Initializing the coordinate system	81_H	0	○	×	×
STOP	Starting sending the coordinate data	82_H	0	○	×	×
START	Restarting sending the coordinate data	83_H	0	○	×	×
CAL-IN	Starting correction	84_H	9	○	×	×
CAL-OUT	Terminating correction	85_H	4	○	×	×
CAL-SET	Setting the latest data at the correction point	86_H	0	○	×	×
CANCEL	Stopping correction	87_H	0	○	×	×
REPORT	Inquiring about the condition of the controller	88_H	0	○	×	○
DIAG	Executing the self diagnosis	89_H	1	○	×	×
SET-TIME	Setting the timer after pen-up	$8A_H$	1	○	×	×
SET-RATE	Setting the interval between sampling	$8B_H$	1	○	×	×
WRITE	Writing into E^2PROM	$8C_H$	3	○	×	×
READ	Reading out of E^2PROM	$8D_H$	1	○	×	○
-	Reserve	$8E_H$	–	–	–	–
-	Reserve	$8F_H$	–	–	–	–
CALTRN	Transmitting the correction factor to MAIN	$E0_H$	1	○	×	×
CALRCV	Transmitting the correction factor to this controller	$E1_H$	170	○	×	○
DUMY	Dummy data for stopping sleep	FF_H	0	–	–	–
- Pen-down -		–	–	×	○	×

- Commands other than described below are judged as errors during calibration.

① CAL-IN ② CAL-OUT ③ CALSET ④ CANCEL ⑤ RESET

(2) Details of command

① RESET

[Code]

$(80)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	0	0	0

[Explanation]

- Each set value other than in the coordinate system of the controller is initialized and the end code is returned.
- The coordinate becomes a coordinate system after correction. But, the coordinate becomes an initial coordinate system when both CAL-OUT and CALRCV are not performed (See the item about coordinate system).
- Data from MAIN is ignored while the command is executed.

② COLD-RST

[Code]

$(81)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	0	0	1

[Explanation]

- The coordinate system is returned to the initial coordinate system and the end code is returned. (Correction data in E^2PROM and RAM are maintained.)

③ STOP

[Code]

$(82)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	0	1	0

[Explanation]

- The coordinate detection stops and the end code is returned. Thereafter, the coordinate data is not sent even if the panel is turned on.
- START and RESET commands release the stop.

④ START

[Code]

$(83)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	0	1	1

[Explanation]

- The coordinate detection restarts and the end code is returned (initial state).

⑤ CAL-IN

[Code]

$(84)_H$

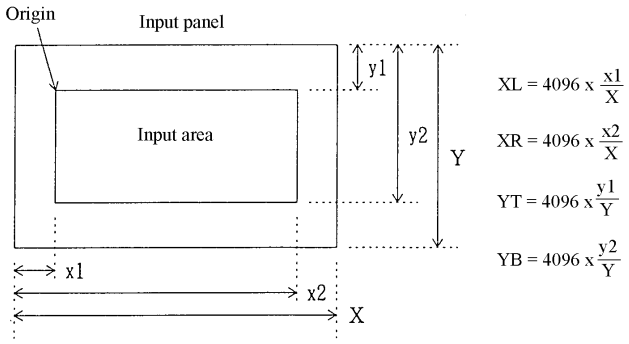
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	1	0	0
POINT	0	0	Y correction point			X correction point		
			PY2	PY1	PY0	PX2	PX1	PX0
XL(L)	0	XL6	XL5	XL4	XL3	XL2	XL1	XL0
XL(H)	0	0	XL12	XL11	XL10	XL9	XL8	XL7
XR(L)	0	XR6	XR5	XR4	XR3	XR2	XR1	XR0
XR(H)	0	0	XR12	XR11	XR10	XR9	XR8	XR7
YT(L)	0	YT6	YT5	YT4	YT3	YT2	YT1	YT0
YT(H)	0	0	YT12	YT11	YT10	YT9	YT8	YT7
YB(L)	0	YB6	YB5	YB4	YB3	YB2	YB1	YB0
YB(H)	0	0	YB12	YB11	YB10	YB9	YB8	YB7

[Explanation]

- The correction mode starts and the end code is returned.
- Coordinate data in the initial coordinate system is output in correction mode.
- The number of correction points is specified according to the point value of the operation code.

  Error is returned unless X is 2 to 5 and Y is 2 to 4.

  Only the points from 3 by 3 or less are valid if there is no E^2PROM.
- The value of the input area for the dimensions of the Touch-panel (or for the distance between electrodes) is specified in the operation code using 3 to 10 bytes.



- Example of operation codes
  [when correction is made using the points of 3 by 3, using a 10.4-type Touch-panel, and using the origin in C]
  (X=243.8 mm, Y=187.4 mm, X1=18.2 mm, X2=229.4 mm, Y1=14.5 mm, Y2=172.9 mm)
  Operation codes = POINT, XL(L), XL(H), XR(L), XR(H), YT(L), YT(H), YB(L), YB(H)
  = $1B_H$, 32_H, 02_H, $0E_H$, $1E_H$, $3D_H$, 02_H, 43_H, $1D_H$

[Note]

In the case E^2PROM is not used, the correction data in RAM is cleared after the CAL-IN command is received. So, stopping the correction mode by the cancel or reset command produces an initial coordinate.

⑥ CAL-OUT

[Code] $(85)_H$ + operation code

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	1	0	1
X(L)	0	X maximum value (lower figures)						
		X6	X5	X4	X3	X2	X1	X0
X(H)	0	0	X maximum value (upper figures)					
			X12	X11	X10	X9	X8	X7
Y(L)	0	Y maximum value (lower figures)						
		Y6	Y5	Y4	Y3	Y2	Y1	Y0
Y(H)	0	0	Y maximum value (upper figures)					
			Y12	Y11	Y10	Y9	Y8	Y7

[Explanation]

- After the code is received, the correction mode terminates, the correction data is updated, the normal mode returns, and the end code is returned (about 2 seconds operation time)
- The value from X/Y in the operation code is judged to be the maximum value of the input area (bottom right-hand corner) and corrected. Afterwards, the corrected value is output this coordinate system. The value must not exceed 4095.
- An error is returned if the code is received in other than correction mode.

⑦ CAL-SET

[Code] $(86)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	1	1	0

[Explanation]

- After the above code is received, the latest detected data is set as the correction point and the end code is returned.
- An error is returned if the above code is received in other than the correction mode.
- An error is returned if the above point data largely deviates from the correction point.

⑧ CANCEL

[Code] $(87)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	0	1	1	1

[Explanation]

- After the above code is received, the correction mode is released and the end code is returned.
- The correction data is not updated.

⑨ REPORT

[Code] $(88)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	1	0	0	0

[Explanation]

- After the above code is received, the end code is returned, then the condition of the controller is output.

⑩ DIAG

[Code]

$(89)_H$ + operation code

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	1	0	0	1
ECHO	ECHO data							
	B7	B6	B5	B4	B3	B2	B1	B0

[Explanation]

- After the above code is received, the self-diagnosis is performed and the end code is returned.
- The ECHO data of the operation code is "echoed" back into the end code.
- The self-diagnosis is performed in the following order.
  (a) ROM sum check
  (b) RAM W/R check
  (c) Panel voltage check
  (d) E^2PROM W/R check
  (e) E^2PROM check (except for the user area)
  If there is no ^{4} E^2PROM, (d) and (e) are not performed.

⑪ SET-TIMER

[Code]

$(8A)_H$ + operation code

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	1	0	1	0
T DATA	0	0	TIME data					
			B5	B4	B3	B2	B1	B0

[Explanation]

- After the above code is received, the timer function starts and the end code is returned. When the set time elapses after the panel is turned off, notification of timer operation completion is output.
- The timeout value is set based on T data of the operation code.
- The time is set in units of 50 ms. T data must range 1 to 63 (50 to 3,150 ms).
- To stop the timer, T data is set to 0 and this command is executed (initial value).
- When the above code is received during the timer operation, the timer operates at the new set time.

⑫ SET-RATE

[Code] $(8B)_H$ + operation code

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	1	0	1	1
R DATA	0	0	0	Sampling rate				
				B4	B3	B2	B1	B0

[Explanation]

- After the above code is received, the sampling rate is changed and the end code is returned.
- The interval between sampling is based on R data of the operation code.
- If R data is set to 0, the sampling value becomes the initial value (initial value: 10 ms)
- The unit of R data is 5 ms. R data ranges from 1 to 31 (5 to 155 ms).

Note: the interval between sampling is 10 ms even if R data is set to 1 when an E^2PROM is used.

⑬ WRITE

[Code] $(8C)_H$ + operation code

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	1	1	0	0
ADDR	E^2PROM address							
	A7	A6	A5	A4	A3	A2	A1	A0
DATA(L)	E^2PROM address (lower figures)							
	D7	D6	D5	D4	D3	D2	D1	D0
DATA(H)	E^2PROM address (upper figures)							
	D15	D14	D13	D12	D11	D10	D9	D8

[Explanation]

- After the above code is received, one word (16 bits) is written in E^2PROM and the end code is returned.
- The data and address to be written are specified based on ADDR and DATA of the operation code.
- ADDR must be set at $(F0)_H$ to $(FF)_H$. If ADDR is outside the range, an error is returned. If there is no E^2PROM, a WRITE error is returned.

⑭ READ

[Code] $(8D)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	0	0	0	1	1	0	1
ADDR	E^2PROM address							
	A7	A6	A5	A4	A3	A2	A1	A0

[Explanation]

- After the above code is received, the end code is returned and the one-word (16-bit) data in E^2PROM is output.
- The addresses of data to be read out are specified based on ADDR of the operation code.
- The value of ADDR must be set at $(0)_H$ to $(FF)_H$. If there is no E^2PROM, a READ error is returned.

⑮ CALTRN

[Code] $(E0)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	1	1	0	0	0	0	0

[Explanation]

- After the above code is received, the end code is returned and the correction factor is transmitted to MAIN.
- If correction is not performed, an error is returned without transmitting the correction factor.
- If the correction points of CAL-IN are set to outside the range 2 × 2 to 3 × 3, this command is invalid and an error is returned.

⑯ CALRCV

[Code] $(E1)_H$

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMMAND	1	1	1	0	0	0	0	1
COUNT(L)	0	0	1	0	1	0	0	0
COUNT(H)	0	0	0	0	0	0	0	1
HDATA1	HD7	HD6	HD5	HD4	HD3	HD2	HD1	HD0
HDATA168	HD7	HD6	HD5	HD4	HD3	HD2	HD1	HD0

[Explanation]

- The correction factor is transmitted to this controller.
- The operation code must have a capacity of 170 bytes (the correction code has a capacity of 168 bytes).
- If the correction points of CAL-IN are set to outside the range 2 × 2 to 3 × 3, this command is invalid and an error is returned.
  If CAL-IN is not executed, the correction is set based on this data.

Note: If CALTRN and CALRCV are executed when there is E^2PROM, an error is returned.

7.5 Response

Data output from this controller has an unspecific length.

(1) List of response

Response	Leading codes	Number of bytes
End code	90_H or $D0_H$	2
End code (at diagnosis)	90_H or $D0_H$	3
Attribute information	91_H	7
Notification of complete of timer operation	92_H or $D2_H$	1
E^2PROM READ data	93_H	3
Coordinate data	80_H, 81_H, 82_H, 88_H, 89_H, $8A_H$, $C0_H$, $C1_H$, $C2_H$, $C8_H$, $C9_H$, or CA_H	5
Correction data	$9F_H$	115

(2) Details of response

① End code

[Code]

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
STATUS	1	CAL	0	PACKET-CODE				
				1	0	0	0	0
R-CODE	0	Return code						
		B6	B5	B4	B3	B2	B1	B0
(ECHO)	Echo data							
	B7	B6	B5	B4	B3	B2	B1	B0

CAL = 1: calibration mode

0: normal mode

[Explanation]

- Completion of command execution is indicated.
- Echo data is added when the DIAGNOSIS command terminates, and the echo byte value is returned.
- The contents of the return code are shown below:

Return codes	Contents
00_H	Normal termination
01_H	Command was not received. - Unspecified command was received. - The value of bit 7 in operands other than those in DAIG, WRITE, READ, CALRCV is 1. - CAL-OUT, CAL-SET, CALCEL are received even in normal mode. - An address unidentified by the READ and WRITE commands has been specified. - The value of data in the operand exceeds the provided range. - CALTRN was received before correction
02 to 09_H	Reserve
$0A_H$	ROM error
$0B_H$	RAM error
$0C_H$	Panel voltage error
$0D_H$	Reserve
$0E_H$	E^2PROM WRITE error (E^2PROM WRITE is error whenever there is no E^2PROM)
$0F_H$	E^2PROM READ error (E^2PROM WRITE is error whenever there is no E^2PROM)
10_H	E^2PROM check sum error (E^2PROM WRITE is error whenever there is no E^2PROM)
11_H	Correction error (sampling data error)
12 to 15_H	Correction error (parameter error)

② Attribute information

[Code]

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
STATUS	1	0	0	PACKET-CODE				
				1	0	0	0	1
R-DATA	0			Interval between sampling				
		0	0	R4	R3	R2	R1	R0
V-DATA	0	Version						
		V6	V5	V4	V3	V2	V1	V0
X(L)	0	CAL-OUT set value						
		X6	X5	X4	X3	X2	X1	X0
X(H)	0		CAL-OUT set value					
		CDAT	X12	X11	X10	X9	X8	X7
Y(L)	0	CAL-OUT set value						
		Y6	Y5	Y4	Y3	Y2	Y1	Y0
Y(H)	0		CAL-OUT set value					
		CDNT	Y12	Y11	Y10	Y9	Y8	Y7

CDAT = 1: correction is valid
0: correction is invalid
CDNT = 0: indicates that the current coordinate system is the one after correction.
1: indicates that the current coordinate system is the initial one after COLD-RST or before correction.

[Explanation]

- Response data for the REPORT command from MAIN
- The unit of the interval between sampling is 5 ms.
- X(H), X(L), Y(H), Y(L) are set values of the CAL-OUT command. However, if the correction is invalid, the value is not specified.
- Version means the ROM version.

③ Notification of the timer operation completion

[Code]

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
STATUS	1	CAL	0	PACKET-CODE				
				1	0	0	1	0

CAL = 1: calibration mode
0: normal mode

[Explanation]

- This data reports that the set time has passed since the panel was turned off when the SET-TIMER command operates the timer.

④ E^2PROM READ data

[Code]

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
STATUS	1	0	0	PACKET-CODE				
				1	0	0	1	1
DATA 0	Data (lower figures)							
	B7	B6	B5	B4	B3	B2	B1	B0
DATA 1	Data (upper figures)							
	B15	B14	B13	B12	B11	B10	B9	B8

[Explanation]

- E^2PROM data output as a response to the READ command

⑤ Coordinate data

[Code]

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
STATUS	1	CAL	0	PACKET-CODE				
				0	CDNT	Pointer attribute		
X(L)	0	X coordinate data (lower figures)						
		X6	X5	X4	X3	X2	X1	X0
X(H)	0	X coordinate data (upper figures)						
		X13	X12	X11	X10	X9	X8	X7
Y(L)	0	Y coordinate data (lower figures)						
		Y6	Y5	Y4	Y3	Y2	Y1	Y0
Y(H)	0	Y coordinate data (upper figures)						
		Y13	Y12	Y11	Y10	Y9	Y8	Y7

CAL = 1: under calibration
0: normal mode

Pointer attribute = 0: MAKE (indicates the initial point for turning the panel on)
1: BODY (indicates the point continued from the previous one)
2: BREAK (indicates that the panel is off, and produces the coordinate just before the release)

CDNT = 0: indicates the coordinate data after correction
1: indicates the coordinate data after COLD-RST or before correction

[Explanation]

- The detected coordinate data is indicated.
- The data of X and Y are expressed as two's compliment. (-5=11111111111011, +6=00000000000110)

⑥ Correction factor data

[Code]

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
STATUS	1	0	0	1	1	1	1	1
COUNT(L)	0	0	1	0	1	0	0	0
COUNT(H)	0	0	0	0	0	0	0	1
HDATA1	HD7	HD6	HD5	HD4	HD3	HD2	HD1	HD0
				⋮				
HDATA168	HD7	HD6	HD5	HD4	HD3	HD2	HD1	HD0

[Explanation]

- CALTRN command transfers a correction factor to the controller.
- An operand code must be 170 bytes, and a correction factor must be 168 bytes.

7.6 Correction

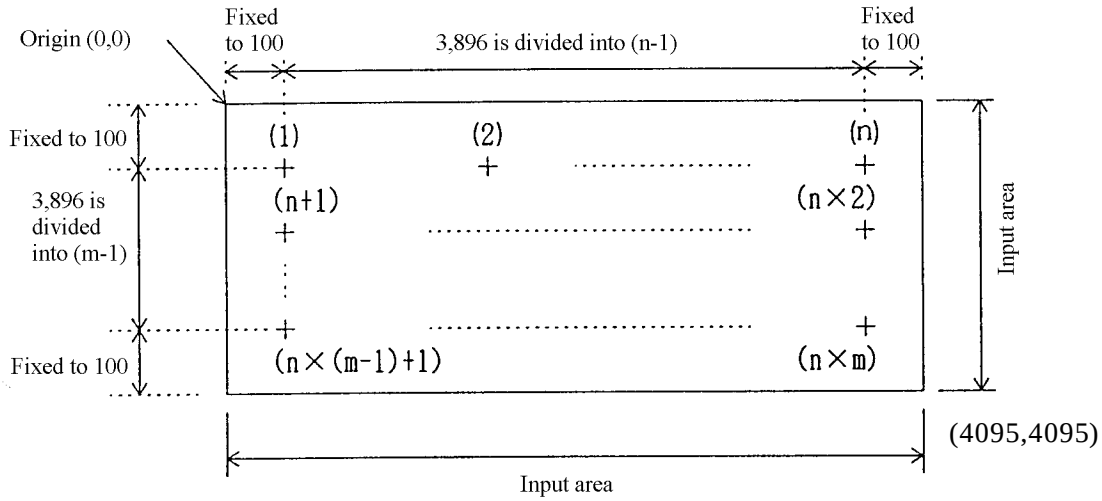
To obtain the position accuracy specified in the Touch-panel Product Specifications, the following correction must be made.

[Note]

Even without E^2PROM, the controller can work because of the correction data transfer function (by using CALTRN, CALRCV commands). It is recommended, however, that the E^2PROM be used to avoid repeating the correction if a correction data file has been destroyed at system failure.

7.6.1 Correction position

(1) Relationship between correction position and coordinates



[Example]

When the position is corrected on the display screen, adjust the "+" sign at the following display position.

- 640 × 480 dots, 3 × 3 points correction

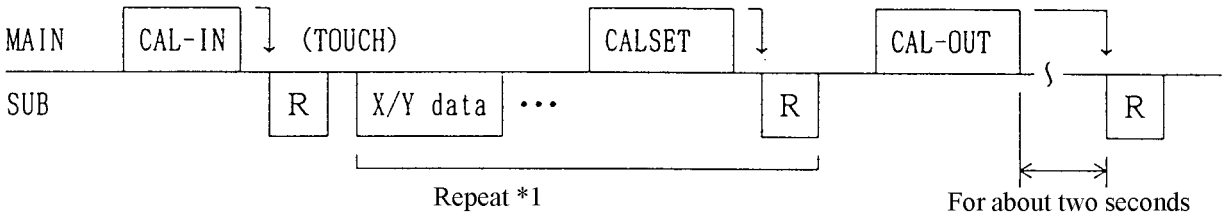
Correction point No.	X coordinate of display
(1), (4), (7)	16
(2), (5), (8)	320
(3), (6), (9)	624

Correction point No.	Y coordinate of display
(1), (2), (3)	12
(4), (5), (6)	240
(7), (8), (9)	468

(2) Number of correction points

Although the number of correction points can be set from 2 × 2 to 5 × 4 by using the CAL-IN command, it is recommended that these points be set according to the Position Accuracy section of the Touch-panel Product Specifications.

7.6.2 Correction procedure



*1 When the E^{2}PROM is used: Since sampling data is stored, the number of repeats can be set arbitrarily (0 to CAL-IN setting points) except for the initial case.
When the E^{2}PROM is not used: Since sampling data cannot be stored, all the items must be entered. After CAL-IN, if CAL-OUT is executed without inputting panel, only the maximum value of the coordinates is changed.

(1) To set in correction mode, MAIN issues the CAL-IN command.

(2) MAIN display a reference point indicating a correction position on the display screen of the device.

(3) Touch the reference point with the input pen to output the corresponding coordinate data from the controller.

(4) The main controller issues the CAL-SET command when the input pen separates the panel. At this time, changing the pattern of the reference point displayed facilitates further operation.

(5) When receiving CALSET command, the controller stores the latest coordinate data as data to be used at correction.

However, if the data largely deviates from the correction point, it is ignored and an ERROR is returned.

(6) Repeat (3) to (5) above with different reference points by the number of times specified using the CAL-IN command. The repeat procedure is arbitrary.

(7) After correction, issue the CAL-OUT command from the MAIN side to terminate the correction mode and specify the maximum coordinate to determine scale.

(8) After receiving CAL-OUT command, the controller calculates the correction factor.

If all the required points are not prepared, the controller returns an error and does not overwrite the correction factor. When the correction factor and points are consistent, the controller writes the correction factor in E^{2}PROM and RAM.

Notes:
1. Since the linearity characteristics differ between Touch-panels, when the Touch-panel is replaced, repeat the correction.
2. If the E^{2}PROM is not provided, the correction factor is cleared by a hardware reset and restart. If the correction factor is cleared, repeat the correction or retransfer correction data with the CALRCV command.

7.6.3 Correction data transfer procedure

(1) After executing the above correction procedure, the MAIN issues the CALTRN command.

(2) When receiving the command, the controller transfers the termination code and correction data.

(3) The MAIN receives the correction data and saves it in nonvolatile memory or a file.

(4) Then, when the power is turned on, the MAIN sends the correction data using the CALRCV command to the controller to execute the correction. The above correction process is not required.

7.7 Plug and play (PnP) ID response

According to host's RTS signal, this product has the function for plug and play ID to respond based on Plug and Play External COM Device Specification Ver1.00.

7.7.1 Forwarding method

(1) Transfer rate : 1200bps
(2) Data transmission mode : Asynchronous start-stop synchronization
(3) Bit format : No parity bits (LSB first)

7.7.2 PnP ID response operation

The operation when PnP ID is transmitted to the host is described as follows. RTS means host's RTS signal. The RTS signal receives a level conversion and a logical reversing on the way, and the circuit to which RTS=H is recognized as a Low-level signal is required in this MCU terminal.

(1) It responds that the response of PnP ID : synchronizing with standing up of RTS=H after about 20ms "M" ("4DH"(hexadecimal mark))
(2) About 60ms is put after "M" responds and the following 11 byte respond.
08H , 01H , 24H , 26H , 2AH , 23H , 15H , 10H , 10H , 10H , 09H (hexadecimal mark)
(3) MCU is done the same operation as power-on reset, is changed the baud rate and the data from without parity by 9600bps, 8 bits in the data length, start bit 1 bit, and the stop bit 1bit, and usually starts after the ID response operation.
(4) The RTS signal line functions as a complete hardware reset signal.
When the RTS signal is L, It enters the state of the standby to RTS=H, and transmitting and receiving of all data is not done.
In the transition from RTS=H to L, if any operation is stopped on the way, and data is being transmitted, the completion of the data transmission is not guaranteed.
(5) If the RTS signal maintains the state of H. When power-on is reset, this MCU is not executed the PnP ID response, and usually being operating.
If the RTS signal maintains the state of L. When this MCU make power-on reset, Operation dose not usually begin by the loop of H level waiting of the signal.
(6) Connect DTR with DSR in the loop back on the PC side ,when you use the PnP function on windows PC.

7.7.3 Others

(1) The PnP ID response function becomes effective by the pull-down of PnPCEL Pin (the 51st Pin) equipped with this product.
(2) The PnP ID response function can be nullified by the pull-up of PnPCEL Pin (the 51st Pin) unrelated to the connection of the RTS signal.
(3) When you nullify the PnP ID response function, because of a noise, PnPINT0 must be pull-down and the pull-up of *PnPINT1.
(4) In this product, the communication control lines other than (CTS) which comes in contact with host's RTS signal are not applied, and the (CTS) line is not an original function.
Moreover, plug OFFF recognition is not supported because the application device is a built-in basically usage, and hot plugging is outside the guarantee in MCU installed in this product.

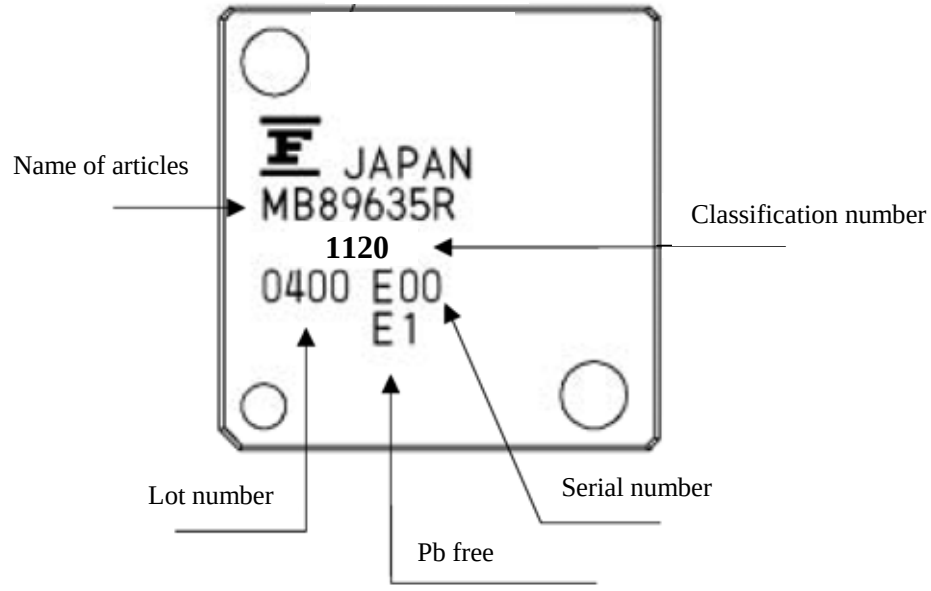
8. Packing Specification

The controller must be packed in a tray exclusive for LSI in a corrugated carton.

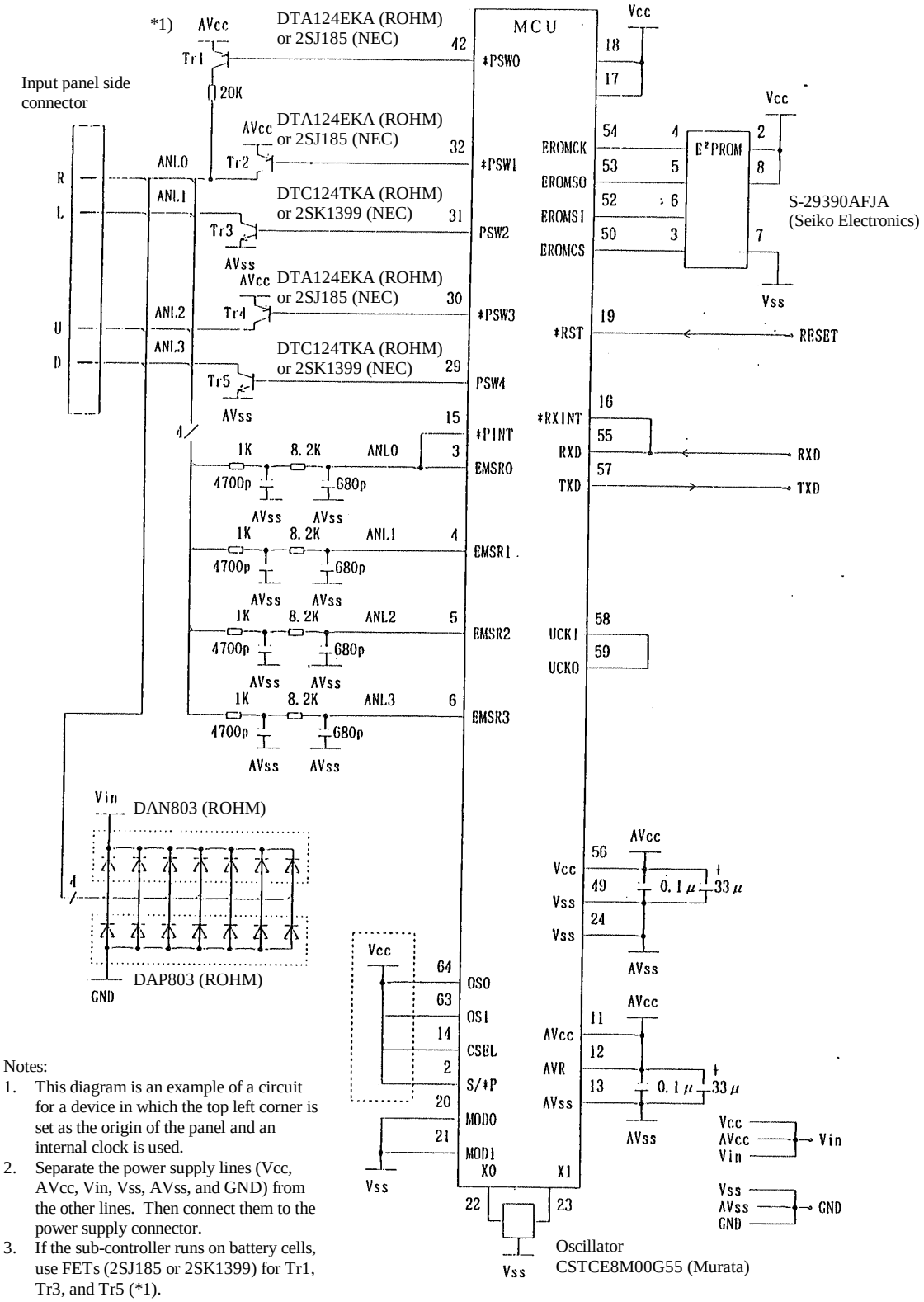
9. Indication

The markings on the product are shown below.

(1) Markings on the IC package



10. Example of a Circuit Diagram



Notes:

1. This diagram is an example of a circuit for a device in which the top left corner is set as the origin of the panel and an internal clock is used.
2. Separate the power supply lines (Vcc, AVcc, Vin, Vss, AVss, and GND) from the other lines. Then connect them to the power supply connector.
3. If the sub-controller runs on battery cells, use FETs (2SJ185 or 2SK1399) for Tr1, Tr3, and Tr5 (*1).

The table below lists the reference values when FCL Touch-panel and controller are configured according to the circuit diagram shown above.

(Supplied voltage: 5.0 V, Ta = 25°C)

Item		Reference value	Remarks
Current consumption	In operation	15 mA typ.	
	Sleep mode	0.05 mA typ.	FET for Tr1, Tr3, Tr5
		0.6 mA typ.	Digital transistor for Tr1, Tr3, Tr5

11. Notes

(1) Latch-up prevention

Since the controller is a CMOS IC, if excessive or insufficient voltage than allowed by Vcc is applied or a voltage exceeding the rating is applied between Vcc to Vss, a latch-up may occur.

If a latch-up occurs, the current overloads and circuits may be destroyed due to heat. Be careful not to exceed the maximum rating.

When turning on or off analog power supply, ensure that the analog power supply outputs (AVcc, AVR) and input do not exceed the digital power supply output (Vcc).

(2) Current or voltage fluctuation

The operating conditions of the Vcc power supply voltage are clearly specified. However, if the power supply voltage changes suddenly even within the rated specifications, the controller may malfunction. Therefore, stabilize the IC voltage supply as much as possible.

To stabilize the supplied voltage, it is recommended that the ripple (P-P value) be maintained within 10% of the standard Vcc value of the commercial frequency (50 to 60 Hz). It is also recommended that instantaneous voltage variations be restricted to 0.1 V/ms or less in instant fluctuation (e.g., due to power supply switching).

(3) Notes on using an external clock

Even when an external clock is used, to release the power-on reset and sleep modes, an external clock input is required because it takes time for the oscillation to stabilize.

(4) Procedure for power supply and analog input of A/D converter

The power supply (AVcc, AVR, AVss) and analog input (EMSR0 to 3) of the A/D converter must be applied when or after power (Vcc) has been turned on.

(5) Wiring of analog power supply

To reduce noise, the analog power supply of the controller must be supplied from a different system than the digital power supply. (See "Example of Circuit Configuration.")

(6) Wiring of analog signal

Analog signals (EMSR0 to 3) from the Touch-panel to controller and vibrator must be wired over the shortest route without crossing other signal lines.

(7) Storage and drying

The controller must be stored as shipped from us.

- It is recommended that the controller be kept at normal temperature (5 to 30°C) and humidity (40 to 70%).
- Do not store in a place exposed to corrosive gas or dust.
- To prevent condensation, do not store in a place subject to dramatic temperature fluctuations.
- When the controller has been stored for an excessive period of time, note that the soldering of lead terminals may deteriorate or become rusty or that the electrical characteristics may become substandard.

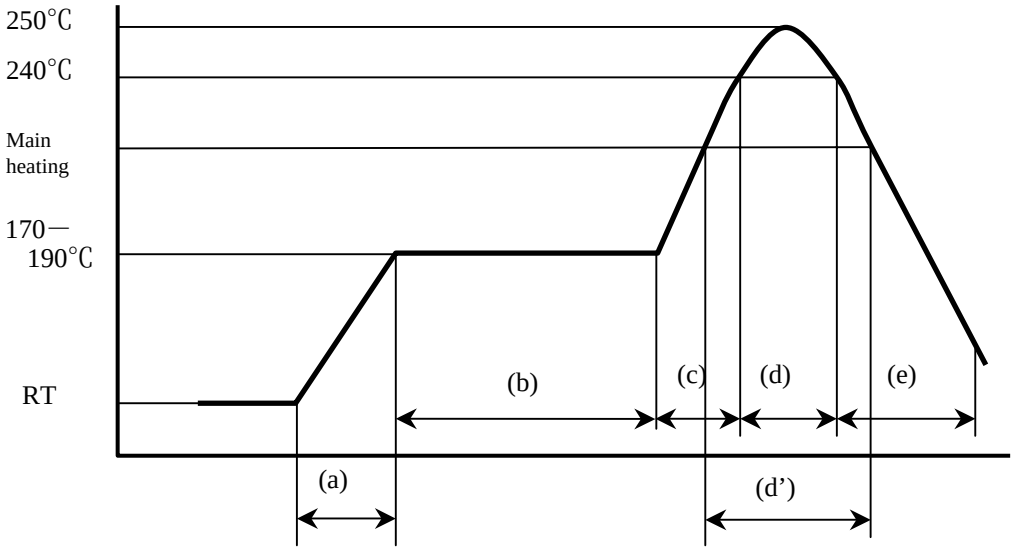
Since the controller is a QFP of plastic package, the package must be controlled so that moisture is not absorbed at re-flow soldering.

Therefore, note that the controller must be mounted within the periods shown below:

Whole dip soldering	Infrared light re-flow soldering	Infrared light re-flow soldering × 2	Vapor phase
Disable	Within two days	Disable	Within two days

12. Re-flow

The example of recommending the solder re-flow (infrared rays re-flow) is shown below.



(a) Temperature increase gradient : Average : Average 1°C/s to 4°C/s
(b) Preliminary heating : 170°C to 190°C , 60s to 180s
(c) Temperature increase gradient : Average 1°C/s to 4°C/s
(d) Peak temperature : 250°CMax., 245°C or more, 10s or less
(d')Main heating : 230°C or more, 40s or less , or
225°C or more, 60s or less , or
220°C or more, 80s or less .
(e) Cooling : Air cooling or Forced cooling

Above temperature is measured on the surface side of IC

13. Others

If other problems which are not covered in this specifications occur, please consult with us so that we can determine proper corrective action.