

SHARP

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# LH168D/LH168J

384 Outputs 64 Gradations  
TFT-LCD Source Driver

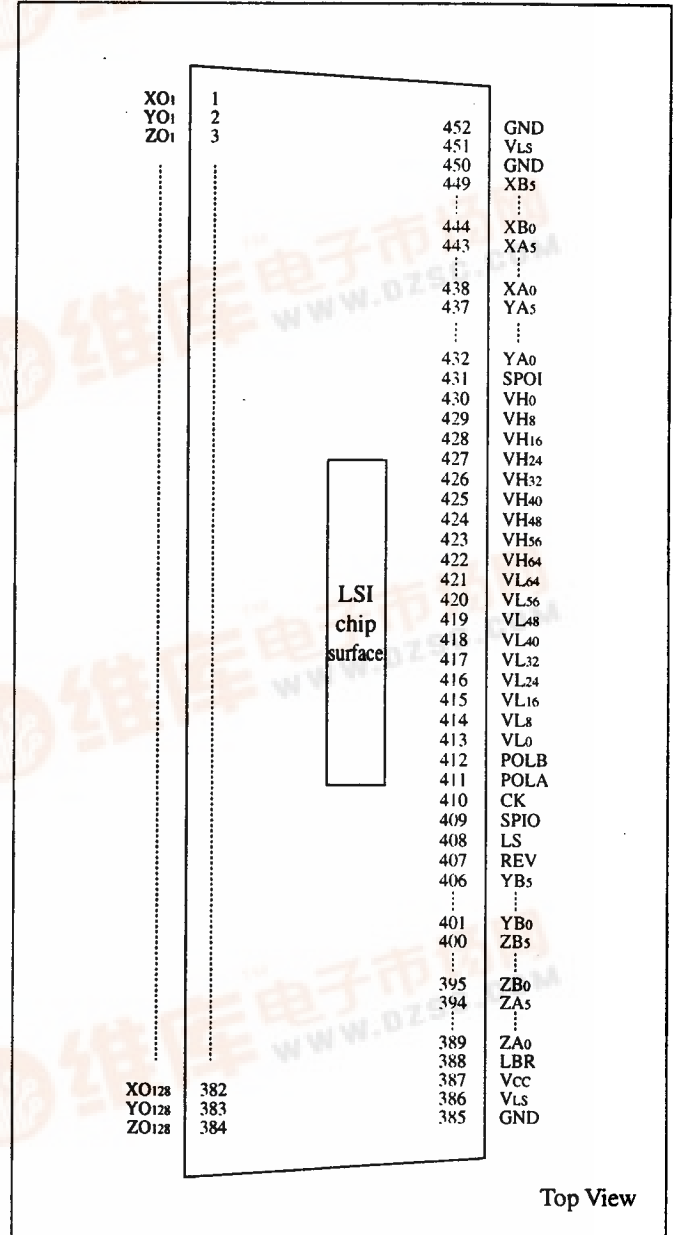
## ■ Description

The LH168D/LH168J are a source driver with 384 LCD drive outputs, and are used for the TFT LCD unit which can simultaneously display 262 144 colors in 64 gradations.

## ■ Features

1. The LH168D/LH168J are a driver which incorporates a 6-bit digital input DAC.
2. The LH168D/LH168J are a Dot-Inversion driver that the LCD drive pin inverted gradational voltage at the next LCD drive pins.
3. The number of LCD drive outputs is 384 outputs.
4. Each circuits of data input R, G and B have two port inputs. They can sample & hold display data of two pixels at the sametime.
5. The basic voltage input of 18 gradations can display 262 144 colors in 64 gradations. This basic voltage input corresponds to  $\gamma$  correction and the intermediate basic voltage input can be abbreviated.
6. Shift clock frequency is 65 MHz (MAX.).
7. The LH168D/LH168J have the function of cascade connection.
8. It is possible to switch the output directivity of LCD drive output.  
( $XO_1, YO_1, ZO_1 \rightarrow XO_{128}, YO_{128}, ZO_{128}$  and  $ZO_{128}, YO_{128}, XO_{128} \rightarrow ZO_1, YO_1, XO_1$ )
9. Supply voltage  $V_{cc}$  for the digital system : 2.7 to 3.6 V
10. Supply voltage  $V_{LS}$  for the analog system : 8.0 to 13.0 V
11. Package SST

## ■ Pin Connections



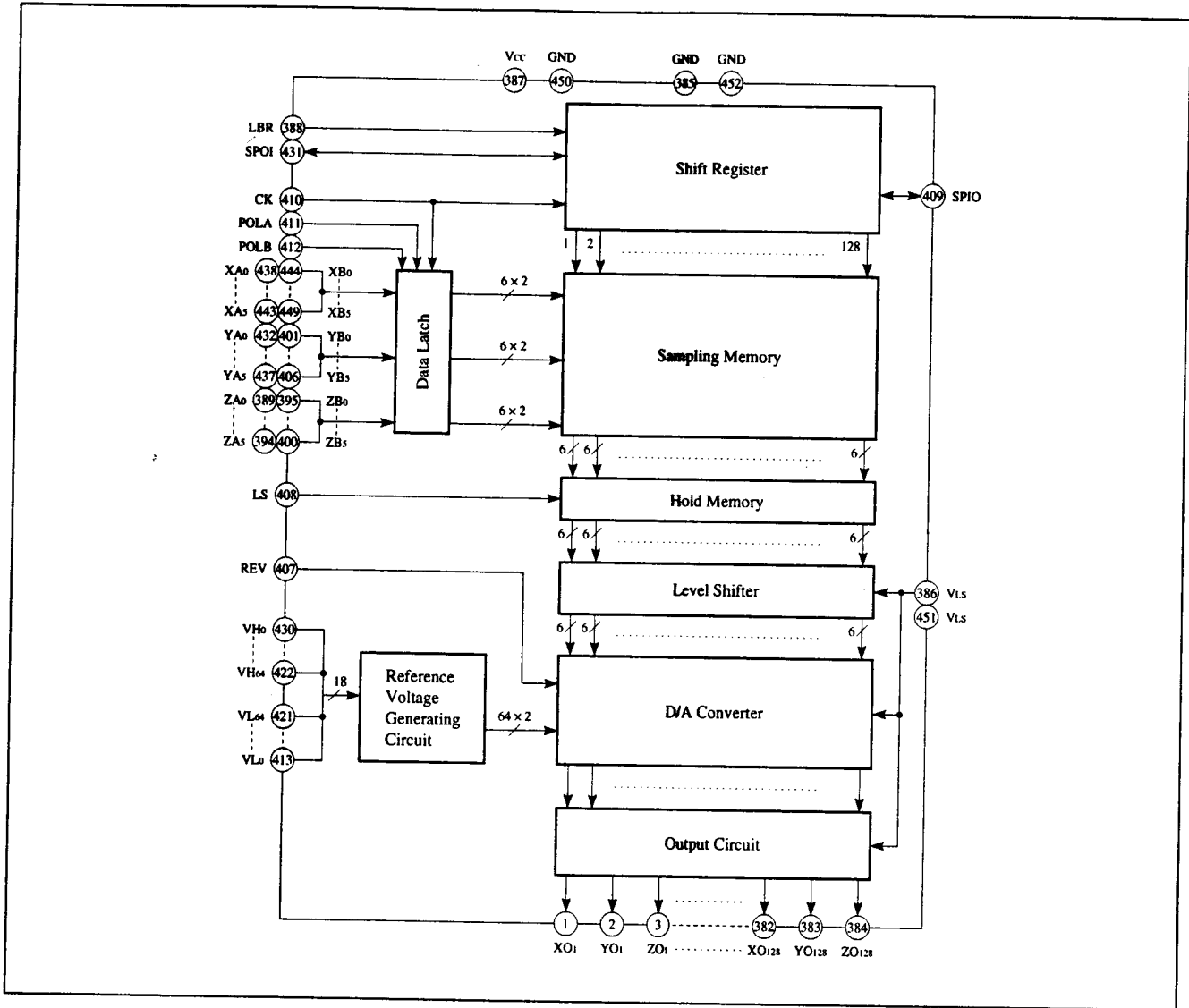
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### ■ Pin Description

No.	Symbol	I/O	Pin name
1-384	XO <sub>1</sub> -ZO <sub>128</sub>	O	LCD drive output pins
385	GND	—	GND
386	V <sub>LS</sub>	—	Power supply pin for analog circuit
387	V <sub>CC</sub>	—	Power supply pin for digital circuit
388	LBR	I	Shift direction switching input pin
389-394	ZA <sub>0</sub> -ZA <sub>5</sub>	I	Data input pin
395-400	ZB <sub>0</sub> -ZB <sub>5</sub>	I	Data input pin
401-406	YB <sub>0</sub> -YB <sub>5</sub>	I	Data input pin
407	REV	I	LCD drive output polarity exchange input pin
408	LS	I	Latch input pin
409	SPIO	I/O	Start pulse input/cascade output pin
410	CK	I	Shift clock input pin
411	POLA	I	Input data polarity exchange input pin
412	POLB	I	Input data polarity exchange input pin
413-421	VL <sub>0</sub> -VL <sub>64</sub>	I	Reference voltage input pin
422-430	VH <sub>64</sub> -VH <sub>0</sub>	I	Reference voltage input pin
431	SPOI	I/O	Start pulse input/cascade output pin
432-437	YA <sub>0</sub> -YA <sub>5</sub>	I	Data input pin
438-443	XA <sub>0</sub> -XA <sub>5</sub>	I	Data input pin
444-449	XB <sub>0</sub> -XB <sub>5</sub>	I	Data input pin
450	GND	—	GND
451	V <sub>LS</sub>	—	Power supply pin for analog circuit
452	GND	—	GND

■ Block Diagram



■ Block Function

Block name	Block function
Shift register	Used as a bi-directional shift register, which performs the shifting operation by CK and selects bits for data sampling.
Data latch	Used to temporarily latch the input data, which is sent to the sampling memory.
Sampling memory	Used to sample the data to be entered by time sharing.
Hold memory	Used for temporary latch processing of data in the sampling memory by LS input.
Level shifter	Used to shift the data in the hold memory to the power supply level of the analog circuit unit and send the shifted data to D/A converter.
Reference voltage generating circuit	Used to generate a 64 × 2-level voltage corrected of gamma by the resistance split circuit.
D/A converter	Used to generate analog signal according to the displayed data and send the signal to the output circuit.
Output circuit	Used as a voltage follower configured with an operational amplifier and an output buffer, which outputs analog signals of 64 × 2 gradations to LCD drive output pin.

## ■ Description of Functions and Operations

### (1) Pin function

Symbol	I/O	Function
V <sub>CC</sub>	—	Used as power supply pin for digital circuit (Use in the range of 2.7 to 3.6 V.)
V <sub>LS</sub>	—	Used as power supply pin for analog circuit (Use in the range of 8 to 13 V.)
GND	—	Used as GND pin, which must be connected to 0 V.
SPIO SPOI	I/O	Used as input pin of start pulse and is also used as output pin for cascade connection. When "High" is input into start pulse input pin, data sampling is started. On completion of sampling, "High" pulse is output to output pin for cascade connection. Pin functions are switched by LBR. For relations of switching, refer to "(2) Operation of function".
LBR	I	Used as input pin for switch shift register directivity. For relations of switching, refer to "(2) Operation of function".
LS	I	Used as input pin for parallel transfer from sampling memory to hold memory. Data is transferred at rising edge and output from LCD drive output pin.
CK	I	Used as shift clock input pin. Data is latched into sampling memory from data input pin at rising edge.
VH <sub>0</sub> -VH <sub>64</sub> VL <sub>0</sub> -VL <sub>64</sub>	I	Used as basic voltage input pin. Hold the basic potential before outputting gradation voltage. For relation between displayed data and output voltage value, refer to "(4) Output voltage value". For internal gamma correction, refer to "(5) Gamma correction value". Observe the following relation for input potential. V <sub>LS</sub> > VH <sub>0</sub> > VH <sub>8</sub> > ... > VH <sub>64</sub> > VL <sub>64</sub> > VL <sub>56</sub> > ... > VL <sub>0</sub> > GND.
XA <sub>0</sub> -XA <sub>5</sub> YA <sub>0</sub> -YA <sub>5</sub> ZA <sub>0</sub> -ZA <sub>5</sub> XB <sub>0</sub> -XB <sub>5</sub> YB <sub>0</sub> -YB <sub>5</sub> ZB <sub>0</sub> -ZB <sub>5</sub>	I	Used as data input pin of R, G, and B colors. Takes in 6-bits × 2 pixels data from data pin at rising edge of CK. For relation between input data and output, refer to "(4) Output voltage value". Correlate data to be entered into X, Y, and Z according to picture element arrays of the panel used.
XO <sub>1</sub> -XO <sub>128</sub> YO <sub>1</sub> -YO <sub>128</sub> ZO <sub>1</sub> -ZO <sub>128</sub>	O	Used as LCD drive output pin, which outputs the voltage corresponding to the input of data input pin (XA <sub>0</sub> -XA <sub>5</sub> , YA <sub>0</sub> -YA <sub>5</sub> , ZA <sub>0</sub> -ZA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> ). Data of XO <sub>1</sub> -XO <sub>128</sub> correspond to XA <sub>0</sub> -XA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> . Data of YO <sub>1</sub> -YO <sub>128</sub> correspond to YA <sub>0</sub> -YA <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZO <sub>1</sub> -ZO <sub>128</sub> correspond to ZA <sub>0</sub> -ZA <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> . For relation of switching and input data, refer to "(2) Operation of function" and "(4) Output voltage value".
POLA POLB	I	Used as input pin for input data polarity exchange, POLA corresponds to XA <sub>0</sub> -XA <sub>5</sub> , YA <sub>0</sub> -YA <sub>5</sub> , ZA <sub>0</sub> -ZA <sub>5</sub> , POLB corresponds to XB <sub>0</sub> -XB <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> . When "Low" is entered, displayed data is normal mode becomes enable. When "High" is entered, input data is polarity exchange mode becomes enable. For relation between input data and output, refer to "(4) Output voltage value". Usually, these pins are pull-down at the inside.
REV	I	Used as polarity exchange pin of LCD drive output. Takes in data at the term that LS is "High", decides output polarity of LCD drive output pin. For switching relation refer to "(3) Output characteristics".

(2) Operation of Function

The following describes the relation between data input pin and output direction.

Data input Pin	XA0-XA5	YA0-YA5	ZA0-ZA5	XB0-XB5	YB0-YB5	ZB0-ZB5	.....	XB0-XB5	YB0-YB5	ZB0-ZB5
Output Direction	XO1	YO1	ZO1	XO2	YO2	ZO2	.....	XO128	YO128	ZO128

The following describes the relation between LBR pin, SP pin and output direction.

Pin	RIGHT SHIFT (Shift register directivity)	LEFT SHIFT (Shift register directivity)
LBR	"High"	"Low"
SPOI	Input	Output
SPIO	Output	Input
Output direction	XO1, YO1, ZO1 (first clock) → XO128, YO128, ZO128 (last clock)	ZO128, YO128, XO128 (first clock) → ZO1, YO1, XO1 (last clock)

Note. Color data corresponding to X, Y and Z vary depending on RIGHT SHIFT/LEFT SHIFT.

(3) Output characteristics

The following describes the relation between REV pin and output polarity of LCD drive pin.

REV	"High"	"Low"
XO1	+	-
YO1	-	+
ZO1	+	-
XO2	-	+
YO2	+	-
ZO2	-	+
XO3	+	-
YO3	-	+
ZO3	+	-
XO4	-	+
YO4	+	-
ZO4	-	+
⋮	⋮	⋮
XO125	+	-
YO125	-	+
ZO125	+	-
XO126	-	+
YO126	+	-
ZO126	-	+
XO127	+	-
YO127	-	+
ZO127	+	-
XO128	-	+
YO128	+	-
ZO128	-	+

Note. + : The gradation voltages corresponding to basic voltage VH0-VH64 are outputs.  
 - : The gradation voltages corresponding to basic voltage VL0-VL64 are outputs.

## (4) Output voltage value

Of the 6-bit data (D<sub>5</sub>, D<sub>4</sub>, D<sub>3</sub>, D<sub>2</sub>, D<sub>1</sub>, and D<sub>0</sub>) taken in by time sharing, reference power supply V<sub>0</sub> - V<sub>64</sub> is selected by upper 3 bits (D<sub>5</sub>, D<sub>4</sub>, and D<sub>3</sub>) and interpolation value of output voltage is determined by lower 3 bits (D<sub>2</sub>, D<sub>1</sub> and D<sub>0</sub>). The basic voltage V<sub>i</sub> is reference voltage (V<sub>Hi</sub> or V<sub>Li</sub>) that determined by polarity exchange input (REV).

Relation between input data and output voltage values is shown below.

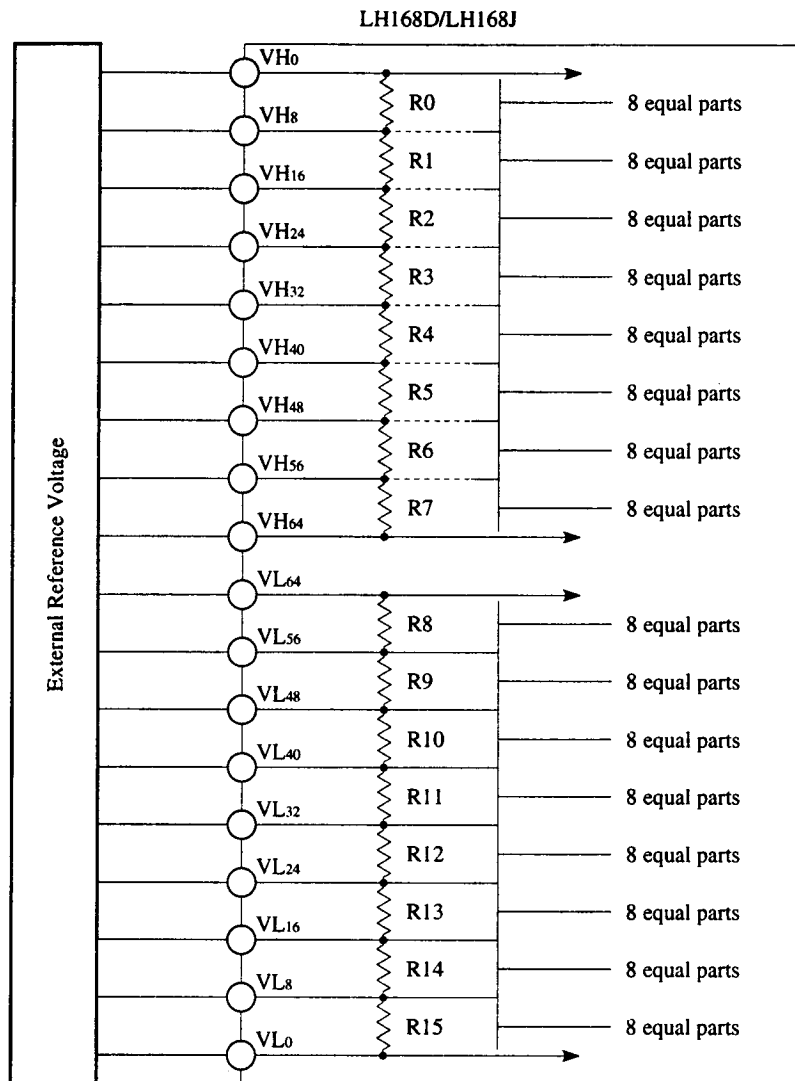
Input data	Output voltage		Input data	Output voltage	
	POLA(POLB)="Low"	POLA(POLB)="High"		POLA(POLB)="Low"	POLA(POLB)="High"
0	V <sub>0</sub>	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 1/8	20	V <sub>32</sub>	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 1/8
1	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 7/8	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 2/8	21	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 7/8	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 2/8
2	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 6/8	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 3/8	22	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 6/8	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 3/8
3	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 5/8	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 4/8	23	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 5/8	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 4/8
4	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 4/8	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 5/8	24	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 4/8	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 5/8
5	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 3/8	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 6/8	25	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 3/8	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 6/8
6	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 2/8	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 7/8	26	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 2/8	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 7/8
7	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 1/8	V <sub>56</sub>	27	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 1/8	V <sub>24</sub>
8	V <sub>8</sub>	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 1/8	28	V <sub>40</sub>	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 1/8
9	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 7/8	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 2/8	29	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 7/8	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 2/8
A	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 6/8	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 3/8	2A	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 6/8	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 3/8
B	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 5/8	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 4/8	2B	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 5/8	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 4/8
C	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 4/8	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 5/8	2C	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 4/8	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 5/8
D	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 3/8	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 6/8	2D	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 3/8	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 6/8
E	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 2/8	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 7/8	2E	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 2/8	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 7/8
F	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 1/8	V <sub>48</sub>	2F	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 1/8	V <sub>16</sub>
10	V <sub>16</sub>	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 1/8	30	V <sub>48</sub>	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 1/8
11	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 7/8	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 2/8	31	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 7/8	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 2/8
12	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 6/8	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 3/8	32	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 6/8	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 3/8
13	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 5/8	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 4/8	33	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 5/8	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 4/8
14	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 4/8	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 5/8	34	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 4/8	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 5/8
15	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 3/8	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 6/8	35	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 3/8	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 6/8
16	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 2/8	V <sub>48</sub> + (V <sub>40</sub> - V <sub>48</sub> ) × 7/8	36	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 2/8	V <sub>16</sub> + (V <sub>8</sub> - V <sub>16</sub> ) × 7/8
17	V <sub>24</sub> + (V <sub>16</sub> - V <sub>24</sub> ) × 1/8	V <sub>40</sub>	37	V <sub>56</sub> + (V <sub>48</sub> - V <sub>56</sub> ) × 1/8	V <sub>8</sub>
18	V <sub>24</sub>	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 1/8	38	V <sub>56</sub>	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 1/8
19	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 7/8	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 2/8	39	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 7/8	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 2/8
1A	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 6/8	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 3/8	3A	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 6/8	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 3/8
1B	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 5/8	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 4/8	3B	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 5/8	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 4/8
1C	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 4/8	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 5/8	3C	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 4/8	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 5/8
1D	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 3/8	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 6/8	3D	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 3/8	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 6/8
1E	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 2/8	V <sub>40</sub> + (V <sub>32</sub> - V <sub>40</sub> ) × 7/8	3E	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 2/8	V <sub>8</sub> + (V <sub>0</sub> - V <sub>8</sub> ) × 7/8
1F	V <sub>32</sub> + (V <sub>24</sub> - V <sub>32</sub> ) × 1/8	V <sub>32</sub>	3F	V <sub>64</sub> + (V <sub>56</sub> - V <sub>64</sub> ) × 1/8	V <sub>0</sub>

(5)  $\gamma$  (gamma) correction value

Between reference voltage input pin  $VH_0$  and  $VH_{64}$ , 64 resistors are connected in series. And between reference voltage input pin  $VL_0$  and  $VL_{64}$ , 64 resistors are connected in series. And between reference voltage input pin  $VH_{64}$  and  $VL_{64}$ , a resistor isn't connected.

The  $\gamma$  correction curve is broken line connected between intermediate voltage input ( $VH_8, VH_{16}, VH_{24}, VH_{32}, VH_{40}, VH_{48}, VH_{56}, VL_8, VL_{16}, VL_{24}, VL_{32}, VL_{40}, VL_{48}$  and  $VL_{56}$ ).

Between the intermediate voltage input, it is individed into 8 parts by the same resistor.



The following shows the ratio of 2 correction resistance, when R0 equals 1.

R0	1.00
R1	0.50
R2	0.50
R3	0.50
R4	0.50
R5	0.50
R6	0.50
R7	1.00

R8	1.00
R9	0.50
R10	0.50
R11	0.50
R12	0.50
R13	0.50
R14	0.50
R15	1.00

### ■ Absolute Maximum Ratings

Parameter		Symbol	Condition	Rating	Unit
Supply voltage	V <sub>CC</sub>	V <sub>CC</sub>	T <sub>a</sub> =25°C	-0.3 to +7.0	V
	V <sub>LS</sub>	V <sub>LS</sub>	T <sub>a</sub> =25°C	-0.3 to +15.0	V
Input voltage	V <sub>H0</sub> -V <sub>L0</sub>	V <sub>i</sub>	T <sub>a</sub> =25°C	-0.3 to V <sub>LS</sub> +0.3	V
	Other	V <sub>i</sub>	T <sub>a</sub> =25°C	-0.3 to V <sub>CC</sub> +0.3	V
Output voltage	SPIO, SPOI	V <sub>o</sub>	T <sub>a</sub> =25°C	-0.3 to V <sub>CC</sub> +0.3	V
	XO <sub>1</sub> -ZO <sub>128</sub>	V <sub>o</sub>	T <sub>a</sub> =25°C	-0.3 to V <sub>LS</sub> +0.3	V
Storage temperature		T <sub>stg</sub>		-45 to +125	°C

### ■ Recommended Operating Conditions

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Note
Supply voltage	V <sub>CC</sub>	2.7		3.6	V	
	V <sub>LS</sub>	8.0		13.0	V	
Reference voltage input	V <sub>H0</sub> -V <sub>H64</sub>	0.5V <sub>LS</sub>		V <sub>LS</sub> - 0.1	V	1
	V <sub>L0</sub> -V <sub>L64</sub>	+0.1		0.5V <sub>LS</sub>	V	
Clock frequency	f <sub>CK</sub>			65	MHz	
LCD drive output load capacity	C <sub>L</sub>			150	pF	
Operating temperature	T <sub>opr</sub>	-20		75	°C	

Note 1. Observe the following relation for the potential of the reference voltage input.

$$V_{LS} > V_{H0} > V_{H8} > V_{H16} > V_{H24} > V_{H32} > V_{H40} > V_{H48} > V_{H56} > V_{H64} \geq 0.5 V_{LS}$$

$$\geq V_{L64} > V_{L56} > V_{L48} > V_{L40} > V_{L32} > V_{L24} > V_{L16} > V_{L8} > V_{L0} > GND$$

Note 2. Observe the following sequence of switching power supply on the device.

$$V_{CC} \rightarrow \text{Logic input} \rightarrow V_{LS}, V_{H0}-V_{H64}, V_{L64}-V_{L0}$$

Observe the contrary sequence of switching power supply off the device.

## ■ DC Electrical Characteristics

( $V_{CC}=2.7$  to  $3.6$  V,  $V_{LS}=8.0$  to  $13$  V,  $T_a=-20$  to  $+75$  °C)

Parameter	Symbol	Measuring condition	Applicable pin	MIN.	TYP.	MAX.	Unit
Input "Low" current	$I_{ILL1}$		XA <sub>0</sub> -XA <sub>5</sub> , YA <sub>0</sub> -YA <sub>5</sub> , ZA <sub>0</sub> -ZA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> , SPIO, SPOI, CK, LS, LBR, REV, POLA, POLB			10	μA
Input "High" current	$I_{ILH1}$		XA <sub>0</sub> -XA <sub>5</sub> , YA <sub>0</sub> -YA <sub>5</sub> , ZA <sub>0</sub> -ZA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> , SPIO, SPOI, CK, LS, LBR, REV			10	μA
	$I_{ILH2}$		POLA, POLB			400	μA
Input "Low" voltage	$V_{IL}$		XA <sub>0</sub> -XA <sub>5</sub> , YA <sub>0</sub> -YA <sub>5</sub> , ZA <sub>0</sub> -ZA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> , SPIO, SPOI, CK, LS, LBR, REV, POLA, POLB	GND		$0.3V_{CC}$	V
Input "High" voltage	$V_{IH}$		XA <sub>0</sub> -XA <sub>5</sub> , YA <sub>0</sub> -YA <sub>5</sub> , ZA <sub>0</sub> -ZA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> , SPIO, SPOI, CK, LS, LBR, REV, POLA, POLB	$0.7V_{CC}$		$V_{CC}$	V
Output "Low" voltage	$V_{OL}$	$I_{OL}=0.3$ mA	SPIO	GND		$GND + 0.4$	V
Output "High" voltage	$V_{OH}$	$I_{OH}=-0.3$ mA	SPOI	$V_{CC} - 0.4$		$V_{CC}$	V
Current consumption (In operation mode)	$I_{CC1}$	*1	$V_{CC} - GND$			14	mA
Current consumption (In standby mode)	$I_{CC2}$	*2	$V_{CC} - GND$			4.0	mA
Current consumption (In operation mode)	$I_{LS1}$	*1	$V_{LS} - GND$			10	mA
Current consumption (In standby mode)	$I_{LS2}$	*2	$V_{LS} - GND$			8.0	mA
Output voltage range	$V_{OUT}$			$GND + 0.2$		$V_{LS} - 0.2$	V
Deviations between output voltage pins	$V_{OD}$		XO <sub>1</sub> -ZO <sub>128</sub>	-20		20	mV
Output current	$I_{O1-I04}$	*3			200		μA
Resistance between reference power supplies	$R_{GMAH}$		Between VH <sub>0</sub> and VH <sub>64</sub>		20		kΩ
	$R_{GMAL}$		Between VL <sub>0</sub> and VL <sub>64</sub>		20		kΩ

[Measuring condition]

\*1  $f_{CK}=65$  MHz,  $f_{LS}=50$  kHz (Data sampling state)

\*2  $f_{CK}=65$  MHz,  $f_{LS}=50$  kHz, SPI=GND is fixed. (Standby state)

\*3 ○ IO<sub>1</sub> • Applied voltage = 8.0 V(XO<sub>1</sub>-ZO<sub>128</sub>)

• Output voltage = 7.5 V(XO<sub>1</sub>-ZO<sub>128</sub>)

•  $V_{LS}=10$  V

○ IO<sub>2</sub> • Applied voltage = 7.0 V(XO<sub>1</sub>-ZO<sub>128</sub>)

• Output voltage = 7.5 V(XO<sub>1</sub>-ZO<sub>128</sub>)

•  $V_{LS}=10$  V

○ IO<sub>3</sub> • Applied voltage = 3.0 V(XO<sub>1</sub>-ZO<sub>128</sub>)

• Output voltage = 2.5 V(XO<sub>1</sub>-ZO<sub>128</sub>)

•  $V_{LS}=10$  V

○ IO<sub>4</sub> • Applied voltage = 2.0 V(XO<sub>1</sub>-ZO<sub>128</sub>)

• Output voltage = 2.5 V(XO<sub>1</sub>-ZO<sub>128</sub>)

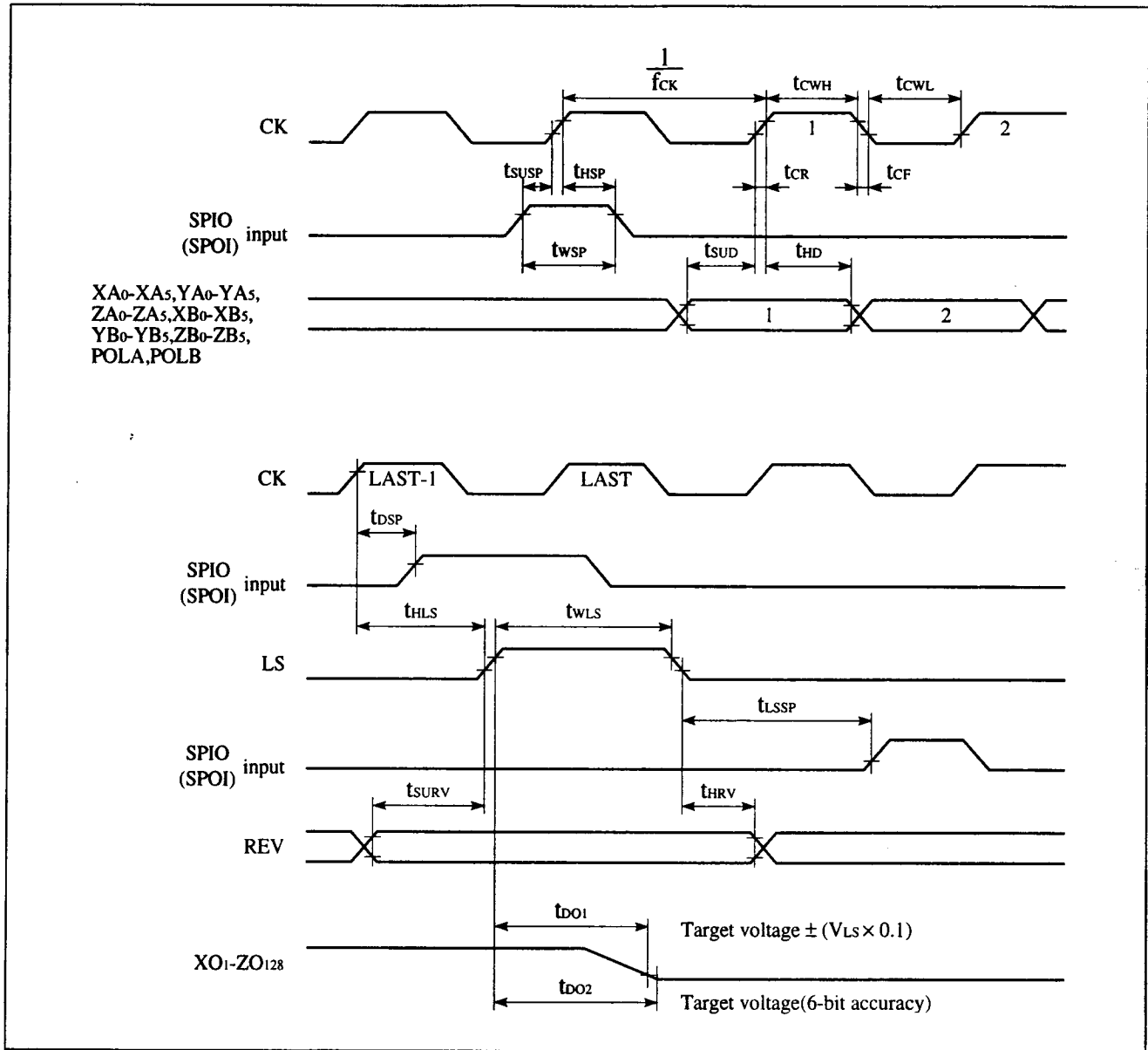
•  $V_{LS}=10$  V

### ■ AC Electrical Characteristics

( $V_{CC}=2.7$  to  $3.6$  V,  $V_{LS}=8.0$  to  $13$  V,  $T_a=-20$  to  $+75$  °C)

Parameter	Symbol	Measuring condition	Applicable pin	MIN.	TYP.	MAX.	Unit
Clock frequency	f <sub>CK</sub>		CK			65	MHz
"High" level pulse width	t <sub>CWH</sub>			4.0			ns
"Low" level pulse width	t <sub>CWL</sub>			4.0			ns
Input rise time	t <sub>CR</sub>					10	ns
Input fall time	t <sub>CF</sub>					10	ns
Data set up time	t <sub>SUD</sub>		XA <sub>0</sub> -XA <sub>5</sub> , XB <sub>0</sub> -XB <sub>5</sub> YA <sub>0</sub> -YA <sub>5</sub> , YB <sub>0</sub> -YB <sub>5</sub>	4.0			ns
Data hold time	t <sub>HD</sub>		ZA <sub>0</sub> -ZA <sub>5</sub> , ZB <sub>0</sub> -ZB <sub>5</sub> POLA, POLB	4.0			ns
Start pulse setup time	t <sub>SUSP</sub>		SPIO, SPOI	4.0			ns
Start pulse hold time	t <sub>HSP</sub>		SPIO, SPOI	4.0			ns
Start pulse width	t <sub>WSP</sub>		SPIO, SPOI			$\frac{1}{f_{CK}}$	ns
Start pulse output delay time	t <sub>DSP</sub>	C <sub>L</sub> = 15 pF	SPIO, SPOI			11	ns
LCD drive output delay time	t <sub>DO1</sub>	C <sub>L</sub> = 150 pF	XO <sub>1</sub> -ZO <sub>128</sub>			3	μs
	t <sub>DO2</sub>	C <sub>L</sub> = 150 pF				10	μs
LS signal, SPI signal setup time	t <sub>LSSP</sub>		LS	$\frac{1}{f_{CK}}$			ns
LS signal, CK signal hold time	t <sub>HLS</sub>		LS	7			ns
LS signal "High" level width	t <sub>WLS</sub>		LS	$\frac{1}{f_{CK}}$			ns
REV signal, LS signal setup time	t <sub>SURV</sub>		REV	14			ns
REV signal, LS signal hold time	t <sub>HRV</sub>		REV	10			ns

■ Timing Diagram



■ Example of Typical Characteristics

( $T_a=25\text{ }^\circ\text{C}$ ,  $GND=0\text{ V}$ ,  $V_{CC}=3.3\text{ V}$ )

Parameter	MIN.	TYP.	MAX.	Unit
Basic gate propagation delay time		10		ns

# SHARP

## SHARP CORPORATION Japan

### HEAD OFFICE

SALES & MARKETING GROUP  
-ELECTRONIC COMPONENTS & DEVICES  
22-22, NAGAIKE-CHO, ABENO-KU, OSAKA 545, JAPAN  
PHONE: (81) 6-621-1221  
FAX: (81) 6117-725300, 6117-725301, 6117-725302  
http : //www.sharp.co.jp/e-device/index.html

### IC SALES DEPARTMENT

INTERNATIONAL IC SALES DEPARTMENT II  
2613-1 ICHINOMOTO-CHO TENRI-CITY NARA 632, JAPAN  
PHONE: (81) 743-65-1321  
FAX: (81) 743-65-1532

## U.S.A.

### SHARP ELECTRONICS CORPORATION Microelectronics Group

**North American Head Office**  
5700 Northwest Pacific Rim Blvd. #20,  
Camas, WA 98607, U.S.A.  
PHONE: (1)360-834-2500  
FAX : (1)360-834-8903  
http : //www.sharpmeg.com

**West**  
1980 Zanker Road, San Jose, CA 95112  
PHONE: (1)408-436-4900  
FAX : (1)408-436-0924

5901 Bolsa Ave.,  
Huntington Beach, CA 92647  
PHONE: (1)714-250-0225  
FAX : (1)714-250-0438

1025 Royal Lane (PO box 619035),  
DFW Airport, TX 75261-9035  
PHONE: (1)972-574-5205  
FAX : (1)972-574-9870

10222 Scull Creek, Austin, TX 78730  
PHONE: (1)512-349-7262  
FAX : (1)512-349-7002

9950 Cypresswood, Suite 350,  
Houston, TX 77070  
PHONE: (1)281-955-9909  
FAX : (1)281-955-9910

**East**  
1300 Naperville Road, Romeoville, IL 60446  
PHONE: (1)630-226-2400  
FAX : (1)630-759-8572

691 N. Squirrel Road, Suite 110,  
Auburn Hills, MI 48326  
PHONE: (1)810-377-9220  
FAX : (1)810-377-9222

200 Wheeler Rd., Burlington, MA 01803  
PHONE: (1)617-270-7979  
FAX : (1)617-229-9117

Canterbury Hall, 4815 Emperor Blvd.,  
Suite 140, Durham, NC 27703  
PHONE: (1)919-941-0065  
FAX : (1)919-941-0066

## EUROPE

### SHARP ELECTRONICS (EUROPE) GmbH

**Head Office**  
Microelectronics Division, (MED)  
Sonnenstrasse 3, 20097, Hamburg, Germany  
PHONE: (49)40-23 76 22 86  
FAX : (49)40-23 76 22 32

**Germany MED Muenchen Office**  
Fuerstener Strasse 5,  
80687 Muenchen, Germany  
PHONE: (49)89-54-6842-0  
FAX : (49)89-54-6842-50

**Germany MED Nürnberg Office**  
Donaustrasse 69, 90451 Nürnberg, Germany  
PHONE: (49)911-642 70 51  
FAX : (49)911-642 66 69

**France MED Paris Office**  
Immeuble Rosny 2, Avenue du  
Général de Gaulle 93110  
Rosny Sous Bois Cédex, France  
PHONE: (33)1-48 12 19 00  
FAX : (33)1-48 55 46 78

**Italy MED Milano Office**  
Centro Direzionale Colleoni  
Palazzo Taurus Ingresso 2  
20041 Agrate Brianza, Milano, Italy  
PHONE: (39)39-68 99 946  
FAX : (39)39-68 99 948

**U.K. MED London Office**  
Centennial Court, Easthampstead Road,  
Bracknell, Berkshire RG12 1YQ,  
United Kingdom  
PHONE: (44)1344-86 99 22  
FAX : (44)1344-36 09 03

**U.K. MED Scotland Office**  
Unit 48 Grovewood Business Centre,  
Strathclyde Business Park,  
Bellshill ML43NQ,  
Scotland, United Kingdom  
PHONE: (44)1698-84 34 42  
FAX : (44)1698-84 28 99

**Ireland MED Dublin Office**  
First Floor, Block 1, St. Johns Court,  
Santry, Dublin 9, Ireland  
PHONE: (353)1-842 87 05  
FAX : (353)1-842 84 55

## ASIA

### SHARP-ROXY (HONG KONG) LTD.

3rd Business Division,  
17/F, Admiralty Centre,  
Tower 1, 18 Harcourt Road, Hong Kong  
PHONE: (852)28229311  
FAX : (852)28660779

### SHARP ELECTRONICS (SINGAPORE) PTE., LTD.

Electronic Components Division  
438A Alexandra Road #05-01/02  
Alexandra Technopark  
Singapore 119967  
PHONE: (65)271-3566  
FAX : (65)271-3855

### SHARP ELECTRONIC COMPONENTS (TAIWAN) CORPORATION

8F-A, No. 16, Sec. 4, Nanking E. Rd.,  
Taipei, Taiwan, Republic of China  
PHONE: (886)2-577-7341  
FAX : (886)2-577-7326, (886)2-577-7328

### SHARP ELECTRONIC COMPONENTS (KOREA) CORPORATION

RM 501 Geosung B/D, 541,  
Dohwa-dong, Mapo-ku, Seoul, Korea  
PHONE: (82)2-711-5813 to 5818  
FAX : (82)2-711-5819

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