OKI Semiconductor

This version: Nov. 1997
Previous version: Jul. 1996

MSC1208

23-bit × 2 Duplex Controller/Driver with Digital Dimming and Keyscan Function

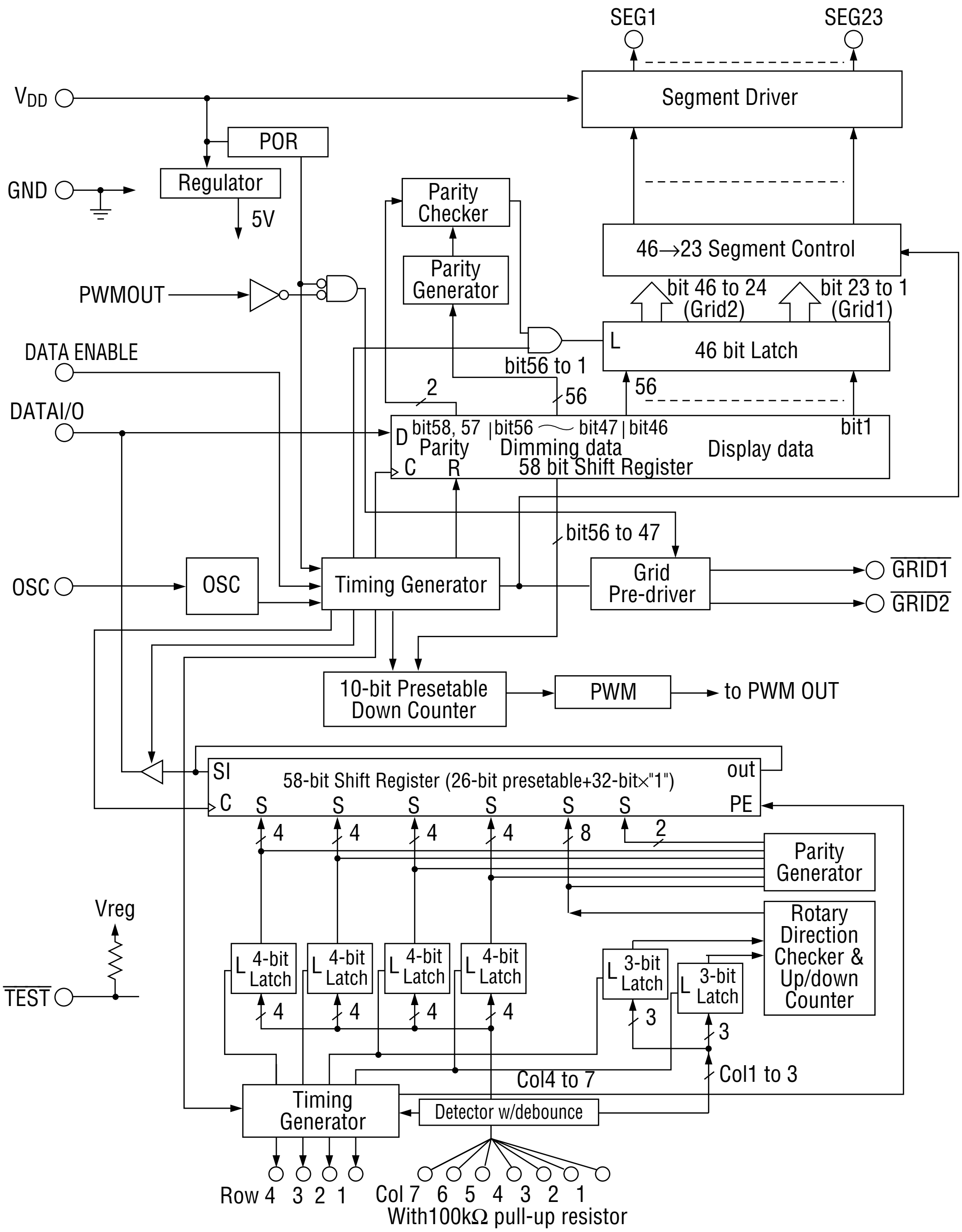
GENERAL DESCRIPTION

The MSC1208 is a Bi-CMOS display driver for 1/2-duty vacuum fluorescent display tube.
It consists of 58-bit shift registers, latch circuits, a 10-bit digital dimming circuit, 4 × 4 switch matrix, and a keyscan circuit for 2-channel, 3-contact rotary switch. With these features, the MSC1208 not only can display frequencies for audio systems used in automobile applications and various information, but also can accept keyboard entry. Thus the front panel functions can be carried out only by this IC.
Since the MSC1208 has the data parity check function and the self-check functions, inspection at shipment and failure detection can easily be performed.
In addition, since the MSC1208 uses serial interfacing, only two signal lines, DATA ENABLE and DATA I/O, are used for connection with a microcontroller.

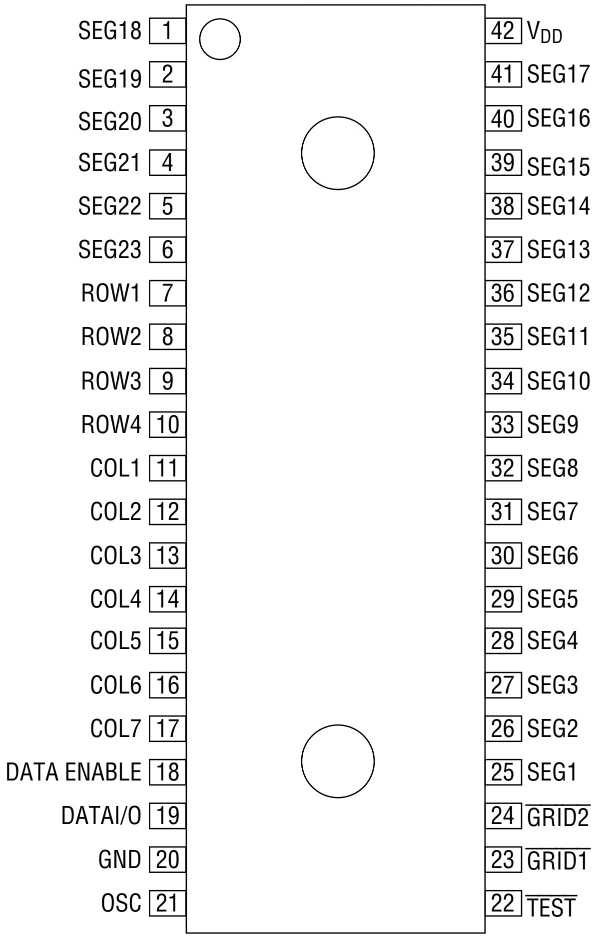
FEATURES

- Power supply voltage : V_{DD}=8 to 18V (Built-in 5V-regulator for logic)
- Operating temperature range : –40 to 85°C
- Directly drives 23 segments : I_{OH}=–8.8mA, Max. at V_{OH}=V_{DD}–0.8V
- Built-in 4 × 4 switch matrix and key scan circuit for 2ch, 3-contact switching
- Built-in digital dimming circuit with 10-bit resolution
- Data parity check function
- Self-check function (segment ON/OFF at intervals of about 1 second in test mode)
- Built-in RC oscillator (capacitor is connected externally)
- Built-in power-on reset circuit
- Package:
  42-pin plastic shrink DIP (SDIP42-P-600-1.78) : (Product name : MSC1208SS)
  ××× indicates the code number.

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



42-Pin Plastic Shrink DIP

PIN DESCRIPTIONS

Pin	Symbol	Type	Description
42	V_{DD}	—	Power Sypply Voltage. A 12V power supply is connected.
20	GND	—	Ground. 0V is applied.
19	DATA	I/O	Serial data input-output. Enters the input mode when a "H" level signal is input to DATA ENABLE; enters the output mode when a "L" level signal is input to DATA ENABLE.
18	DATA ENABLE	I	Serial clock input. During the "H" level of clock pulse, the input data of the DATA I/O pin (display data or dimming data) is read, and during the "L" level of clock pulse, the output data (key swich data) is output to the DATA I/O pin.
11 to 17	COL1 to 7	I	Input for the key matrix. These pins are "L" active. When these keys are in the inactive state, these pins are at "H" level through the internal pull-up resistors. COL1 to COL3 are for the rotary switch and COL4 to COL7 are for the push-button switch.
7 to 10	ROW1 to 4	O	Signal outputs for scanning key matrix. Normally, ROW1 to ROW4 output a "l" level. Key scanning is executed only once when a transfer of the rotary switch contact or pressing down or release of the push-button switch is detected. Key scanning is continued if the rotary switch contact is in the open state after this one-time scanning. Then, scanning stops when the rotary switch contact makes connection with any of the selective contacts. After key scanning is stopped, ROW1 to ROW4 return to a "L" level.
21	OSC	I/O	RC oscillator connection. A capacitor is connected between GND and this pin.
25 to 41, 1 to 6	SEG1 to 23	O	Segment signal output.
23 , 24	GRID1,2	O	Inverted GRID signal output. This signal is connected to an external grid driver (e.g., PNP transistor) input.
22	TEST	I	Input for test. Since this pin has as internal a pull-up resistor, leave this pin open or pull it up for use. When a "L" level signal is input, all segment outputs go on and off at intervals of 1 second.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{DD}	—	–0.3 to+20	V
Input Voltage	V_{IN}	—	–0.3 to+6	V
Storage Temperature	T_{STG}	—	–55 to+150	°C
Power Dissipation	P_D	Ta=85°C	400	mW

RECOMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{DD}	—	8	—	18	V
Operating Temperature	T_{op}	—	–40	—	85	°C
"H" Input Voltage (1)	V_{IH1}	DATA ENABLE, $\overline{\text{TEST}}$	3.8	—	5.5	V
"H" Input Voltage (2)	V_{IH2}	DATA I/O	4.0	—	5.5	V
"L" Input Voltage (1)	V_{IL1}	DATA ENABLE, $\overline{\text{TEST}}$	0	—	0.8	V
"L" Input Voltage (2)	V_{IL2}	DATA I/O	0	—	1.2	V
Oscillation Frequency	f_{OSC}	C=68pF	256	512	768	kHz
DATA ENABLE Frequency	f_E	Refer to Fig. 1	—	—	1.3	kHz
DATA ENABLE Pulse Width	t_W	Refer to Fig. 1	360	—	—	µs
DATA ENABLE Rise Time	t_{RE}	Refer to Fig. 1	—	—	20	µs
DATA ENABLE Fall Time	t_{FE}	Refer to Fig. 1	—	—	20	µs
Data Delay Time	t_X	Refer to Fig. 1	—	—	20	µs
Input Data Valid Time	t_{DV1}	Refer to Fig. 1	200	—	—	µs
Output Data Valid Time	t_{DV2}	Refer to Fig. 1	150	—	—	µs
Frame Frequency	f_{FR}	Refer to Fig. 3	—	250	—	Hz

ELECTRICAL CHARACTERISTICS

DC Characteristics

($Ta=-40$ to $+85°C$, $V_{DD}=8$ to $18V$)

Parameter	Symbol	Condition	Min.	Max.	Unit
"H" Input Voltage	V_{IH1}	DATA ENABLE, $\overline{\text{TEST}}$	3.8	—	V
"H" Input Voltage (2)	V_{IH2}	DATA I/O	4.0	—	V
"L" Input Voltage (1)	V_{IL1}	DATA ENABLE, $\overline{\text{TEST}}$	—	0.8	V
"L" Input Voltage (2)	V_{IL2}	DATA I/O	—	1.2	V
"H" Input Current (1)	I_{IH1}	$V_{IN}=5V$, DATA ENABLE, DATA I/O	–5	5	µA
"H" Input Current (2)	I_{IH2}	$V_{IN}=5V$, COL1 to 7, $\overline{\text{TEST}}$	–30	30	µA
"L" Input Current (1)	I_{IL1}	$V_{IN}=0V$, DATA ENABLE, DATA I/O	–5	5	µA
"L" Input Current (2)	I_{IL2}	$V_{IN}=0V$, COL1 to 7, $\overline{\text{TEST}}$	–15	–160	µA
"H" Output Voltage (1)	V_{OH1}	$I_{OH1}=-3mA$, SEG1 to 17, $V_{DD}=13.8V$	13	—	V
"H" Output Voltage (2)	V_{OH2}	$I_{OH2}=-8mA$, SEG18 to 23, $V_{DD}=13.8V$	13	—	V
"L" Output Voltage (1)	V_{OL1}	$V_{DD}=13.8V$, All SEG pins $I_{OL}=500\mu A$ $I_{OL}=200\mu A$ $I_{OL}=2\mu A$	 — — —	 2 1 0.3	 V V V
"L" Output Voltage (2)	V_{OL2}	$V_{DD}=13.8V$, $I_{OL}=10mA$, $\overline{\text{GRID1,2}}$	—	0.8	V
"L" Output Voltage (3)	V_{OL3}	$V_{DD}=13.8V$, $I_{OL}=200\mu A$, ROW1 to 4	—	0.8	V
"L" Output Voltage (4)	V_{OL4}	$V_{DD}=13.8V$, $I_{OL}=2mA$, DATA I/O	—	1.2	V
Current Consumption	I_{DD}	$f_{osc}=512kHz$, No Load	—	20	mA

AC Characteristics

($Ta=-40$ to $+85°C$, $V_{DD}=8$ to $18V$)

Parameter	Symbol	Condition	Min.	Max.	Unit
DATA ENABLE Frequency	f_E	Refer to Fig. 1	—	1.3	kHz
DATA ENABLE Pulse Width	t_W	Refer to Fig. 1	360	—	µs
DATA ENABLE Rise Time	t_{RE}	Refer to Fig. 1	—	20	µs
DATA ENABLE Fall Time	t_{FE}	Refer to Fig. 1	—	20	µs
Data Delay Time	t_X	Refer to Fig. 1	—	20	µs
Input Data Valid Time	t_{DV1}	Refer to Fig. 1	200	—	µs
Output Data Valid Time	t_{DV2}	Refer to Fig. 1	150	—	µs
Output Data Active-to-High-Impedance Time	t_{HZ}	Refer to Fig. 1	—	5	µs
Output Through Rate (SEG, $\overline{\text{GRID}}$)	t_R	$C_L=100pF$, t=20 to 80% or 80 to 20% of V_{DD}	—	5	µs
DATA ENABLE Setup Time	t_{SE}	Refer to Fig. 2	300	—	µs
Oscillation Frequency	f_{OSC}	C=68pF	256	768	kHz

Key Scan Characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Key Scan Time	t_{KS}	Refer to Fig. 4	164	250	500	µs
Key Scan Width	t_{SW}	Refer to Fig. 4	41	62.5	125	µs

TIMING DIAGRAM

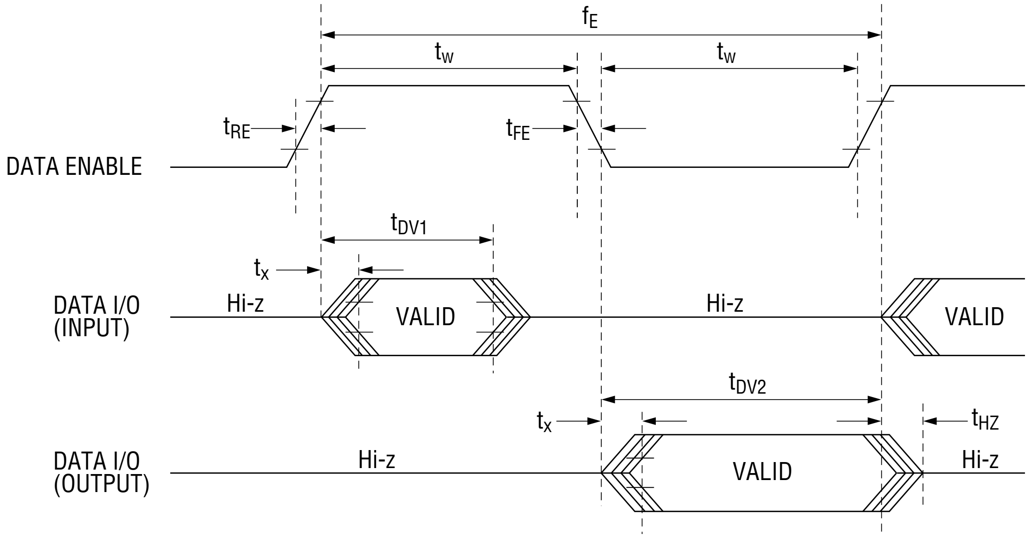


Figure 1. Data Input-Output Timing

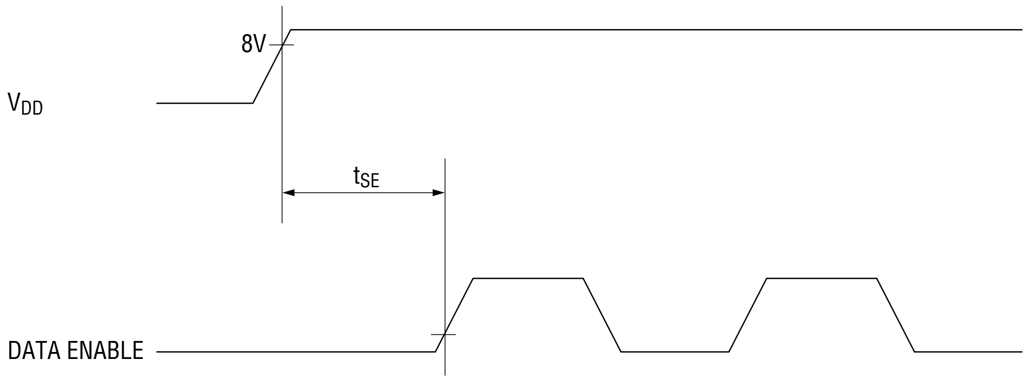


Figure 2. Power-ON Reset Timing

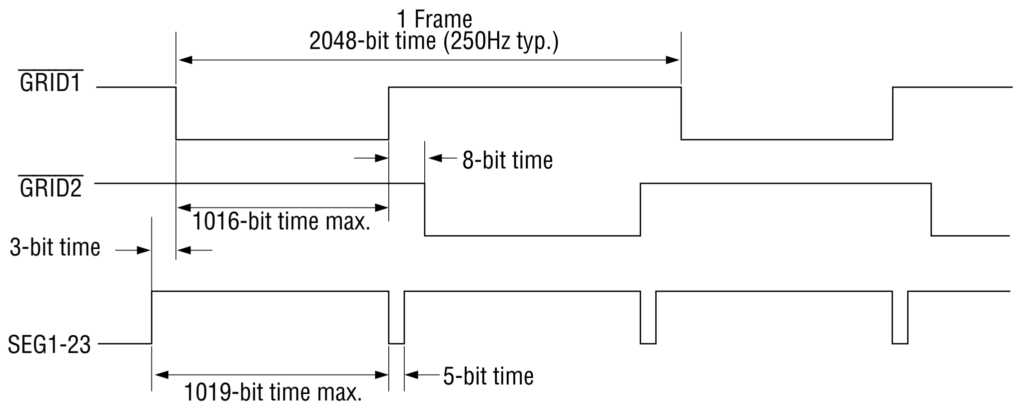


Figure 3. SEG and GRID Output Timing

Note: 1. Shown above is the timing when the duty ratio of digital dimming is 1016/1024.
2. The grid and segment ON time is set by 10-bit digital dimming data.
3. 1-bit time=T_{OSC}(=1/f_{OSC})=1.95 µs typ.

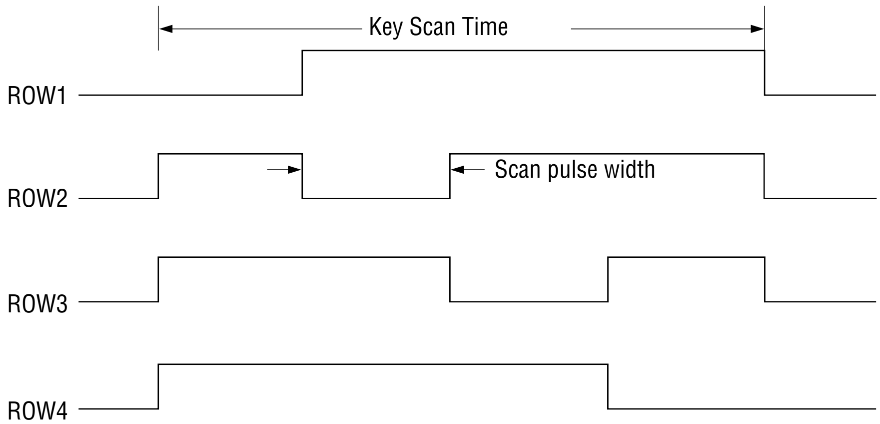


Figure 4. Key Scan Timing

FUNCTIONAL DESCRIPTION

Key Scan

In the case of the push-button switch, key scanning is started only when depression or release of the key is detected for the purpose of minimizing noise caused by scanning signal. Then, after completion of 1-cycle scanning, all the ROW outputs return to a "L" level.
The push-button switch input pins (COL4-COL7) are connected to a chattering absorption circuit that absorbs chattering with the chattering time about 25ms (typ.), so input signals shorter than 25ms are ignored. Because of this, key scanning is started about 25ms after key input.

In the case of the rotary switch, key scanning is started only once when a transfer of the rotary switch contact or pressing down or release of the push-button switch is detected. Key scanning is continued if the rotary switch contact is in the open state after this one-time scanning. Then, scanning stops when the rotary switch contact makes connection with any of the selective contacts. After that, all "L" outputs return to a "L" level.

The rotary switch input pins (COL1-COL3) have an internal chattering absorption circuit that absorbs chattering with the chattering time about 1ms (typ.), so input signals shorter than 1ms are ignored. Because of this, key scanning is started about 1ms after a change in switch status.

The switch data is stored in the internal latch circuit, and then transferred to the output register at the rising edge of the first pulse of DATA ENABLE.

The switch data consists of 16-push button switch data (S1-S16) and 2-rotary switch data (RS1 and RS2). The rotary switch data consists of 3 bits for contact-transfer count and 1-bit for rotating direction. Since the maximum transfer count is "111" in binary, a transfer is counted up to seven times. The rotating direction bit is "0" for the regular direction and "1" for the opposite direction.

[Rotating direction]

Regular direction : R11→R12→R13→R11
Opposite direction : R13→R12→R11→R13 (See figure below)

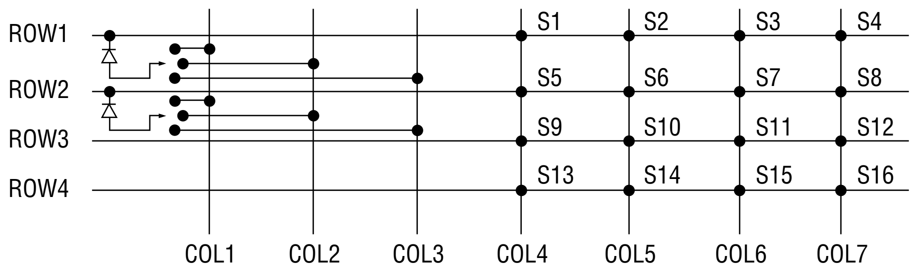


Figure 5. Key Matrix

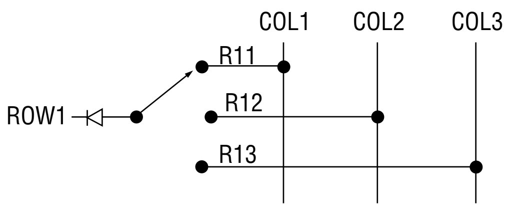


Figure 6. Rotary Switch Section (RS1)

Digital Dimming

The segment and grid ON time can be controlled in the range of 0/1024 (=0%) to 1016/1024 (=99.2%) duty by 10-bit digital dimming data. (See Figure 3, "SEG and GRID Output Timing.")

Data Transfer

The input data (display data or dimming data) from DATA I/O is read into the internal register after the DATA ENABLE input level changes from "L" to "H". The output data (key switch data) is output to the DATA I/O pin after the DATA ENABLE input level changes from "H" to "L". Using this method, bidirectional serial communication using two signal lines, DATA ENABLE and DATA I/O, can be made.
The transfer data consists of 58 bits including 2-bit parity bit. Data transfer is completed if no parity error occurs after the 58-bit data has been transferred to the internal register. If a parity error occurs, the previously transferred data (display data or dimming data) is remained.
If an abnormality occurs in the DATA ENABLE line and no signal pulse is input for 10ms ±5ms or more, the data transfer is terminated even if it is in progress. Then, when the next pulse is input, it is identified as the first pulse.

Diagnositc Function

1. Parity
Bit 57 and bit 58 (PO and PI) of the input data are used for parity check. For the output data, parity is internally generated to add parity bit to bits 25 and 26.
The parity value is, for both input and output, "P0, P1=1, 1" when a total number of "1"s (or "0"s) is even, and "P0, P1=0, 0" when it is odd.

2. Default mode
This device enters the default mode if no pulse is input to DATA ENABLE for about 1 second or if a parity error keeps occurring for about 1 second.
In this mode, at the state of keeping the contents of the dimming data before entering the default mode, the two segment outputs (SEG1, SEG2) only go ON.
This state is reset if no parity error is detected after the data has been transferred.

3. Self test
When the $\overline{\text{TEST}}$ pin is set to a "L" level, all segment outputs go on and off at intervals of about 1 second. At this time, the duty ratio for both segment and grid outputs becomes the maximum (99.2%).

Power-On Reset

When power is turned on, this device is initialized by the internal power-on reset circuit. Then, about 1second after the initialization, the device enters the default mode. At this time, the SEG1 and SEG2 segments go ON with the maximum duty ratio (99.2%). This state is reset if no parity error is detected after the data has been transferred.

Input-Output Configuration

1. Input data (58 bits)

Bit	58	57	56	55	to	48	47	46	45	to	2	1
DATA	P1	P0	10	9	to	2	1	46	45	to	2	1
	PARITY		Dimming DATA					Display DATA				

→ First in

[Correspondence between input data (Display data) and SEG, GRID]

Display DATA	1 to 23	24 to 26
SEG NO.	SEG1 to SEG23	SEG1 to SEG23
GRID NO.	$\overline{\text{GRID1}}$	$\overline{\text{GRID2}}$

[Correspondence between dimming data and duty]

Dimming DATA **(LSB) 1 2 3 4 5 6 7 8 9 10 (MSB)**	**Duty (%)**
0 0 0 0 0 0 0 0 0 0 to 0 0 0 1 1 1 1 1 1 1 to 1 1 1 1 1 1 1 1 1 1	0 to 99.2

* For dimming data greater than or equal to 0001111111, the duty is 99.2%.
(LSB) (MSB)

[Parity]
When the total number of "1"s or "0"s in the display data and dimming data is even, add "P0, P1=1, 1" to input data, and when it is odd, add "P0, P1=0, 0".

2. Output data (58 bits)

Bit	58 to 27	26	25	24 to 9	8	7	6	5	4	3	2	1
DATA	ALL"1"	P1	P0	S16 to S1	Q23	Q22	Q21	D2	Q13	Q12	Q11	D1
	ALL"1"	PARITY		16 SWITCHES	RS2 DATA				RS1 DATA			

→ First out

[Direction bit (Rotary switch rotating direction)]
D1, D2=Regular direction: 0, Opposite direction: 1

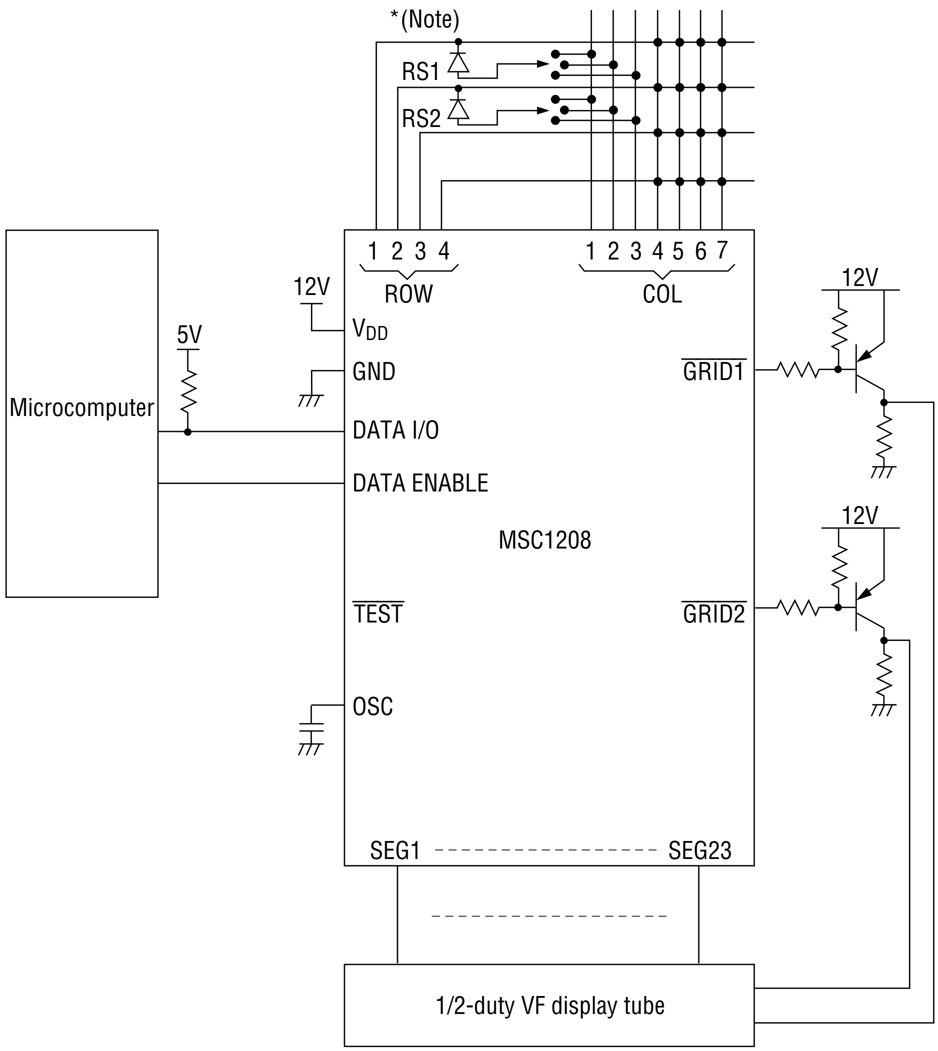
[Contact transfer count (rotary switch)]
Q11(LSB) to 13(MSB), Q21(LSB) to 23(MSB)
[Push-butter switch]
DS1 to S16=Pressing switch down: 1, Release: 0

[Parity]
When the total number of "1"s or "0"s in the key switch data is even, "P0, P1=1, 1" is added to the output, and when it is odd, "P0, P1=0, 0" is added.

Note: "1" is output to every bit from bit 27 to bit 58.

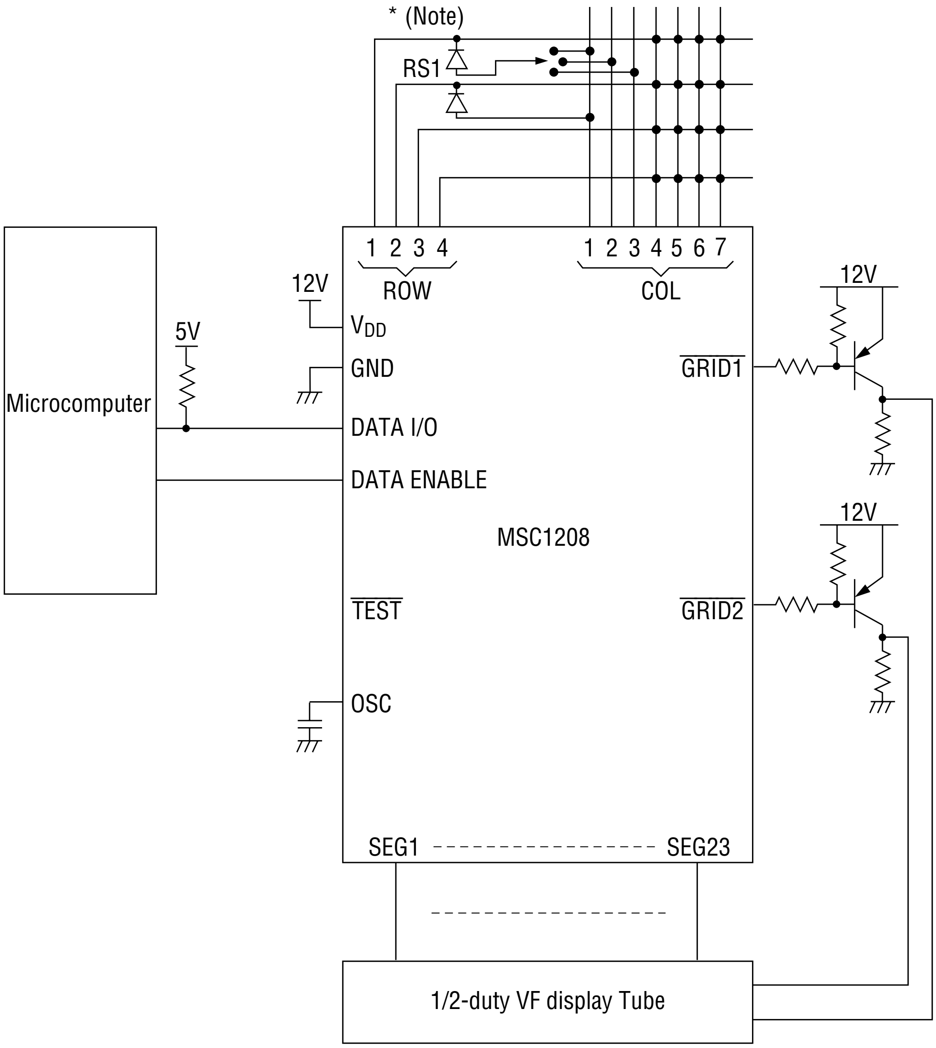
APPLICATION CIRCUITS

Example of a Basic Application Circuit



Note: Connect a diode between the rotary switch common contact and selective contacts, as shown in the diagram above.

Example of Using a Single Rotary Switch

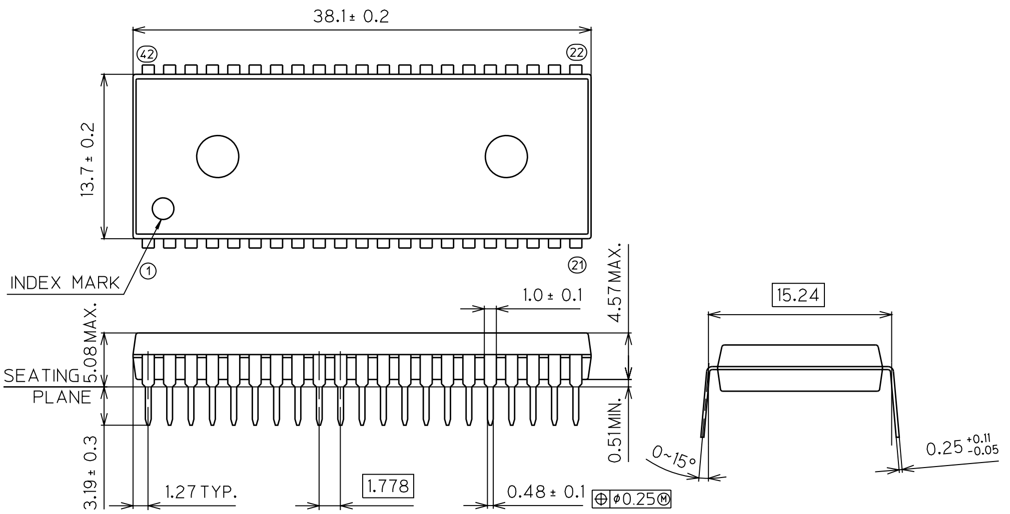


Note: When using a sigle rotary switch, connect the ROW that is not used (ROW1 or ROW2) and one of COL1 to COL3 via a diode.
If no rotary switch is used, connect ROW1 and one of COL1 to COL3 via a diode, and also connect ROW2 and one of COL1 to COL3 via a diode.

PACKAGE DIMENSIONS

(Unit : mm)

SDIP42-P-600-1.78



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	4.52 TYP.

Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage.
Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).