OKI Semiconductor

MSM6606

80-DOT LCD DRIVER WITH KEY MATRIX

GENERAL DESCRIPTION

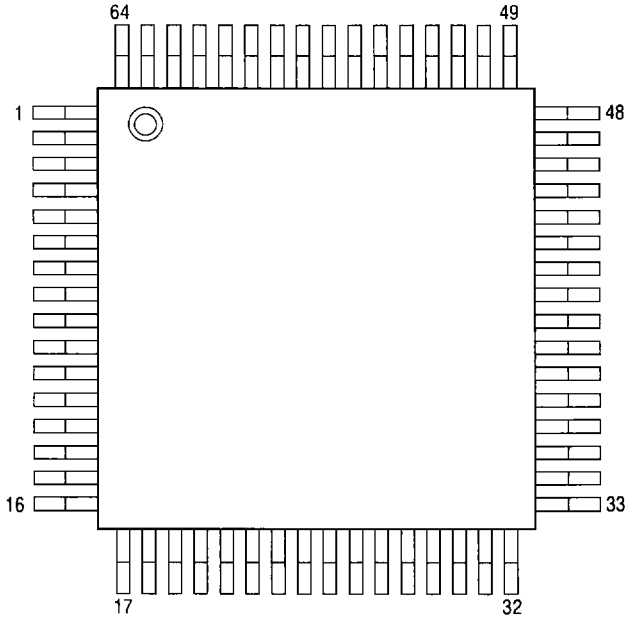
MSM6606 is an LCD driver for a 1/2 duty dynamic display, that can directly drive an LCD for up to 80 segments, and one LED. Due to an internal 5 x 6 keyscan circuit, keyboard input is possible, and the number of wires between the front panel and CPU can be minimized.

FEATURES

- Maximum of an 80-segment LCD can be displayed. (1/2 duty dynamic drive)
- One LED can be driven directly. (Io = –15 mA max.)
- Due to an internal 5 x 6 keyscan circuit, the status of up to 30 key switches can be read.
- A serial method interface with the CPU is implemented by LOAD, DATA I/O, and CLOCK.
- An internal CR oscillation circuit for LCD alternating current drive is included.
- Voltage dividing resistor for bias voltage generation is included.
- Power Voltage: 5V ± 10%
- Temperature Range: –40 ~ +85°C
- Package: 64-pin plastic QFP (QFP 64-P-1414-VK)

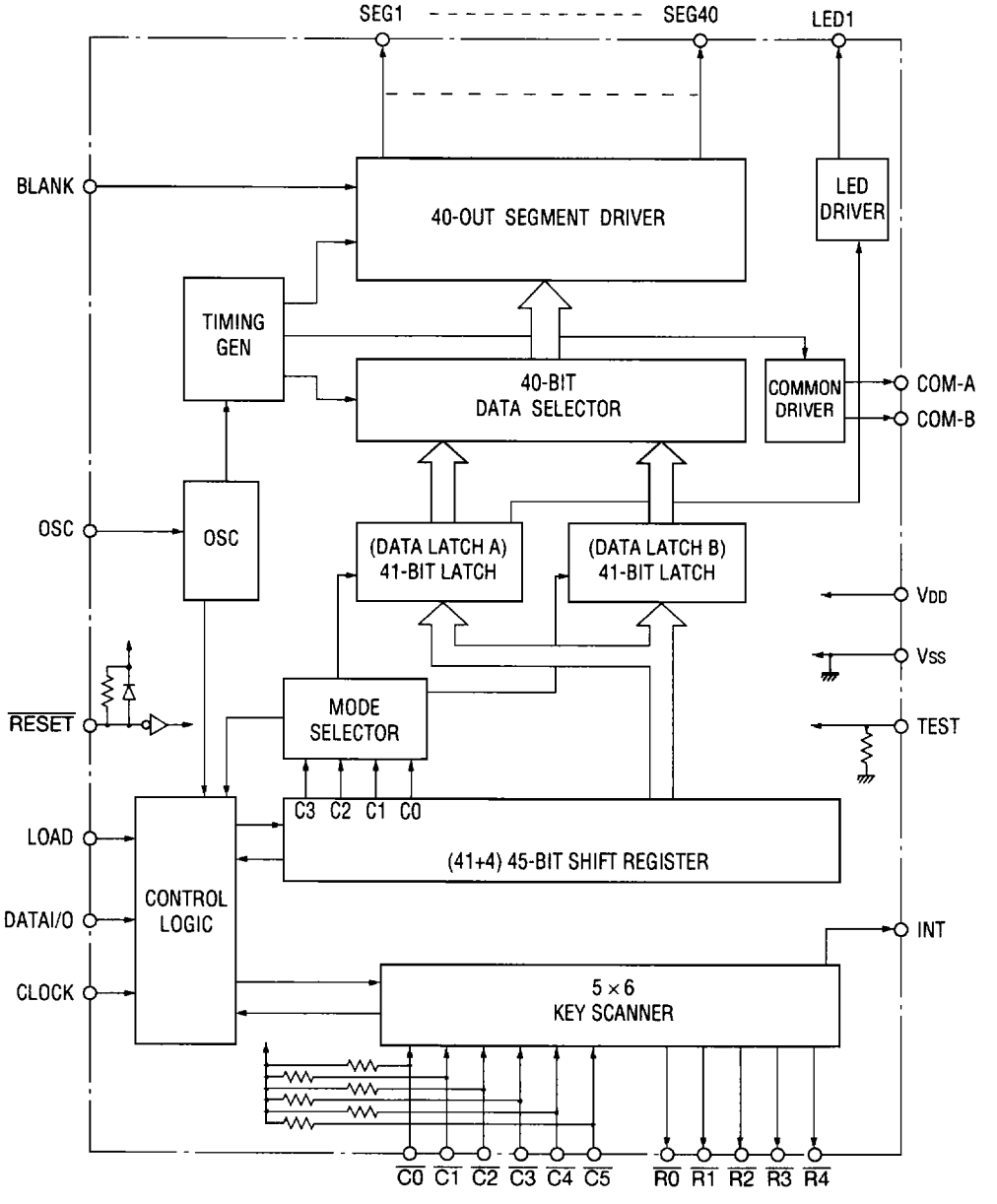
PIN CONFIGURATION

(Top View)-lead Plastic Quad Flat Package



PIN NO.	TERMINAL NAME	PIN NO.	TERMINAL NAME	PIN NO.	TERMINAL NAME	PIN NO.	TERMINAL NAME
1	SEG1	17	SEG17	33	SEG33	49	$\overline{R2}$
2	SEG2	18	SEG18	34	SEG34	50	$\overline{R3}$
3	SEG3	19	SEG19	35	SEG35	51	$\overline{R4}$
4	SEG4	20	SEG20	36	SEG36	52	LED1
5	SEG5	21	SEG21	37	SEG37	53	V_{DD}
6	SEG6	22	SEG22	38	SEG38	54	OSC
7	SEG7	23	SEG23	39	SEG39	55	V_{SS}
8	SEG8	24	SEG24	40	SEG40	56	TEST
9	SEG9	25	SEG25	41	$\overline{C0}$	57	LOAD
10	SEG10	26	SEG26	42	$\overline{C1}$	58	CLOCK
11	SEG11	27	SEG27	43	$\overline{C2}$	59	DATA/O
12	SEG12	28	SEG28	44	$\overline{C3}$	60	INT
13	SEG13	29	SEG29	45	$\overline{C4}$	61	BLANK
14	SEG14	30	SEG30	46	$\overline{C5}$	62	$\overline{RESET}$
15	SEG15	31	SEG31	47	$\overline{R0}$	63	COM-B
16	SEG16	32	SEG32	48	$\overline{R1}$	64	COM-A

FUNCTIONAL BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

- **Absolute Maximum Ratings**

Parameter	Symbol	Condition	Rating	Unit
Supply Voltage	V_{DD}	Ta = 25°C	-0.3 ~ 6.5	V
Input Voltage	V_I	Ta = 25°C	-0.3 ~ V_{DD}+0.3	V
Output Current	I_O	Ta = 25°C *1	-20	mA
Storage Temperature	T_{stg}	–	-55 ~ +150	°C

- **Absolute Maximum Ratings**

Parameter	Symbol	Condition	Rating	Unit
Supply Voltage	V_{DD}	–	4.5 ~ 5.5	V
Operating Temperature	T_{OP}	–	-40 ~ +85	°C

- **Absolute Maximum Ratings**

Parameter	Symbol	Condition	Min.	Max.	Unit
Oscillation Resistance	Ro	–	20	120	V
Oscillation Capacitor	Co	–	0.01	0.047	°C

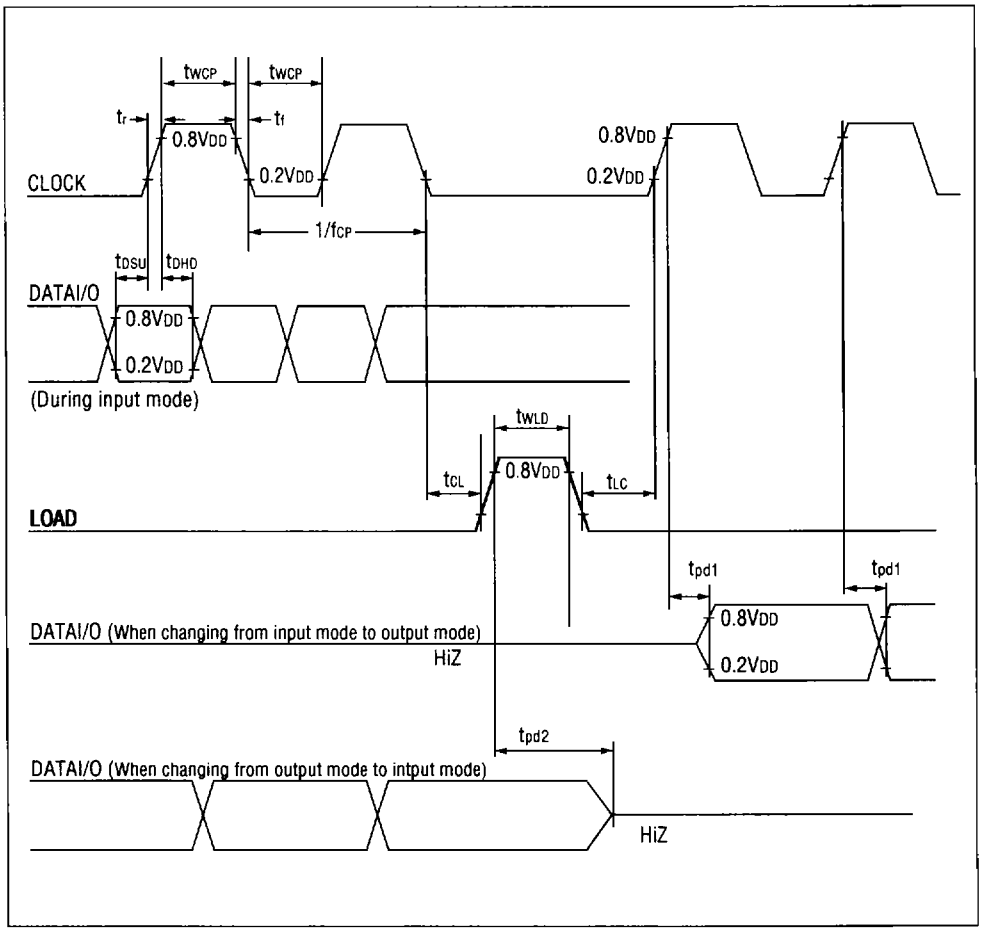
• DC Characteristics

(V_{DD} = 5V ±10%, Ta = -40 ~ +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit	Applicable Terminal
H Input Voltage	V_{IH}	–	0.7V_{DD}	–	V	All input
L Input Voltage	V_{IL}	–	–	0.3V_{DD}	V	
H Input Current	I_{IH1}	V_{DD} = 5.5V, V_I = V_{DD}	–	1	µA	CLOCK, LOAD BLANK
L Input Current	I_{IL1}	V_{DD} = 5.5V, V_I = 0V	–	-1	µA	
H Input Current	I_{IH2}	V_{DD} = 5.5V, V_I = V_{DD}	–	10	µA	DATA/O
L Input Current	I_{IL2}	V_{DD} = 5.5V, V_I = 0V	–	-10	µA	
L Input Current	I_{IL3}	V_{DD} = 5.0V, V_I = 0V	-0.18	-0.8	mA	$\overline{C0}$ ~ $\overline{C5}$
L Input Current	I_{IL4}	V_{DD} = 5.0V, V_I = 0V	-0.02	-0.1	mA	$\overline{RESET}$
H Output Voltage	V_{OH1}	V_{DD} = 4.5V, I_O = -30µA	4.3	–	V	SEG1 ~ SEG40
L Output Voltage	V_{OL1}	V_{DD} = 4.5V, I_O = 30µA	–	0.2	V	
H Output Voltage	V_{OH2}	V_{DD} = 4.5V, I_O = -150µA	4.3	–	V	COM-A COM-B
L Output Voltage	V_{OL2}	V_{DD} = 4.5V, I_O = 150µA	–	0.2	V	
H Output Voltage	V_{OH3}	V_{DD} = 4.5V, I_O = -15mA	3.0	–	V	LED1
L Output Voltage	V_{OL3}	V_{DD} = 4.5V, I_O = 0.1mA	–	0.4	V	
H Output Voltage	V_{OH4}	V_{DD} = 4.5V, I_O = -0.4mA	4.1	–	V	DATA/O INT
L Output Voltage	V_{OL4}	V_{DD} = 4.5V, I_O = 0.4mA	–	0.4	V	
H Output Voltage	V_{OH5}	V_{DD} = 4.5V, I_O = -50µA	2.5	–	V	$\overline{R0}$ ~ $\overline{R4}$
L Output Voltage	V_{OL5}	V_{DD} = 4.5V, I_O = 1.0mA	–	0.4	V	
M Output Voltage	V_{OM}	V_{DD} = 4.5V, I_O = 0mA	2.15	2.35	V	COM-A COM-B
M Output Resistance	R_{OM}	V_{DD} = 4.5V, I_O = ±10µA *1	–	100	kΩ	
Current Consumption	I_{DD}	V_{DD} = 5.5V, no load *2	–	0.5	mA	V_{DD}

- **Switching Characteristics**

Parameter	Symbol	Condition	Min.	Max.	Unit
Clock Frequency	f_{CP}	–	–	2.0	MHz
Clock Pulse Width	t_{WCP}	–	200	–	ns
Rise/Fall Time	t_r, t_f	–	–	50	ns
Data Setup Time	t_{DSU}	–	100	–	ns
Data Hold Time	t_{DHD}	–	100	–	ns
Load Pulse Width	t_{WLD}	–	200	–	ns
Clock→Load Time	t_{CL}	–	100	–	ns
Load→Clock Time	t_{LC}	–	200	–	ns
Output Delay Time 1	t_{pd1}	C_L = 50pF	–	300	ns
Output Delay Time 2	t_{pd2}	–	–	300	ns


twCP
twCP
tr
tf
0.8VDD
0.2VDD
CLOCK
1/fCP
0.8VDD
0.2VDD
tDSU
tDHD
DATAI/O
0.8VDD
0.2VDD
(During input mode)
tWLD
tCL
0.8VDD
tLC
LOAD
tpd1
tpd1
DATAI/O (When changing from input mode to output mode)
HiZ
0.8VDD
0.2VDD
tpd2
DATAI/O (When changing from output mode to intput mode)
HiZ

PIN DESCRIPTION

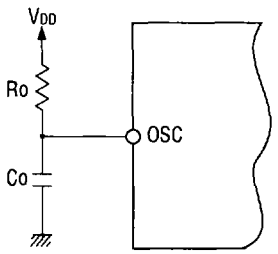
• OSC

This is an input/output terminal for the oscillator to generate LCD AC lighting and keyscan signals. Connect external capacitor and resistor as shown below to form RC oscillation circuit.

The relationship between frame frequency f_{FRM}, keyscan period T_{SCN} and oscillation frequency f_{OSC} is:

$f_{FRM} = f_{OSC}/32$, $T_{SCN} = 15/f_{OSC}$

(See reference data for information on relationship between Co, Ro values, and frame frequency or keyscan periods.)



• DATA I/O

This is serial data input/output terminal. The terminal is in output state from the first shift clock rise after key data output command writing, to the load signal rise, and in input state otherwise. (The terminal is in input state during resetting.)

Level	Display	Key Status
"H"	ON	ON (close)
"L"	OFF	OFF (open)

• CLOCK

This is an input terminal for the shift clock. DATAI/O terminal data is either input or output in synchronization with the rise of the clock.

• LOAD

This is a load signal input terminal used to transfer serial input data to a latch for display, to write commands, or to reset the DATAI/O terminal in input state.

• BLANK

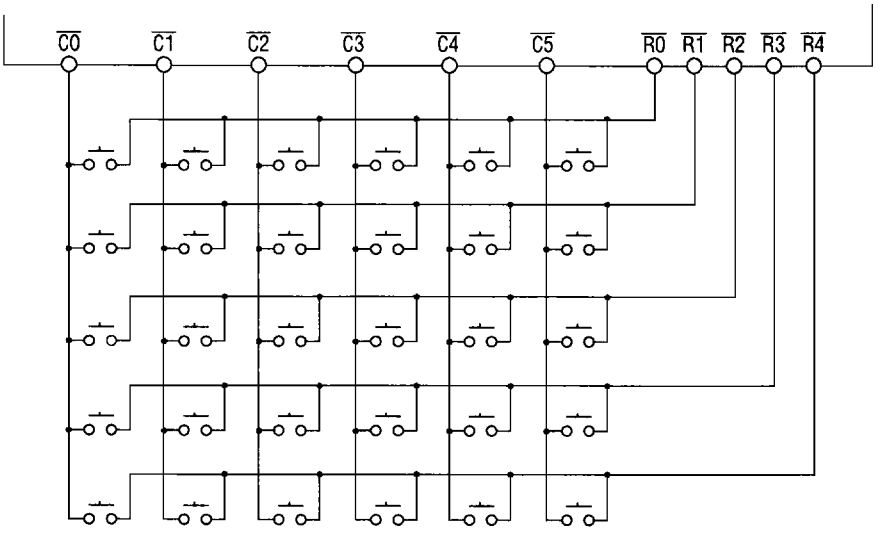
This is an display blanking signal input terminal. When at "H" level the LED and LCD display go out regardless of the display data. The display returns to the original status when at "L" level.

- **$\overline{R0}$ ~ $\overline{R4}$**

These are keyswitch scan signal output terminals. During the scan operating, "L" level is output in sequence. All signals go to "L" level when scanning stops.

- **$\overline{C0}$ ~ $\overline{C5}$**

These are input terminals that detect the key status. Pullup resistor is included. Key matrices are formed with R0 ~ R4 terminals.

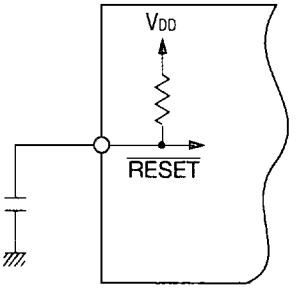


- **INT**

This is the keyscan end signal output terminal. This terminal becomes "H" level when one scan cycle ends, and returns to "L" level by a load signal after data output or the "Scan Stop" command write. (The terminal is in "L" status during reset.)

- **$\overline{\text{RESET}}$**

This is the reset signal input terminal that initializes the IC, and it is activated at "L" level. This terminal has internal pull-up resistor. The power ON reset operation is usually performed by externally connecting a capacitor.



- **SEG 1 ~ SEG 40**

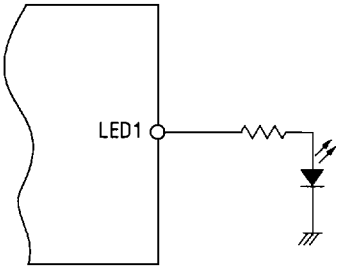
These are the output terminals for LCD display, and are connected to the segment terminals of the LCD panel. See the section on data configuration for the correspondence between SEG output and input data.

- **COM-A, COM-B**

These are output terminals for the LCD display, and are connected to a common terminal of the LCD panel.

- **LED 1**

This is an output terminal for the LED drive. The LED and current limit resistance are externally connected.



- **TEST**

This is an input terminal for IC testing. This terminal should be connected to V_{SS}.

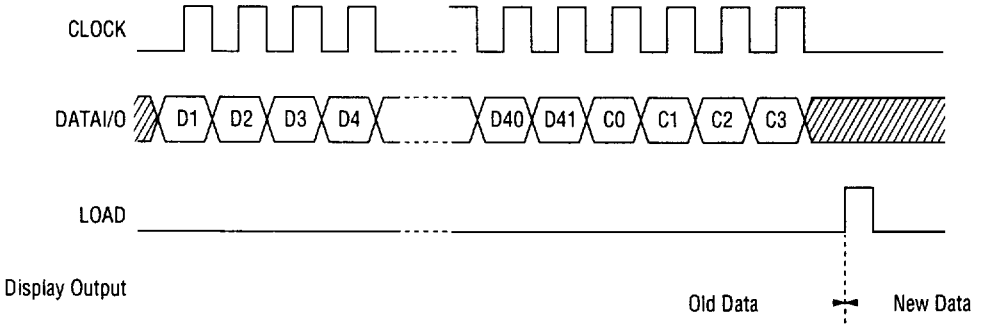
- **V_{DD}, V_{SS}**

These are power voltage supply and ground terminals.

OPERATING DESCRIPTION

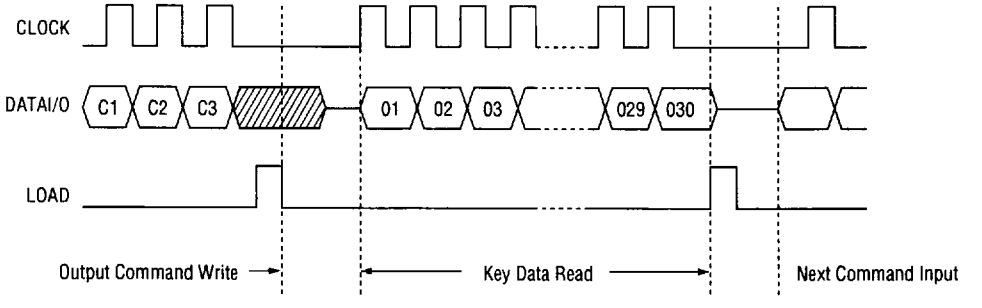
As shown in the section on data configuration, the data for display consists of data fields that correspond to segment ON/OFF and command fields which indicate display data input.

The C0 bit of the command field is set to "0" (common A) or "1" (common B) according to the common corresponding to the display data. LED display data corresponds to common A. Data input to the DATAI/O terminal is caputured by a shift register at rising edge of a clock signal, then is transferred to a data latch for display when the LOAD signal is at "H" level, and is then output through a segment driver.



KEY DATA OUTPUT

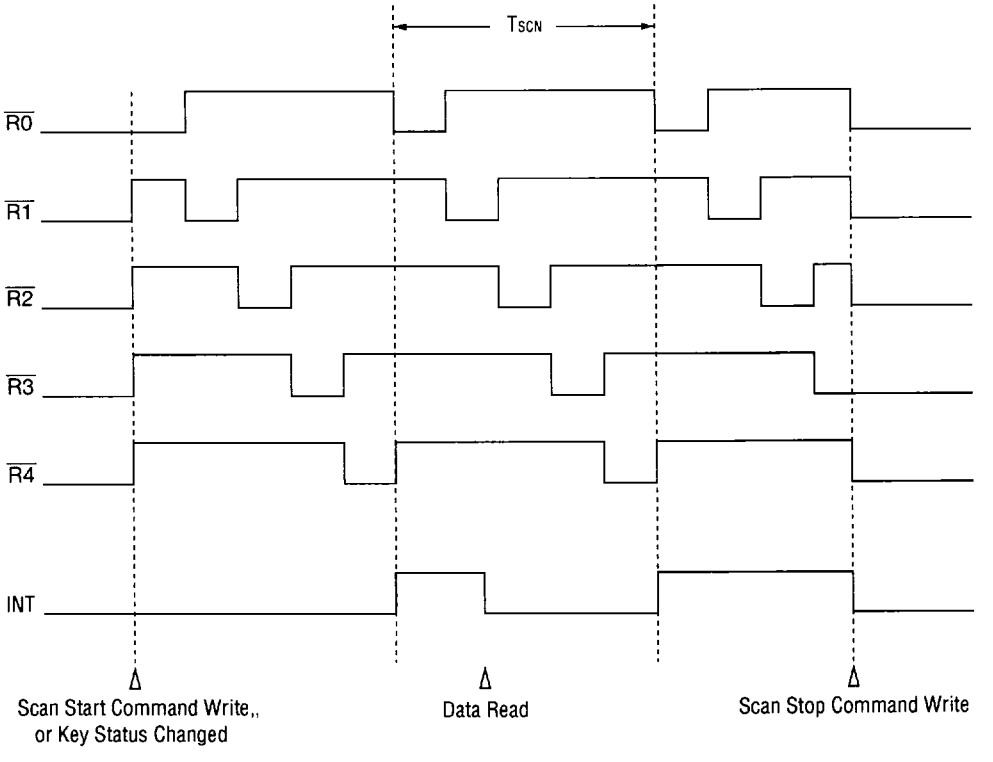
The status of a key switch is indicated by ON = 1, OFF = 0, and is read as 30 bits serial data. (For information on the sequence, see the section on data configuration.) To output data, an output command is first written. Then data is output synchronizing with the rise of a clock signal. If a LOAD pulse is then added, the DATAI/O terminal returns to the input status, and the next data or command can be input.



KEYSCAN

Keyscan starts when the key status is changed, or when the "Keyscan Start" command is written. Scan continues until the "Keyscan Stop" command is written. (Scan stops when signal is applied.)

When 1 keyscan cycle ends, the INT signal becomes "H", so this signal can be used as an interrupt flag. The INT signal is reset when either the LOAD pulse is input after key data is output, when the "Keyscan Stop" command is set, or when a reset signal is applied.

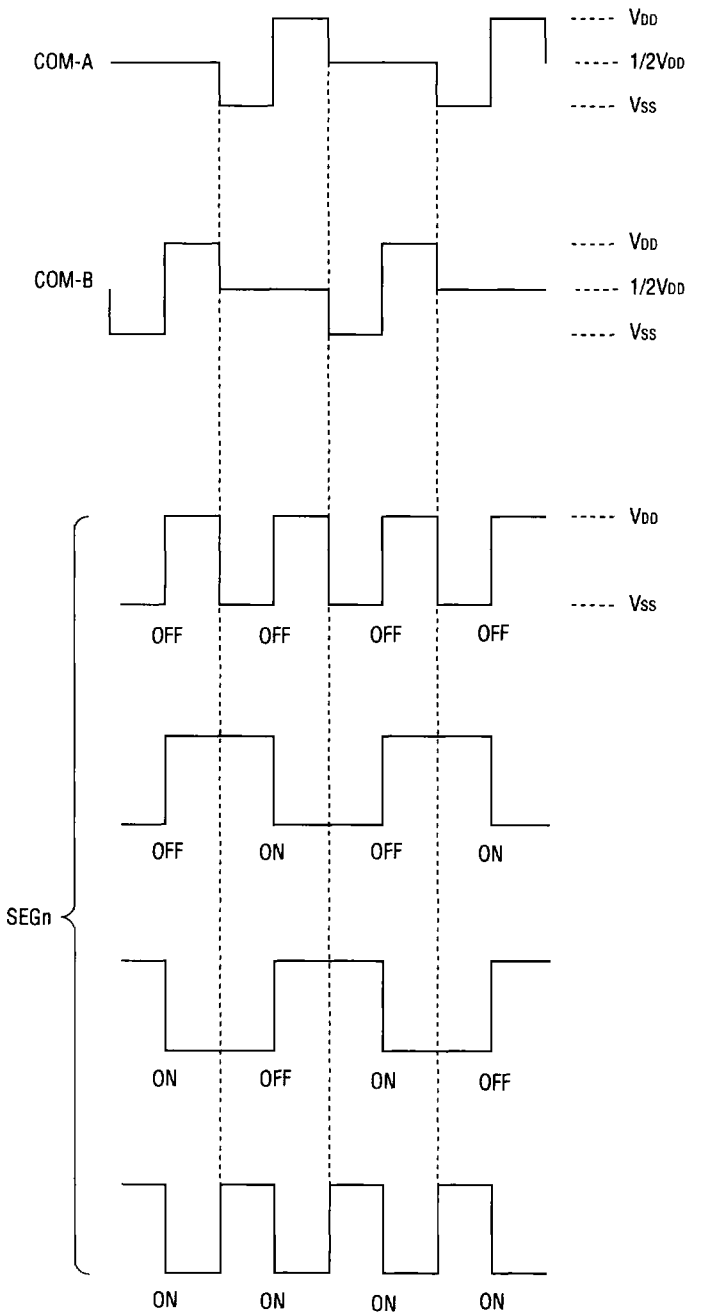


Note 1: Error recognition may occur when more than 2 key switches are pressed at the same time.

(A switch that was not pressed is recognized as being pressed.) To properly recognize the 3 or more key switches were pressed, serially insert diodes at each switch. If pressing more than 2 key switches is not allowed, a possible approach is to ignore the read data when there are 3 or more 1s in the data.

Note 2: A change of key status is detected as a change in column input (C0 ~ C5). Therefore if multiple switches which connected to the same column are pressed at the same time, a change will not be detected.

LCD DRIVE WAVEFORM



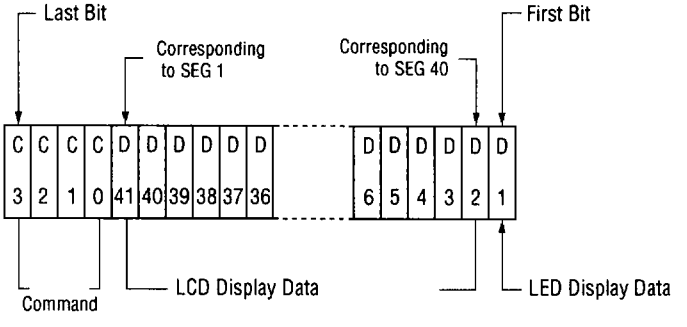
COMMAND LIST

Command Name	C3	C2	C1	C0	Operation
F1	0	0	1	0	Display Data Input (Corresponding to common A)
				1	Display Data Input (Corresponding to common B)
F2	0	1	0	x	Key Data Output
F3	0	1	1	0	Display Data Input (A) + Key Data Output
				1	Display Data Input (B) + Key Data Output
F4	1	1	0	x	Key Scan Stop + Key Data Output
F5	1	0	0	x	Key Scan Stop
F6	1	1	1	x	Key Scan Start + Key Data Output

x = Don't care

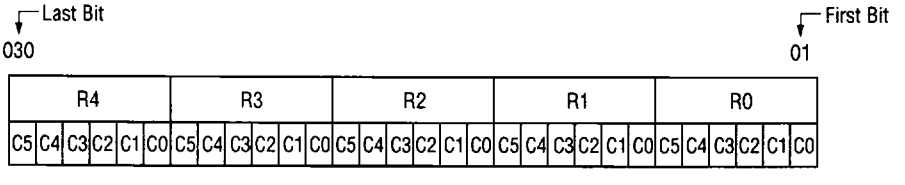
DATA CONFIGURATION

[INPUT DATA]

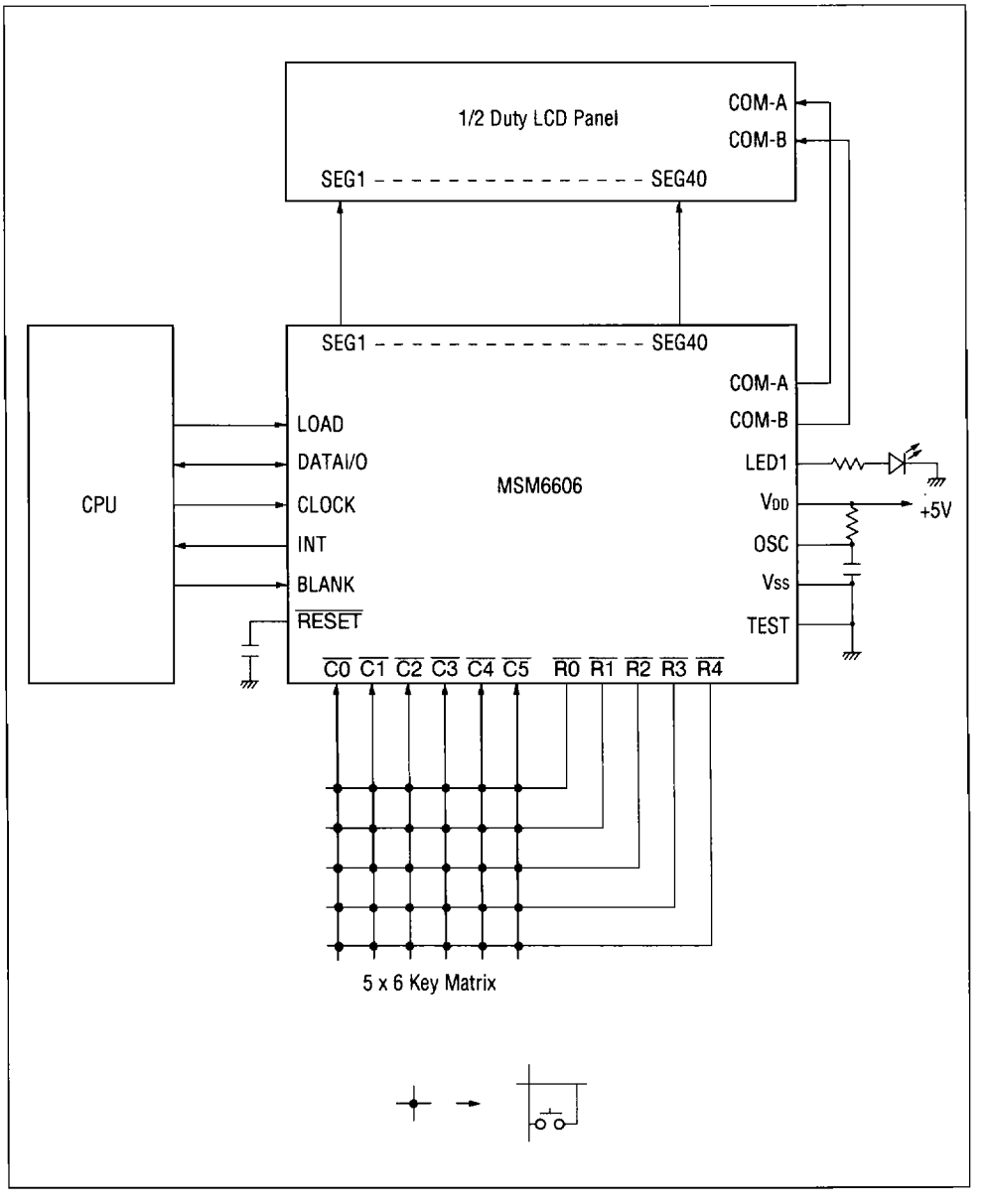


Note 1: LED data corresponds to common A side (C0 = 0).
Note 2: D1 bit is unnecessary when LED output is not used.
Note 3: Data output command F2, F4 ~ F6 becomes effective if at least 3-bit (C1 ~ C3) are input (D1 ~ D41, C0 bits are not necessary.)
Note 4: If dummy bits are necessary, add them before first bit.

[OUTPUT DATA]



APPLICATION CIRCUIT



REFERENCE DATA