OKI SEMICONDUCTOR

Dear customers,

About the change in the name such as "Oki Electric Industry Co. Ltd." and "OKI" in documents to OKI Semiconductor Co., Ltd.

The semiconductor business of Oki Electric Industry Co., Ltd. was succeeded to OKI Semiconductor Co., Ltd. on October 1, 2008. Therefore, please accept that although the terms and marks of "Oki Electric Industry Co., Ltd.", "Oki Electric", and "OKI" remain in the documents, they all have been changed to "OKI Semiconductor Co., Ltd.". It is a change of the company name, the company trademark, and the logo, etc. , and NOT a content change in documents.

October 1, 2008
OKI Semiconductor Co., Ltd.

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OKI Semiconductor

This version: Sep. 2000
Previous version: Nov. 1997

MSM6786

1/3, 1/4 DUTY LCD DRIVER WITH 4-DOT COMMON DRIVER AND 29-DOT SEGMENT DRIVER

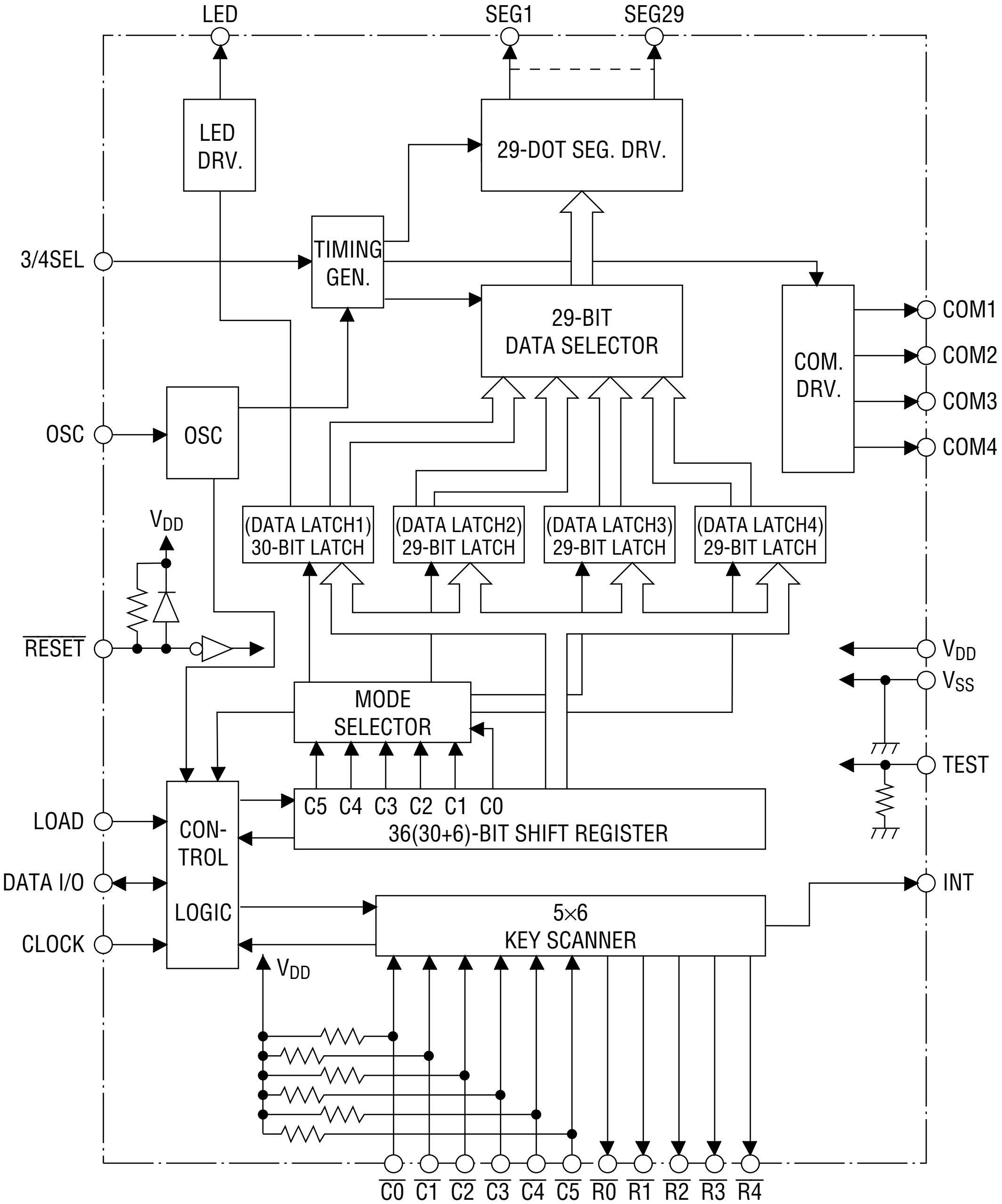
GENERAL DESCRIPTION

The MSM6786 is a dynamic display LCD driver and can be switched to 1/3 or 1/4 duty. It can dis-play up to 116 segments with 1/4 duty and up to 87 segments with 1/3 duty. It can also drive one LED directly. The built-in 5×6 key circuit allows input through a keyboard, and minimizes the number of wires between the front panel and CPU.

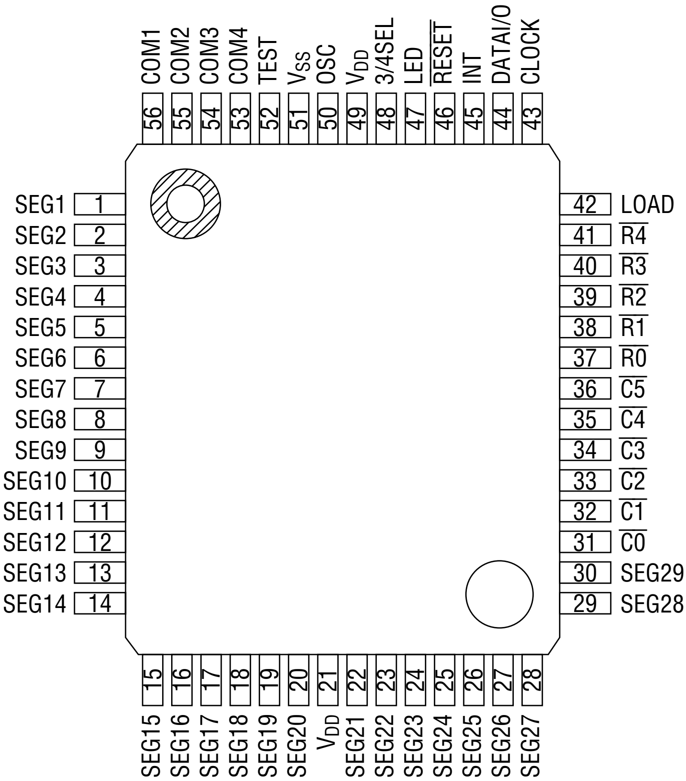
FEATURES

- Power suppy voltage : 5V±10%
- Operating temperature : –40 to +85°C
- 29-output segment driver
  - 1/4 duty dynamic drive : Up to 116 segments can be displayed
  - 1/3 duty dynamic drive : Up to 87 segments can be displayed
- One LED can be driven directly (I_O=–15mA max)
- Built-in 5×6 key scan circuit allows reading of the operation status of up to 30 switches.
- Interface with CPU is implemented by LOAD, DATA I/O and CLOCK in serial method.
- Built-in RC oscillator for LCD AC drive
- Built-in voltage dividing resistor for bias voltage generation
- Package:
  56-pin plastic QFP (QFP56-P-910-0.65-2K) (Product name : MSM6786GS-2K)

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



56-Pin Plastic QFP

ABSOLUTE MAXIMUM RATINGS

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

*1 Applied to LED output

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Range	Unit
Power Supply Voltage	V_{DD}	V_{SS}=0V	4.5 to 5.5	V
Operating Temperature	T_{op}	—	–40 to +85	°C

Specifications of External Parts (oscillation circuit)

Parameter	Symbol	Condition	Min.	Max.	Unit
Oscillation Resistor (Resistance)	R_O	—	20	82	kΩ
Oscillation Capacitor (Capacitance)	C_O	—	0.01	0.047	μF

ELECTRICAL CHARACTERISTICS

DC Characteristics

(V_{DD}=5V±10%, Ta=–40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit	Applied Pin
"H" Input Voltage	V_{IH1}	—	$0.8V_{DD}$	V_{DD}	V	*1
"L" Input Voltage	V_{IL1}	—	0	$0.2V_{DD}$	V	
"H" Input Voltage	V_{IH2}	—	$0.7V_{DD}$	V_{DD}	V	$\overline{C0}$-$\overline{C5}$
"L" Input Voltage	V_{IL2}	—	0	$0.3V_{DD}$	V	
"H" Input Current	I_{IH1}	$V_I=V_{DD}$	—	1	µA	CLOCK, LOAD 3/4SEL
"L" Input Current	I_{IL1}	V_I=0V	—	–1	µA	
"H" Input Current	I_{IH2}	$V_I=V_{DD}$	—	10	µA	DATA I/O
"L" Input Current	I_{IL2}	V_I=0V	—	–10	µA	
"L" Input Current	I_{IL3}	V_{DD}=5.0V, V_I=0V	–0.07	–0.36	mA	$\overline{C0}$-$\overline{C5}$
"L" Input Current	I_{IL4}	V_{DD}=5.0V, V_I=0V	–0.009	–0.045	mA	$\overline{RESET}$
Segment Output Voltage	V_{OS0}	I_O=–10µA	V_{DD}–0.8	—	V	SEG1-SEG29
	V_{OS1}	I_O=±10µA	$2/3V_{DD}$–0.8	$2/3V_{DD}$+0.8	V	
	V_{OS2}	I_O=±10µA	$1/3V_{DD}$–0.8	$1/3V_{DD}$+0.8	V	
	V_{OS3}	I_O=10µA	—	0.8	V	
Common Output Voltage	V_{OC0}	I_O=–10µA	V_{DD}–0.77	—	V	COM1-COM4
	V_{OC1}	I_O=±10µA	$2/3V_{DD}$–0.77	$2/3V_{DD}$+0.77	V	
	V_{OC2}	I_O=±10µA	$1/3V_{DD}$–0.77	$1/3V_{DD}$+0.77	V	
	V_{OC3}	I_O=10µA	—	0.77	V	
"H" Output Voltage	V_{OH1}	I_O=–15mA	V_{DD}–1.5	—	V	LED
"L" Output Voltage	V_{OL1}	I_O=0.1mA	—	0.4	V	
"H" Output Voltage	V_{OH2}	I_O=–0.4mA	V_{DD}–0.4	—	V	DATA I/O INT
"L" Output Voltage	V_{OL2}	I_O=0.4mA	—	0.4	V	
"H" Output Voltage	V_{OH3}	I_O=–50µA	2.5	—	V	$\overline{R0}$-$\overline{R4}$
"L" Output Voltage	V_{OL3}	I_O=1.0mA	—	0.4	V	
Supply Current	I_{DD}	*2	—	0.4	mA	V_{DD}

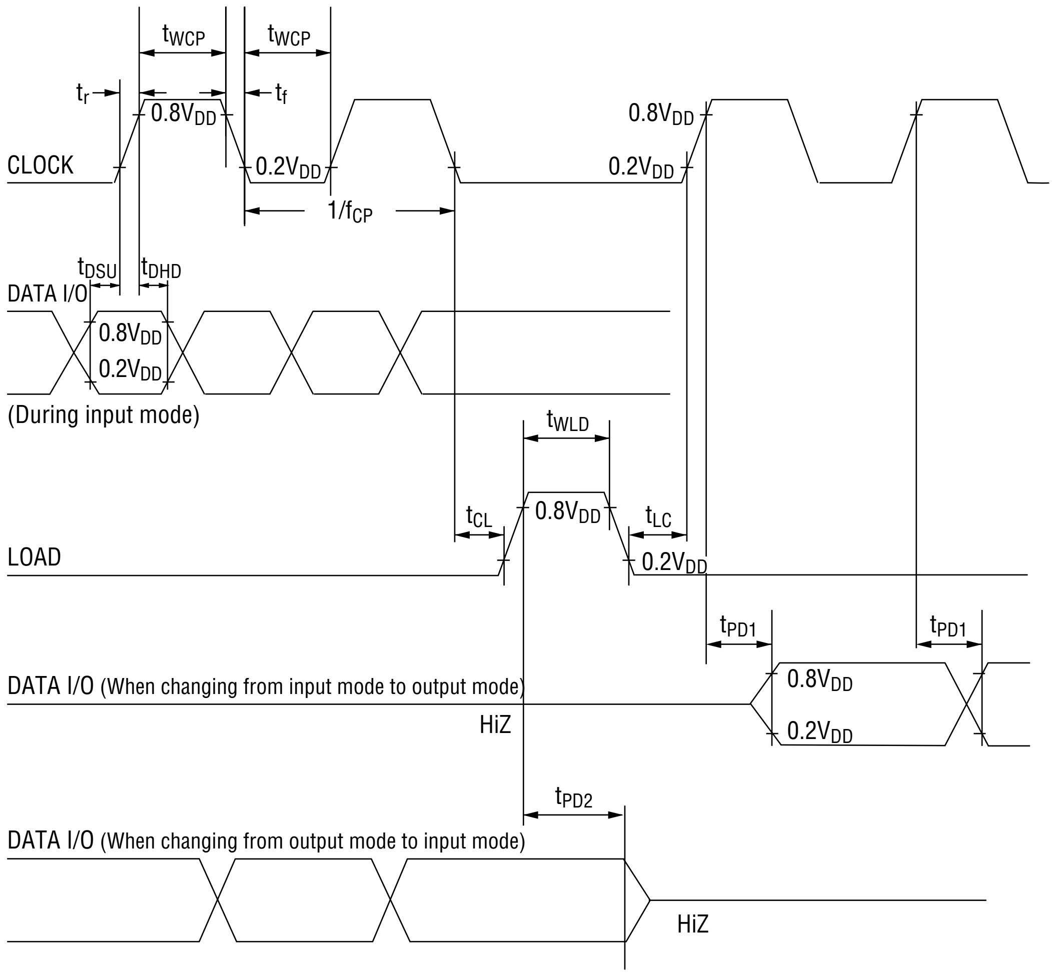
*1 CLOCK, LOAD, DATA I/O, $\overline{RESET}$ and 3/4SEL

*2 C_O = 0.022 µF, R_O = 33 kΩ, no load

Switching Characteristics

(V_{DD}=5V±10%, Ta=–40 to +85°C)

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



(The charging and discharging time during high impedance depends on trace resistance and stray capacitance.)

FUNCTIONAL DESCRIPTION

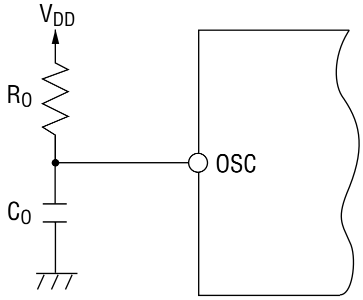
Pin Functional Description

OSC (Pin 50)

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

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

$f_{FRM} = f_{OSC}/24$, $T_{SCN} = 20/f_{OSC}$



DATA I/O (Pin 44)

This is a serial data input/output pin. The pin is in output state from the first shift clock rise after key data output command writing, to the load pulse rise, and in input state otherwise. (The pin is in input state during reset.)
The relationship between the data levels of this pin and the operations is shown below.

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

CLOCK (Pin 43)

This is an input pin for the shift clock. DATA I/O pin data is either input or output in synchroniza-tion with each rising clock edge.

LOAD (Pin 42)

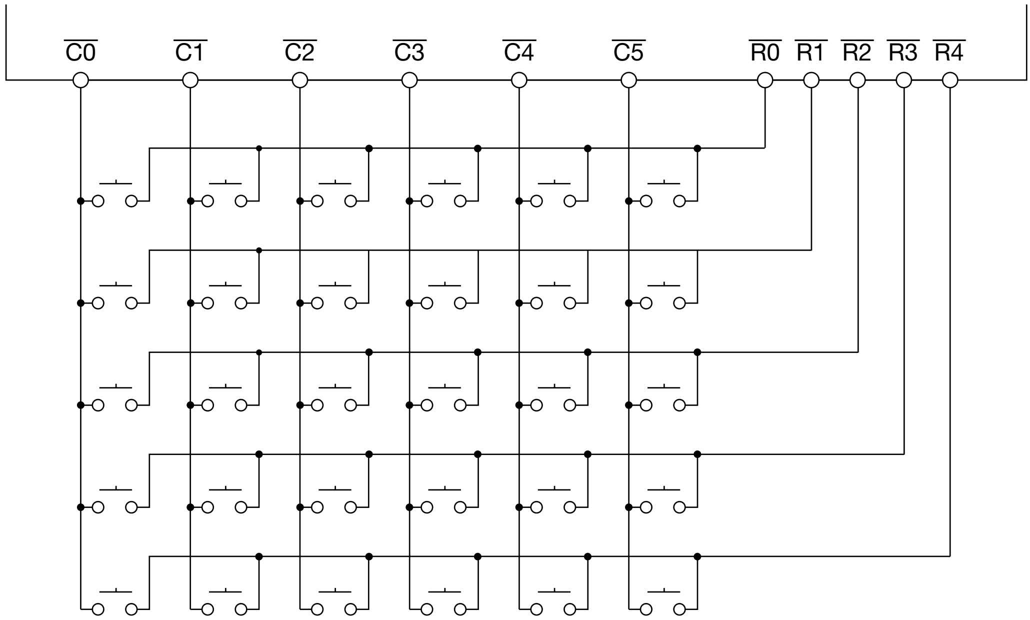
This is a load pulse input pin used to transfer serial input data to a latch for display, to write commands, or to release the DATA I/O pin in output state.

$\overline{\text{R0}}$ – $\overline{\text{R4}}$ (Pin 37-Pin 41)

These are key switch scan pulse output pins. During the scan operating, "L" level is output in sequence. All pluses go to "L" level when scanning stops.

$\overline{\text{C0}}$ – $\overline{\text{C5}}$ (Pin 31-Pin 36)

These are input pins that detect the key status. These pins have pull-up resistors. Key matrices are formed with pins $\overline{\text{R0}}$ – $\overline{\text{R4}}$.

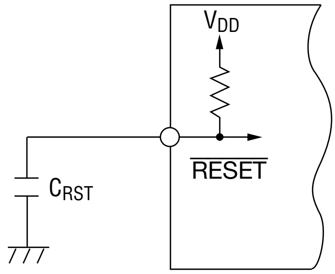


INT (Pin 45)

This is the keyscan end signal output pin. This pin becomes "H" when one scan cycle is completed, and returns to "L" by a load pulse after data output or when the "Scan Stop" command is written. (The pin is in "L" status during reset.)
If this pin is not used, leave it unconnected.

$\overline{\text{RESET}}$ (Pin 46)

This is a reset signal input pin that intializes the IC, and is activated at "L" level. This pin has an internal pull-up resistor. The power ON reset usually operates by externally connecting a capacitor.



SEG1 – SEG29 (Pin 1-Pin 20, Pin 22-Pin 30)

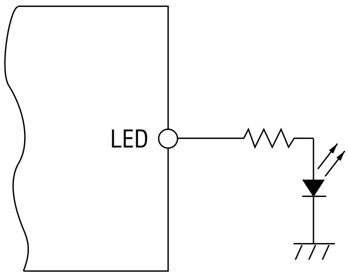
These are the output pins for LCD, and are connected to the segment pins of the LCD panel. See the section on data configuration for the relationship between SEG output and input data.

COM1 – COM4 (Pin 56-Pin53)

These are output pins for the LCD, and are connected to common pins of the LCD panel. When 1/3 duty is selected, COM4 pin should be left unconnected. See the section on data configuration of common output and input data.

LED (Pin 47)

This is an output pin for the LED drive. The LED and current limiting resistor are externally connected.



3/4SEL (Pin 48)

This is a duty select input pin. When "H" level is input, 1/3 duty is selected and when "L" level is input, 1/4 duty is selected.

TEST (Pin 52)

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

V_{DD}, V_{SS} (Pin 21, 49, 51)

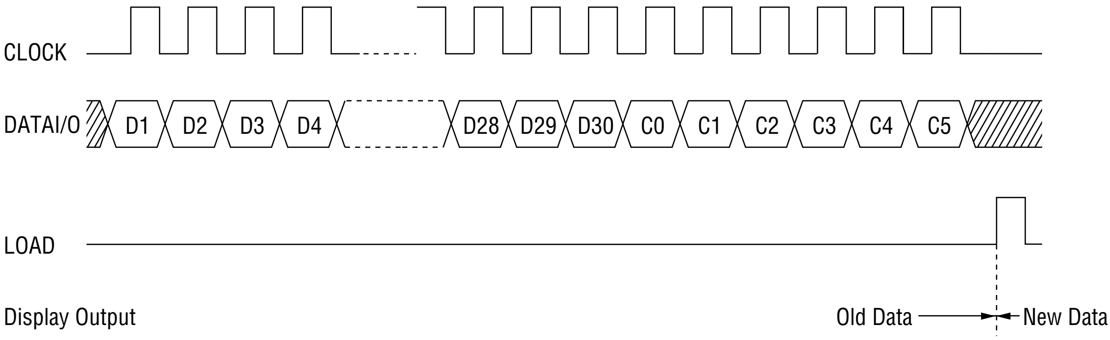
These are power voltage supply and ground pins.

Operating Description

Display data input

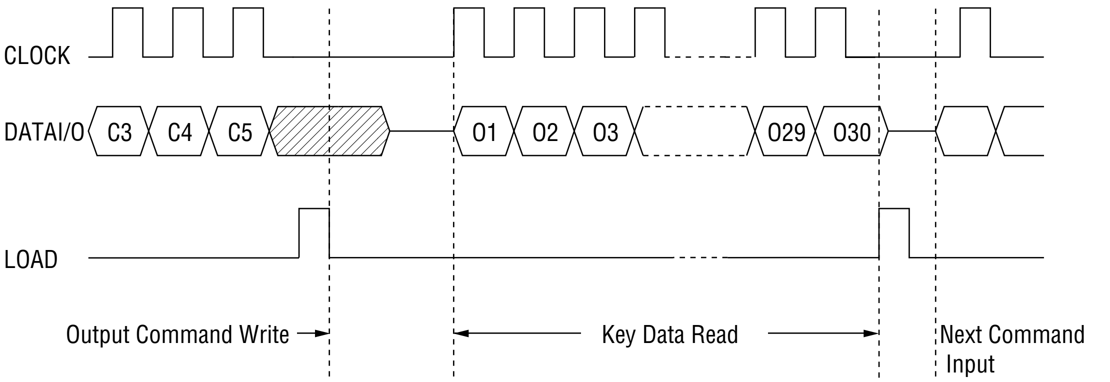
As shown in the section on data configuration, the data for display consists of data fields that correspond to segment ON/OFF and command fields which indicate display data input.

Set the bits C0 to C1 of the command field to "0" or "1" according to the common to which the display data corresponds. To the other four bits, set the display data input commands. LED display data corresponds to common 1. Data input to the DATA I/O pin is saved in a shift register at the rising edge of the CLOCK pulse, and is transferred to a data latch for display while the LOAD pulse is at "H" level, and is then output through a segment driver.



Key data output

The state 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, the output command must be written, which causes the data to be output in synchronization with the rising edge of the CLOCK pulse. By inputting a LOAD pulse after that, the DATA I/O pin returns to the input state, and the next data or command can be input. (If a LOAD pulse is applied earlier than the 30th data, the key data is output only by the number of the CLOCK pulse. If CLOCK pulses more than 30 data bits are applied, 30 data bits of key data are circulated.)



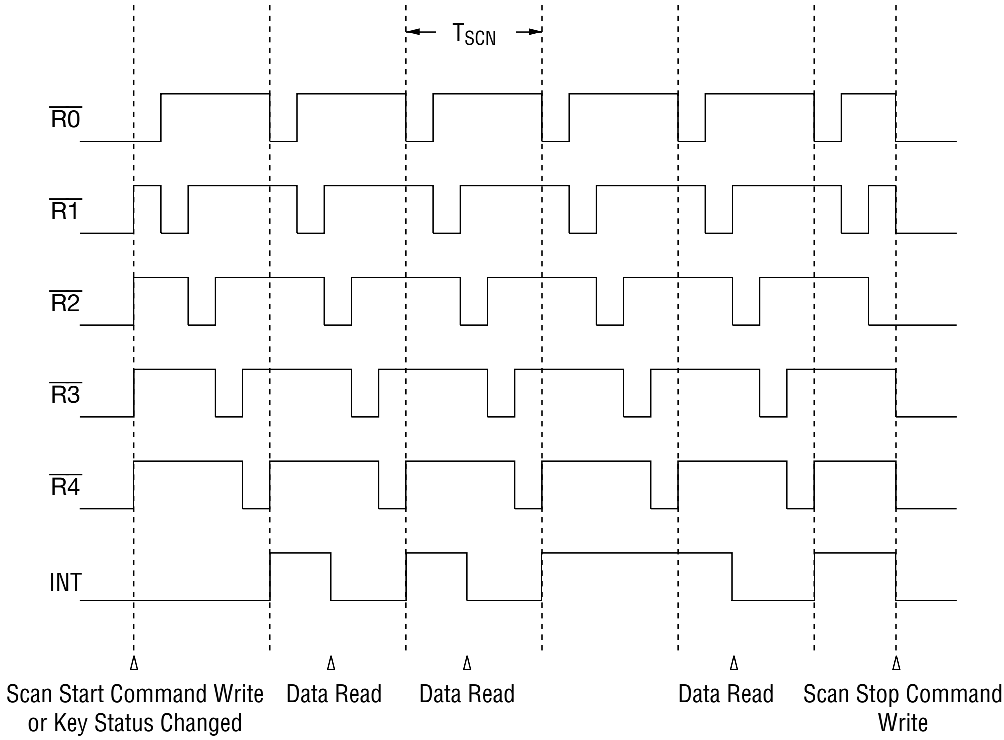
Note1 : The last key data must be read before the LOAD pulse rises.

Note2 : Upon swiching from output mode to input mode, the state of the DATA I/O pin is unstable for the duration of 300 ns after the rising of LOAD pulse. For this reason, never input data to the DATA I/O pin during this period.

Keyscan

Keyscan starts when the key state is changed or when the "Keyscan Start" command is written. Scan continues until the "Keyscan Stop" command is written. (When powered on, the power-ON reset sets at scan stop state.)

When 1 keyscan cycle (T_{SCN}) ends, the INT signal becomes "H", so this signal can be used as an interrupt flag, which is dependent on switching conditions of keys. 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.

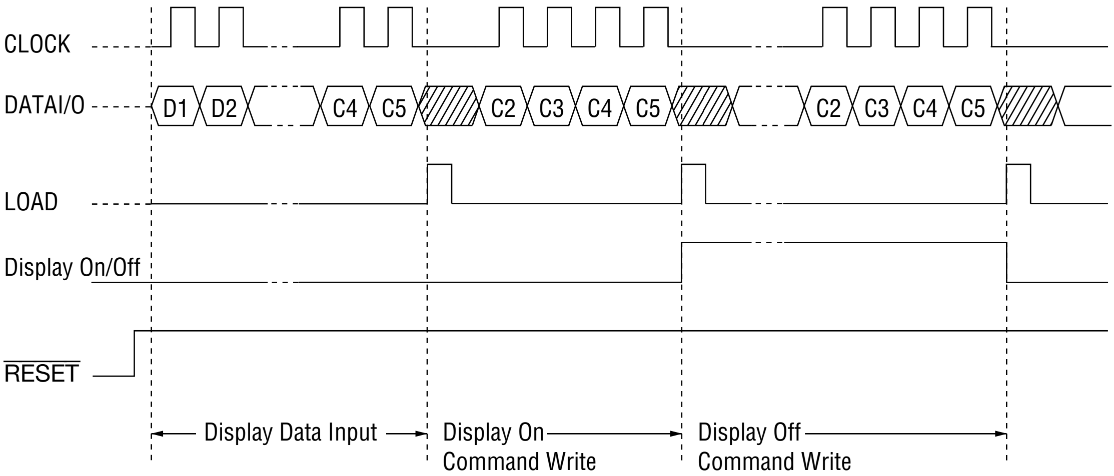


Notes : 1. A recognition error may occur if 3 or more key switches are pressed at the same time. (A switch that was not pressed is recognized as being pressed.) To properly recognize 3 or more key switches as being pressed at the same time, serially insert diodes at each switch. In order not to recognize 3 or more key switches as being pressed at the same time, a possible approach is to program the software so that the read data will be ignored when there are 3 or more ones in the data.
The device recognizes simultaneous pressing of 2 key switches. However, take Note 2 into consideration.

2. A change of key state is detected as a change in column input ($\overline{C0}$ - $\overline{C5}$). Therefore even if multiple switches connected to the same column are pressed at the same time, nothing will be detected as a change.

Display on, Display off

In power ON reset state, display will go out. To turn the display on, write the display ON command. The display and LED can go out by writing the display OFF command, irrespective of display data.
Display ON command releases the display OFF state. By writing this command, display will return to original state.



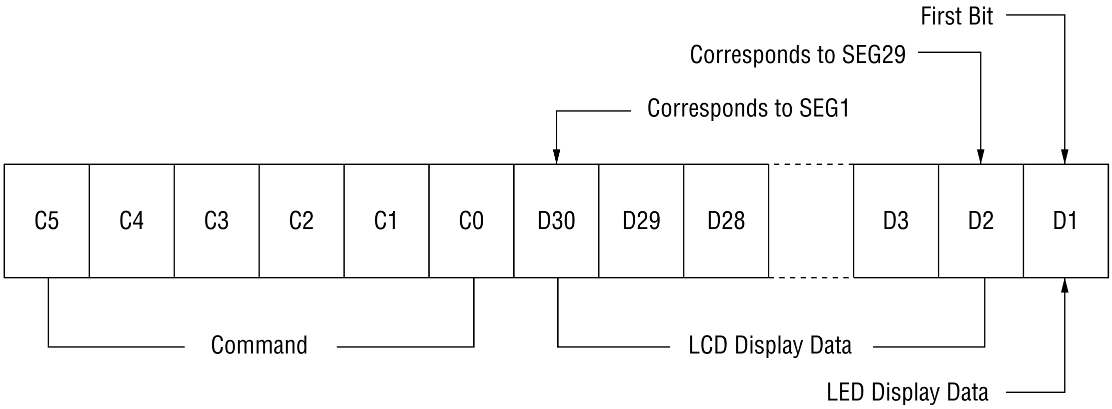
Command List

Command Name	C5	C4	C3	C2	C1	C0	Operation
F1	0	0	1	0	0	0	Display Data Input (Corresponding to Common 1)
						1	Display Data Input (Corresponding to Common 2)
					1	0	Display Data Input (Corresponding to Common 3)
						1	Display Data Input (Corresponding to Common 4)
F2	0	1	0	×	×	×	Key Data Output
F3	0	1	1	0	0	0	Display Data Input (1) + Key Data Output
						1	Display Data Input (2) + Key Data Output
					1	0	Display Data Input (3) + Key Data Output
						1	Display Data Input (4) + Key Data Output
F4	1	0	1	0	×	×	Display Off
F5	1	0	1	1	×	×	Display On
F6	1	1	0	×	×	×	Key Scan Stop + Key Data Output
F7	1	0	0	×	×	×	Key Scan Stop
F8	1	1	1	×	×	×	Key Scan Start + Key Data Output

× : Don't care

Data Configuration

(Input data)



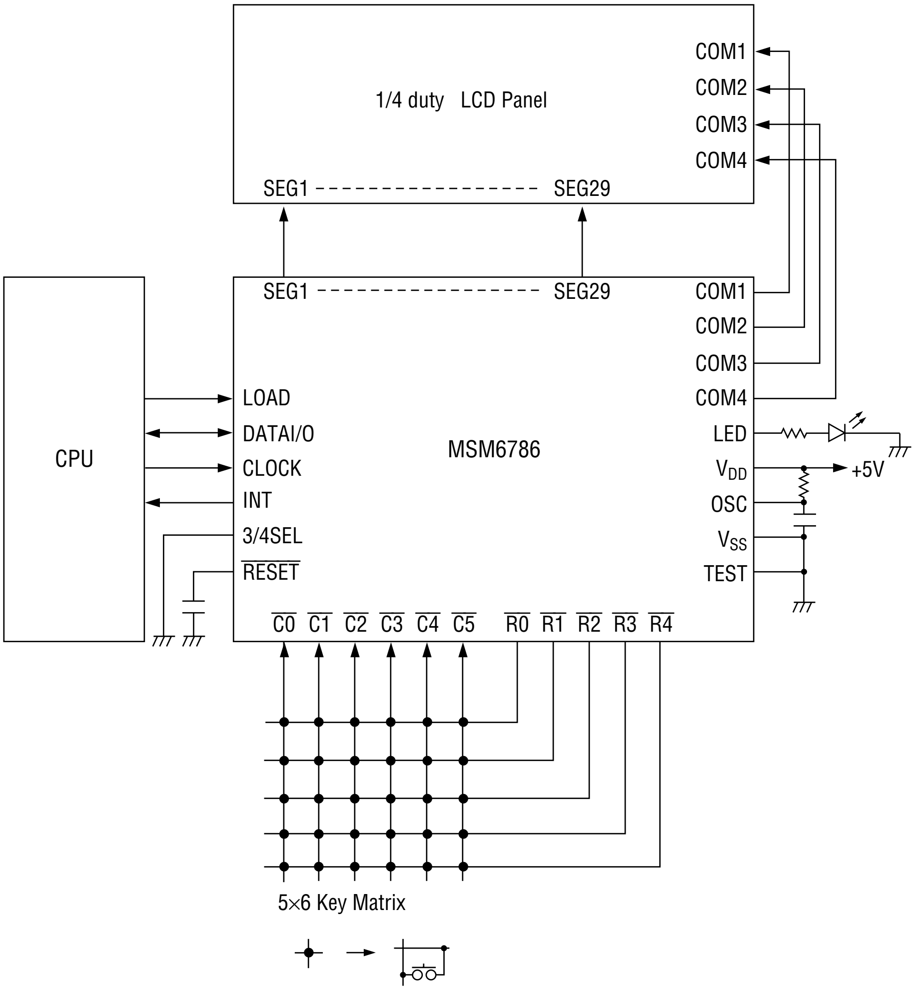
Notes : 1. LED data corresponds to common 1 side (C0, C1 = 0).
2. D1 bit is unnecessary when LED output is not used.
3. Data output commands F2, F6 – F8 become effective if at least 3 bits (C3 – C5) are input. (D1 – D30 and C0 – C2 bits are not necessary.)
Command F4 and command F5 become effective if at least 4 bits (C2 - C5) are input. (D1 - D30, C0 and C1 bits are not necessary.)
4 . If dummy bits are necessary, add them before first bit.

(Output data)

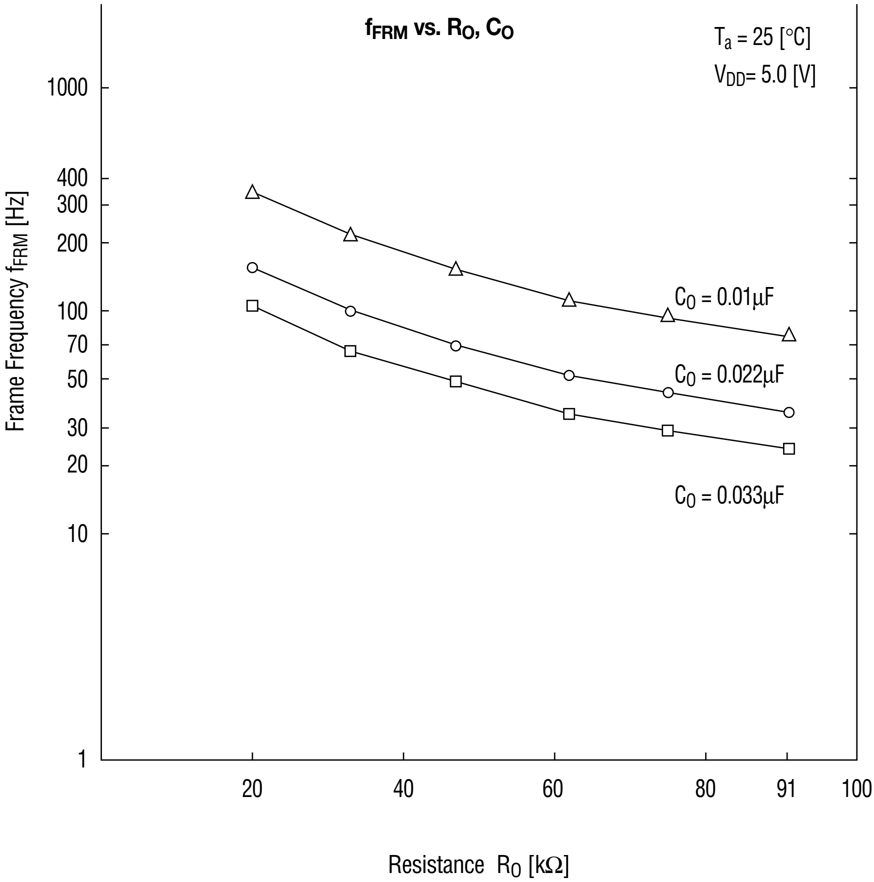
Last Bit 30 — First Bit 1

R4						R3						R2						R1						R0					
C5	C4	C3	C2	C1	C0	C5	C4	C3	C2	C1	C0	C5	C4	C3	C2	C1	C0	C5	C4	C3	C2	C1	C0	C5	C4	C3	C2	C1	C0

APPLICATION CIRCUIT



REFERENCE DATA



Frame frequency Characteristics

The scanning period T_{SCN} is defined by the following equation:

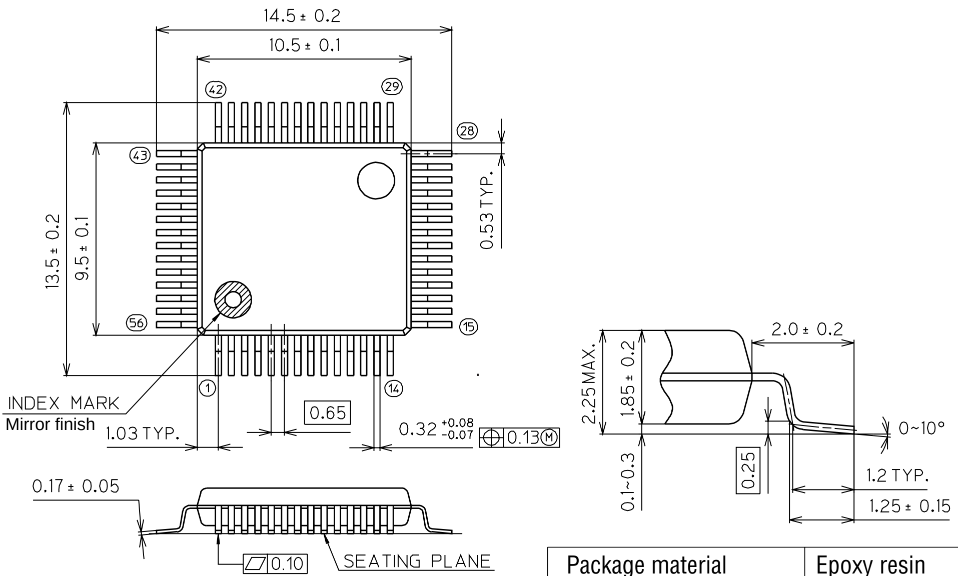
$$T_{SCN} = \frac{5}{6f_{FRM}} \text{ [ms]}$$

$$= \frac{20}{f_{OSC}} \text{ [ms]}$$

PACKAGE DIMENSIONS

(Unit : mm)

QFP56-P-910-0.65-2K



Oki Electric Industry Co., Ltd.

Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating (≥5 μm)
Package weight (g)	0.43 TYP.
Rev. No./Last Revised	4/Nov. 28, 1996

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).

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1. The information contained herein can change without notice owing to product and/or technical improvements. Before using the product, please make sure that the information being referred to is up-to-date.

2. The outline of action and examples for application circuits described herein have been chosen as an explanation for the standard action and performance of the product. When planning to use the product, please ensure that the external conditions are reflected in the actual circuit, assembly, and program designs.

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