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ML9473

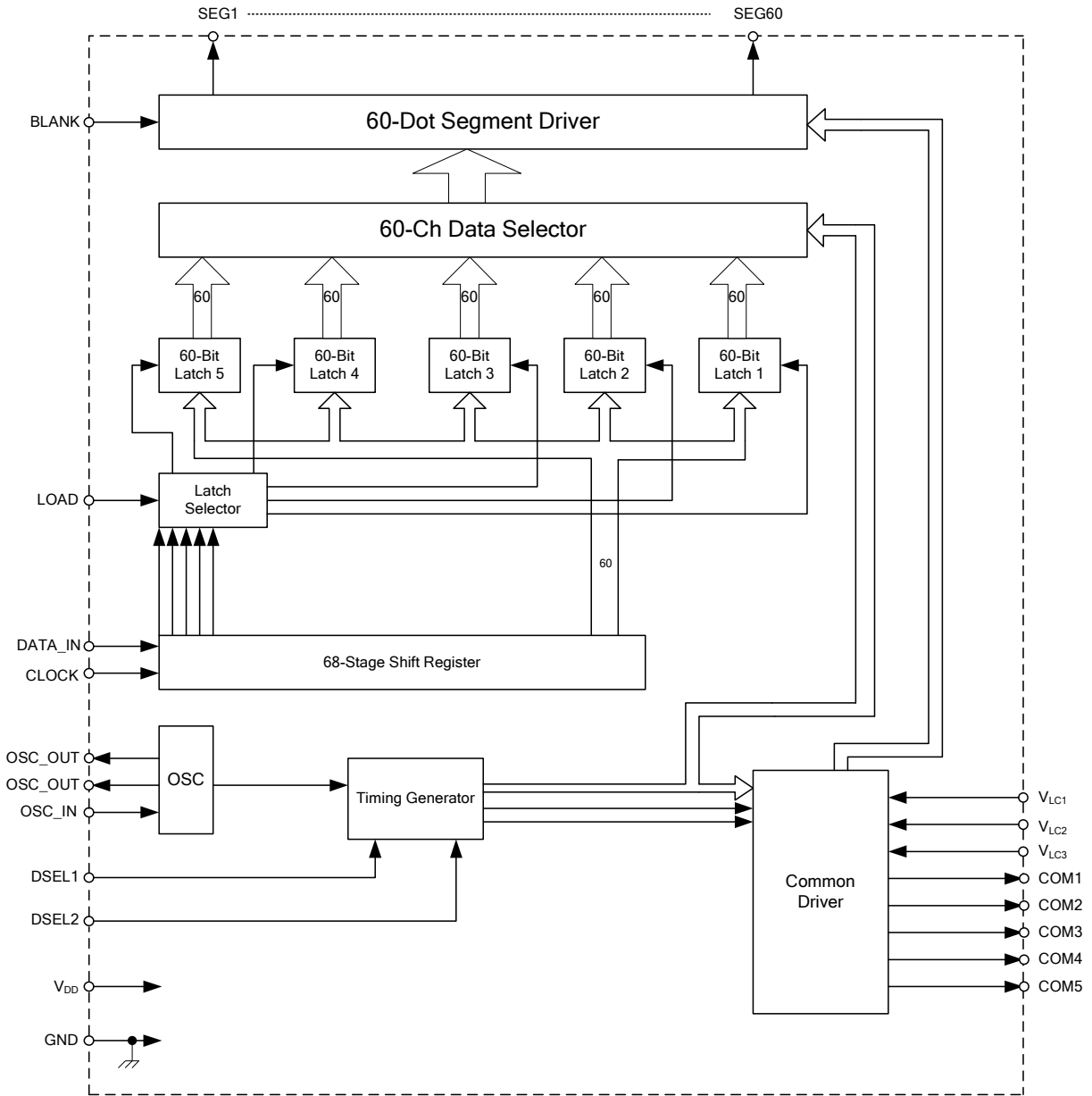**1/3, 1/4, 1/5 Duty 60 Output LCD Driver**

GENERAL DESCRIPTION

The ML9473 is a LCD driver for dynamic display providing 3-duty-switchable pins (1/3, 1/4, 1/5 duty).   It can directly drive LCDs of up to 300, 240 and 180 segments when 1/5, 1/4 and 1/3 duty are selected respectively.
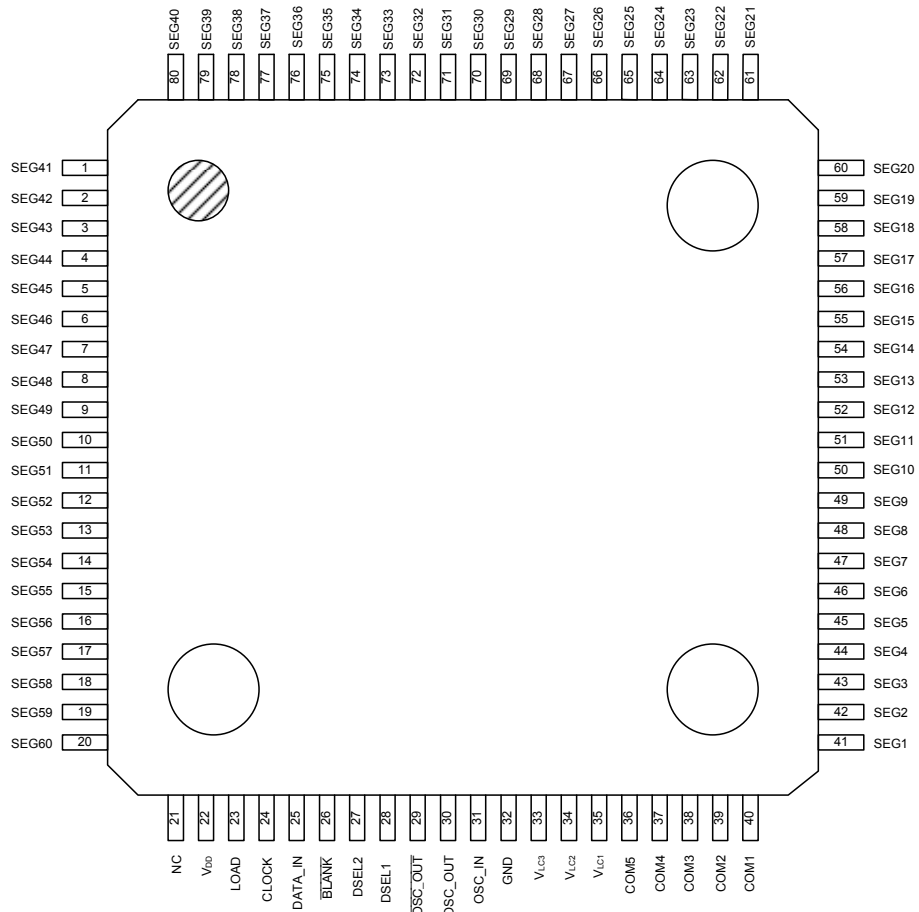
FEATURES

• Operatin g range
   Supply voltage   : 3.0 to 5.5 V
   Operating temperature range   : −40 to + 105°C
• Segment output   : 60 pins
   1/5 duty   : Up to 300 segments can be displayed.
   1/4 duty   : Up to 240 segments can be displayed.
   1/3 duty   : Up to 180 segments can be displayed.
• Serial transfer clock frequency   : 4 MHz
• Serical interface with CPU   :Through three input pins (DATA_IN, LOAD, and CLOCK)
• Built-in oscillator circuit for COMMON signals
• One-to-one correspondence between input data and output data
   When input data is at "H" level   : Display goes on.
   When input data is at "L" level   : Display goes off.
• The entire display can be turned off. ($\overline{\text{BLANK}}$ pin)
• P   ackage options
   80-pin plastic TQFP (TQFP80-P-1212-0.50-K) (Product name: ML9473TB)

BLOCK DIAGRAM

PIN CONFIGURATION (TOP VIEW)

80-Pin Plastic TQFP

PIN DESCRIPTION

Symbol T	ype	Description
OSC_IN OSC_OUT $\overline{OSC\_OUT}$	I O O	Pins for oscillation.　The oscillator circuit is configured by externally connecting two resistors and a capacitor.　Make the wiring length as short as possible, because the resistor connected to the OSC_IN pin has a higher value and the circuit is susceptible to external noise.
DATA_IN	I	Serial data input pin. The display goes on when input data is at a "H" level, and it goes off when input data is at a "L" level.
CLOCK	I	Shift clock input pin.　Data from the DATA_IN pin is transferred in synchronization with the rising edge of the shift clock.
LOAD	I	Load signal input pin.　Serially input data is transferred to the 60-bit latch at "H" level of this load signal, then held at "L" level.
$\overline{BLANK}$	I	Input pin that turns off all segments.　The entire display goes off when "L" level is applied to this pin.　The display returns to the previous state when "H" level is applied.
DSEL1 DSEL2	I I	Input pins to select 1/3, 1/4, or 1/5 duty.　Following shows how each duty is selected. <table><tr><td>DSEL2 D</td><td>SEL1</td><td>Duty selected</td></tr><tr><td>L</td><td>L</td><td>1/3</td></tr><tr><td>L</td><td>H</td><td>1/4</td></tr><tr><td>H</td><td>X</td><td>1/5</td></tr></table>X: Don't care
COM1 to COM5	O	Display output pins for LCD.　These pins are connected to the COMMON side of the LCD panel.
SEG1 to SEG60	O	Display output pins for LCD.　Theses pins are connected to the SEGMENT side of the LCD panel.　For the correspondence between the output of these pins and input data, see the "Data Structure" Section.
V_{LC1}, $V_{LC2,}$ V_{LC3}	—	Bias pins for LCD driver. Through these pins, bias voltages for the LCD are externally supplied.　The bias potential must meet the following condition: $$V_{DD} > V_{LC1} \geq V_{LC2} > V_{LC3} = GND$$
V_{DD}, GND	—	Supply voltage pin and ground pin.

Note: Built-in schmitt circuit is used for all input pins.

ML9473

ABSOLUTE MAXIMUM RATINGS

Parameter S	ymbol	Condition	Rating	Unit
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	
Storage Temperature	T_{STG}	—	−55 to 150	°C
Power Dissipation	P_D	Ta < 105°C	650	mW
Output Current	I_O	—	−2.0 to 2.0	mA

RECOMMENDED OPERATING CONDITIONS

Parameter S	ymbol	Condition	Range	Unit
Supply Voltage	V_{DD}	V_{LC3} = GND	3.0 to 5.5	V
CLOCK Frequency	f_{CP}	—	0.75 to 4	MHz
Operating Temperature	Ta	—	−40 to 105	°C

Oscillator Circuit

Parameter S	ymbol	Applicable pin	Condition	Min.	Max.	Unit
Oscillator Resistance	R_0	$\overline{OSC\_OUT}$	—	20	120	kΩ
Oscillator Capacitance	C_0	OSC_OUT	—	0.00047	0.01	μF
Current Limiting Resistance	R_1	OSC_IN	—	62	360	kΩ
Common Signal Frequency	f_{COM}	COM1 to COM5	—	25	250	Hz

Note: See Section, "Reference Data", for the resistor and capacitor values in the table.

RC Values in Oscillator Circuit

Parameter	Symbol	Applicable pin	1/3 duty	1/4 duty	1/5 duty	Unit
Oscillator Resistance	R_0	$\overline{OSC\_OUT}$	68	51	43	kΩ
Oscillator Capacitance	C_0	OSC_OUT	0.001	0.001	0.001	μF
Current Limiting Resistance	R_1	OSC_IN	220	160	130	kΩ

Example of an oscillator circuit:

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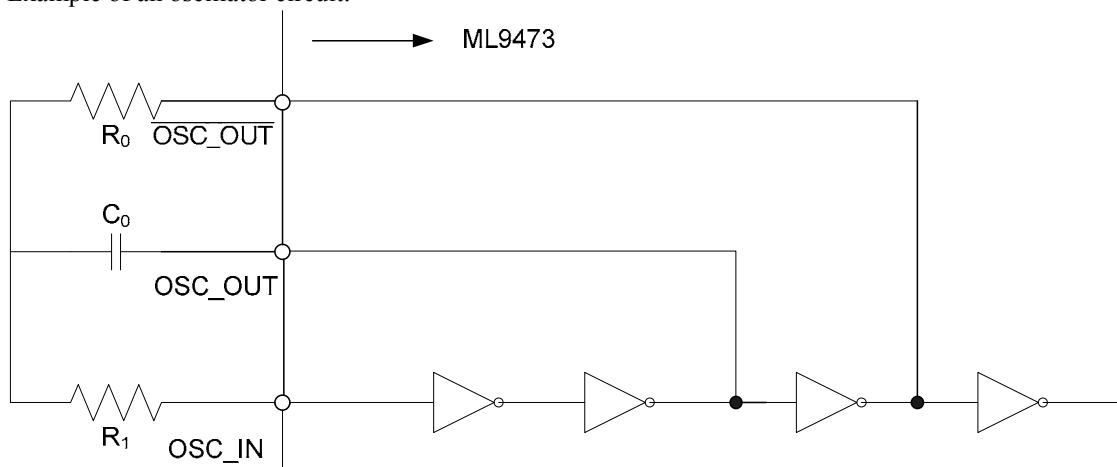
ELECTRICAL CHARACTERISTICS

DC Characteristics

(V_{DD} = 3.0 to 5.5 V, Ta = –40 to +105°C, unless otherwise specified)

Parameter Sy	mbol	Applicable pin	Condition			Min.	Max.	Unit
"H" Input Voltage 1	V_{IH1}	CLOCK, OSC_IN	— 0.85			V_{DD}	V_{DD} V	
"L" Input Voltage 1	V_{IL1}	CLOCK, OSC_IN	— G			ND	0.15 V_{DD}	V
"H" Input Voltage 2	V_{IH2}	*1	—			0.8 V_{DD}	V_{DD}	V
"L" Input Voltage 2	V_{IL2}	*1	—			GND	0.2 V_{DD}	V
"H" Input Current	I_{IH}	All input pins	V_{DD} = 5.5 V, $V_I = V_{DD}$			—	10	μA
"L" Input Current	I_{IL}	All input pins	V_{DD} = 5.5 V, V_I = 0 V			–10	—	μA
COMMON Output Voltage	V_{OC0a}	COM1 - COM5	V_{DD} = 3.0 V	I_O = –100 μA		V_{DD} –1	—	V
	V_{OC1}			I_O = ±100 μA	*3	V_{LC1} –1	V_{LC1} +1	V
	V_{OC2}			I_O = ±100 μA	*4	V_{LC2} –1	V_{LC2} +1	V
	V_{OC3}			I_O = +100 μA *5		—	V_{LC3} +1	V
Segment Output Voltage	V_{OS0}	SEG$_1$ - SEG$_{60,}$	V_{DD} = 3.0 V	I_O = –10 μA		V_{DD} –1	—	V
	V_{OS1}			I_O = ±10 μA	*3	V_{LC1} –1	V_{LC1} +1	V
	V_{OS2}			I_O = ±10 μA	*4	V_{LC2} –1	V_{LC2} +1	V
	V_{OS3}			I_O = +10 μA *5		—	V_{LC3} +1	V
Supply Current	I_{DD}	V_{DD}	V_{DD} = 5.0 V, no load. *2			—	0.5	mA

*1   Applies to all input pins excluding CLOCK and OSC_IN.
*2 R $_0$ = 51 kΩ R $_1$ = 160 kΩ C_0 = 0.001 μF
*3 V $_{LC1}$ = 2.0V
*4 V $_{LC2}$ = 1.0V
*5 V $_{LC3}$ = 0V

AC Characteristics

(V$_{DD}$ =3.0 to 5.5V, Ta = –40 to +105°C, unless otherwise specified)

Parameter S	ymbol	Condition	Min.	Typ.	Max.	Unit
Clock "H" Time	t$_{WHC}$ —		70	—	—	ns
Clock "L" Time	t$_{WLC}$ —		70	—	—	ns
Data Set-up Time	t$_{DS}$ —		50	—	—	ns
Data Hold Time	t$_{DH}$ —		50	—	—	ns
Load "H" Time	t$_{WHL}$ —		100	—	—	ns
Clock-to-load Time	t$_{CL}$ —		100	—	—	ns
Load-to-Clock Time	t$_{LC}$ —		100	—	—	ns
Clock Rise time, Fall time	t$_{R1}$, t$_{F1}$ —		—	—	50	ns
OSC_IN Input Frequency	f$_{OSC}$ —		—	—	20	kHz
OSC_IN "H" Time	t$_{WHO}$ —		20	—	—	µs
OSC_IN "L" Time	t$_{WLO}$ —		20	—	—	µs
OSC_IN Rise time, Fall time	t$_{R2}$, t$_{F2}$ —		—	—	100	ns
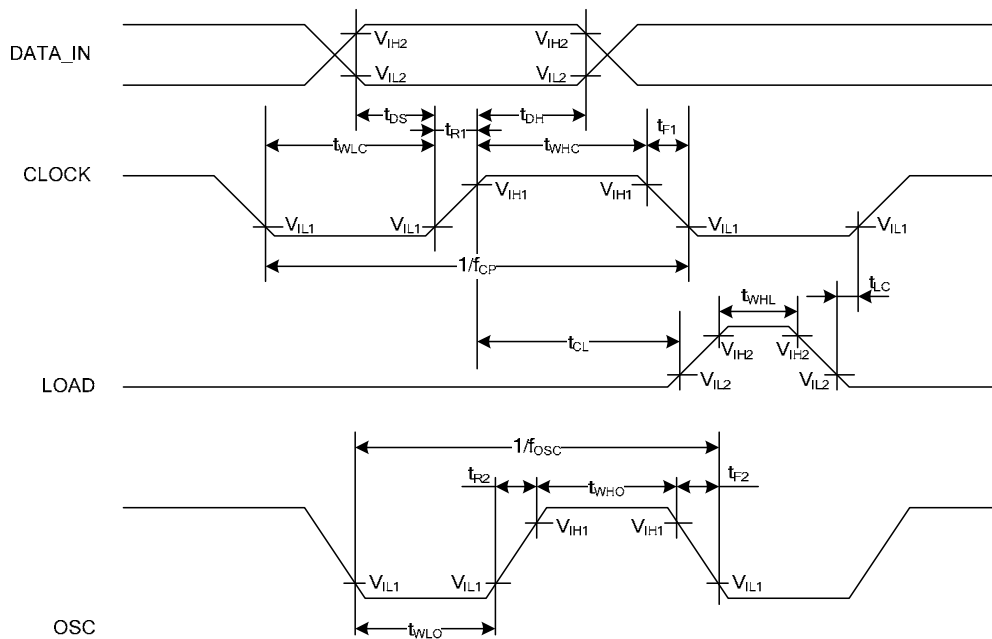
(V$_{IH1}$ = 0.85V$_{DD}$ V$_{IL1}$ = 0.15V$_{DD}$)
(V$_{IH2}$ = 0.8V$_{DD}$ V$_{IL2}$ = 0.2V$_{DD}$)

POWER-ON/OFF TIMING
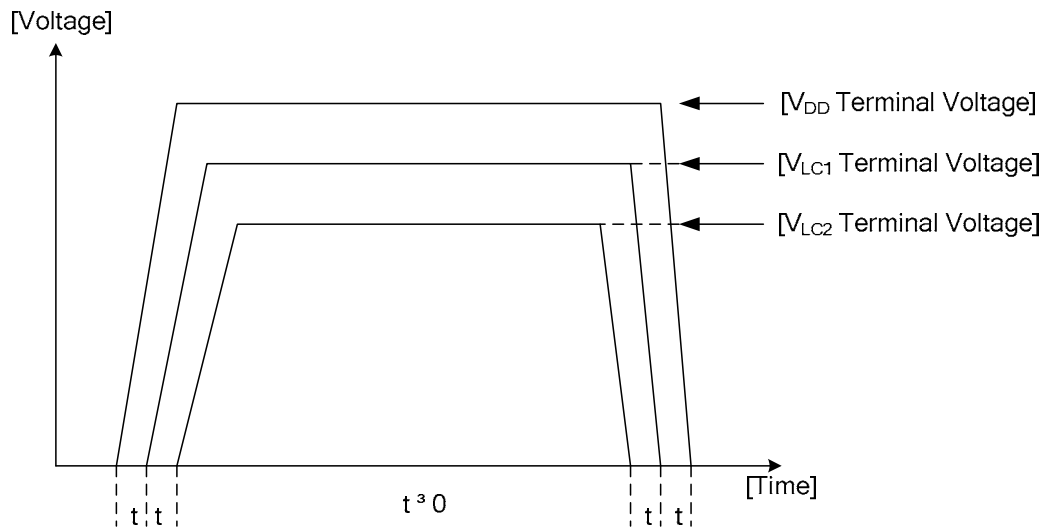
* V_{LC1}, V_{LC2} are applied when V_{DD} is applied to external bias resistor.

INITIAL SIGNAL TIMING

* On ce V_{DD} is applied, $\overline{\text{BLANK}}$ should be applied to 'L' level to make all SEGMENTs off until first group of display data is latched.

FUNCTIONAL DESCRIPTION

Operation

As shown in "Data Structure", the display data consists of the data field corresponding to the output for turning the segments on or off and the select field that selects field that selects the input block of data.   Data input to the DATA_IN pin is loaded into the 68-bit shift register, transferred to the 60-bit latch while the load signal is at "H" level, and then output via the 60-dot segment driver.
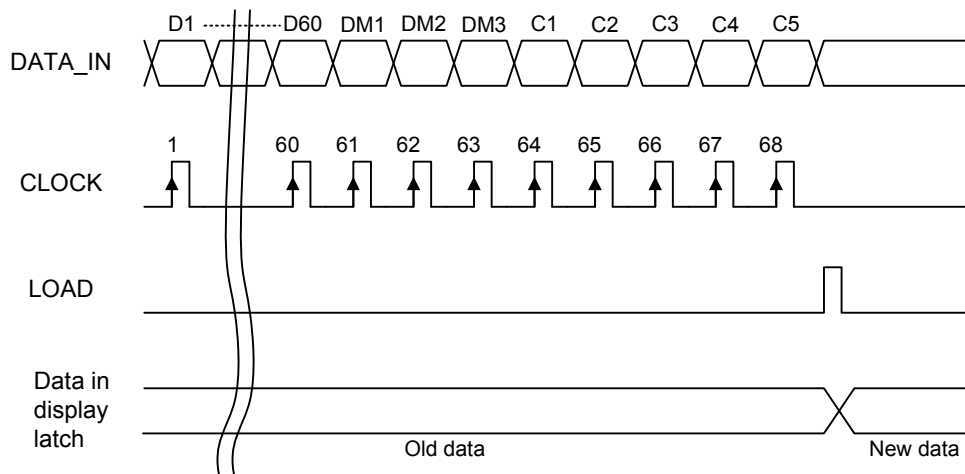
Data Structure
Input data
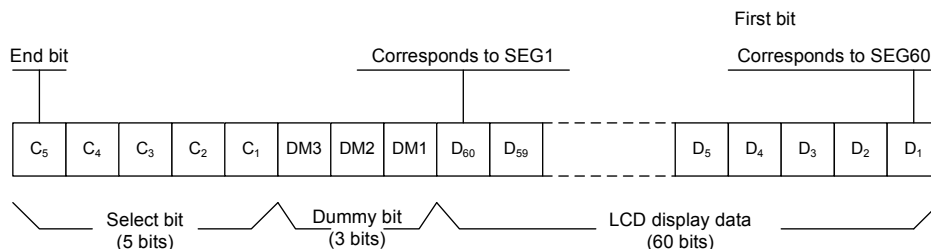
Correspondence between select bits and COM1 to COM5

C5 C	4	C3 C	2	C1	Description
0 0		0 0		1	Display data corresponding to COM1
0 0		0 1		0	Display data corresponding to COM2
0 0		1 0		0	Display data corresponding to COM3
0 1		0 0		0	Display data corresponding to COM4
1 0		0 0		0	Display data corresponding to COM5

Notes: 1.   Arbitrary data can be set for the dummy bits.
   2.   Select b it, C_1 to C_5, se lects 6 0-bit latch es t hat co rrespond to COM1 to   COM5, res pectively. Therefore, if "1" is set for more than one select bit, data is set to all the corresponding 60-bit latches.
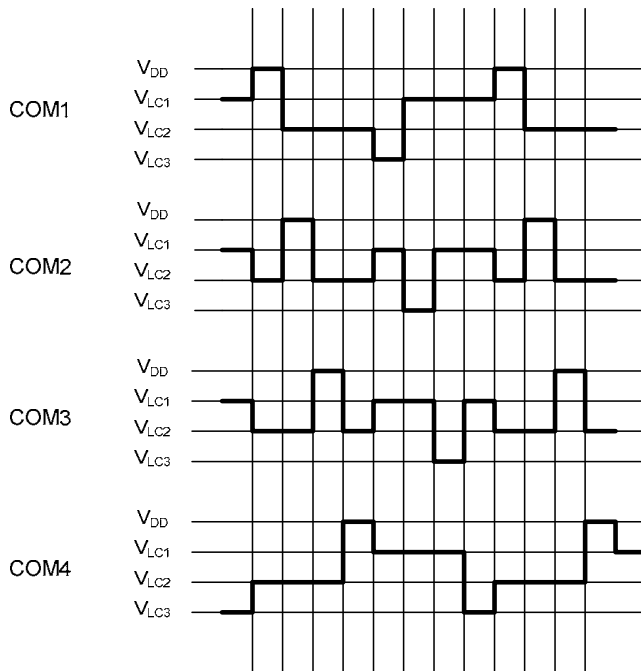
Example:
If "1" is set to all th e selec t b its C_1 to C_5, th e d isplay d ata o f D_1 to D_{60} is set to all th e 6 0-bit latch es th at correspond to COM1 to COM5.

COM1 – COM5 Timing Chart:
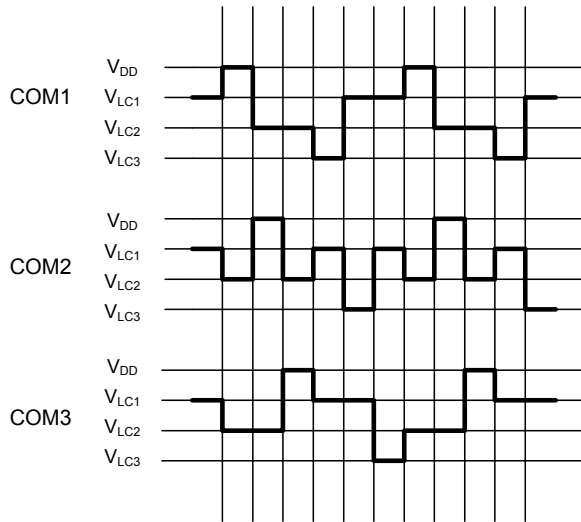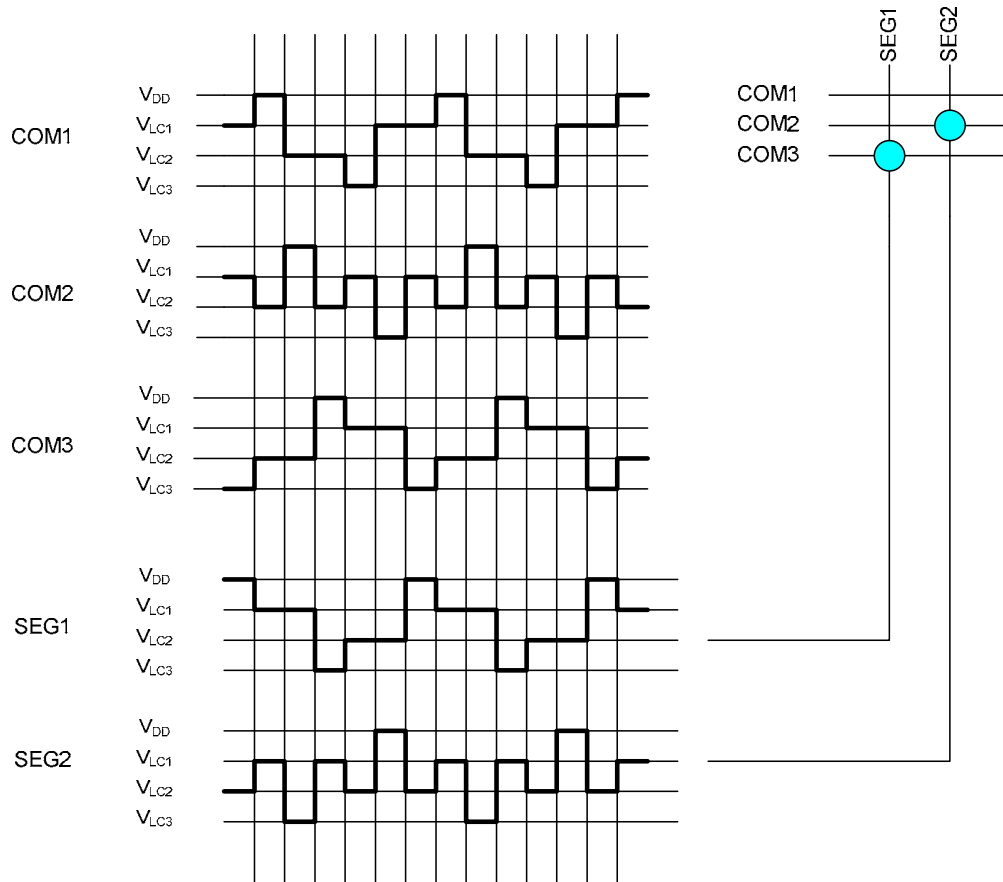

1/3 DUTY COM
TIMING

1/4 DUTY COM
TIMING

1/5 DUTY COM
TIMING
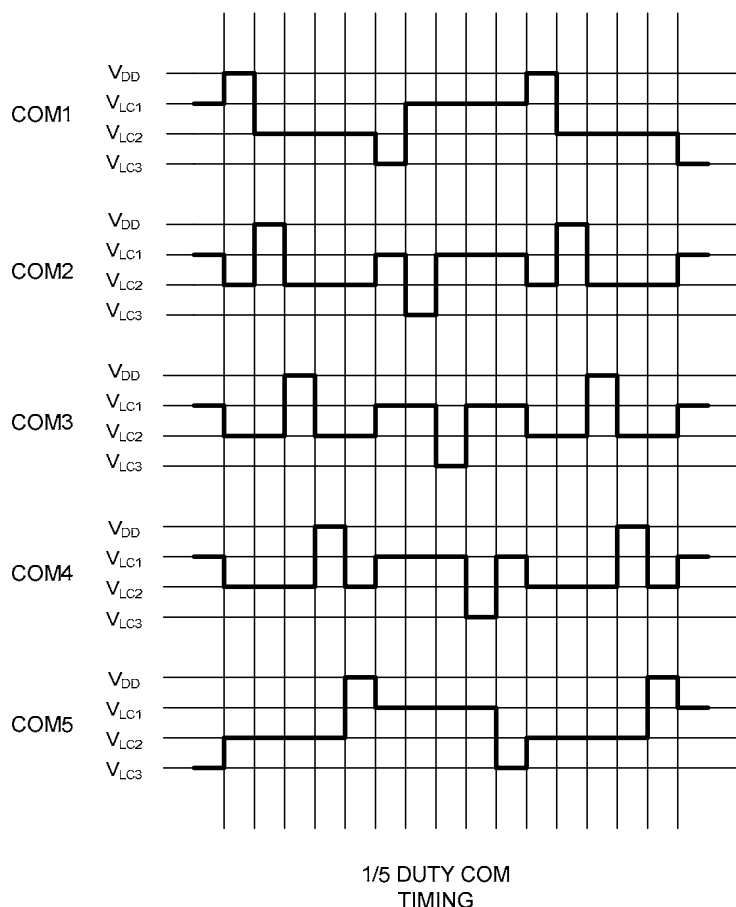
SEGn True Value Table:

LATCH1	LATCH2	LATCH3	LATCH4	LATCH5	COM1	COM2	COM3	COM4	COM5	SEGn
0	0	0	0	1	"H"	"M2"	"M2"	"M2"	"M2"	"1"
					"L"	"M1"	"M1"	"M1"	"M1"	"2"
					"M2"	"H"	"M2"	"M2"	"M2"	"1"
					"M1"	"L"	"M1"	"M1"	"M1"	"2"
					"M2"	"M2"	"H"	"M2"	"M2"	"1"
					"M1"	"M1"	"L"	"M1"	"M1"	"2"
					"M2"	"M2"	"M2"	"H"	"M2"	"1"
					"M1"	"M1"	"M1"	"L"	"M1"	"2"
					"M2"	"M2"	"M2"	"M2"	"H"	"L"
					"M1"	"M1"	"M1"	"M1"	"L"	"H"

*Note: "H" = V_{DD}; "M1" = V_{LC1}; "M2" = V_{LC2}; "L" = V_{LC3}=GND
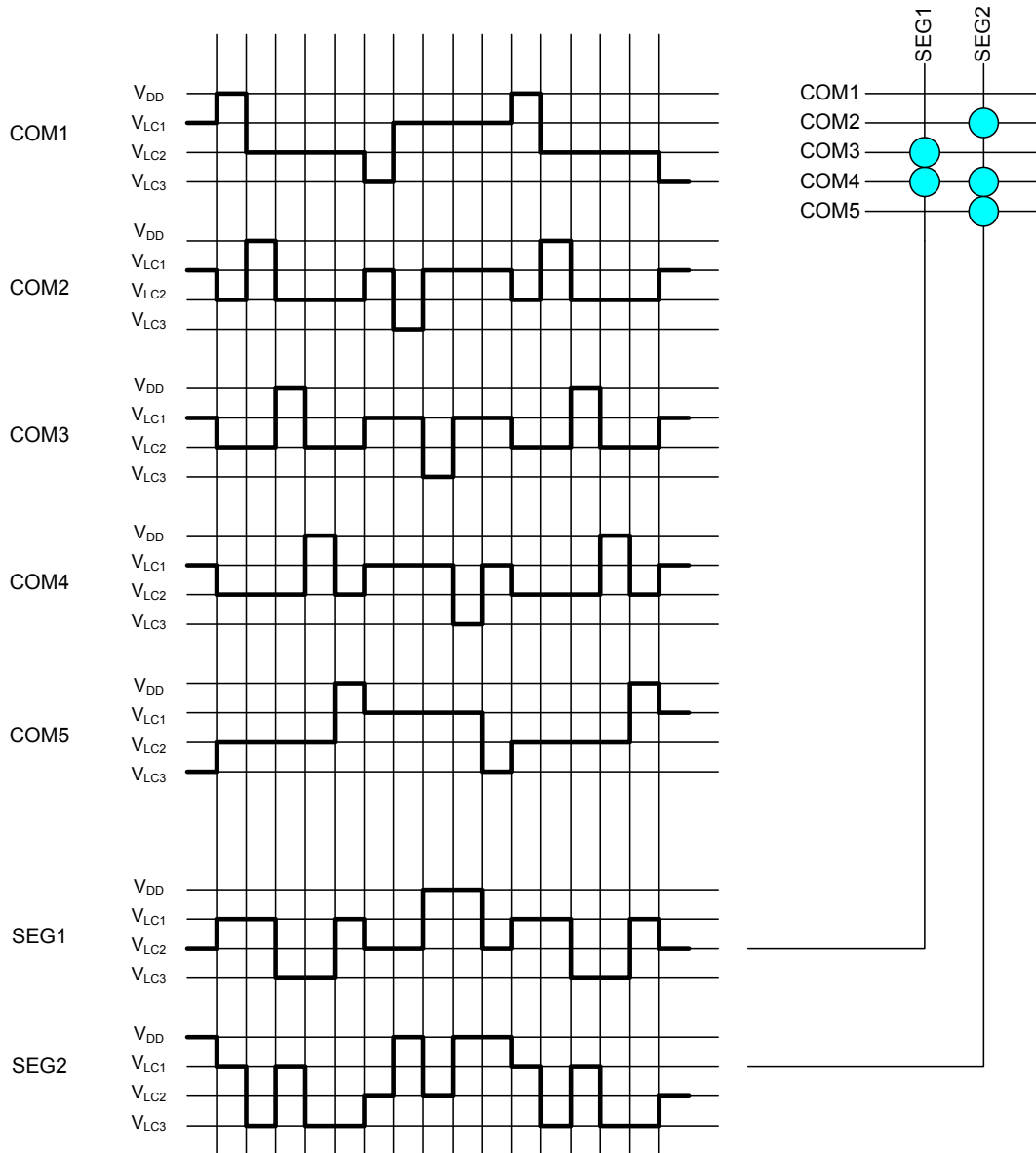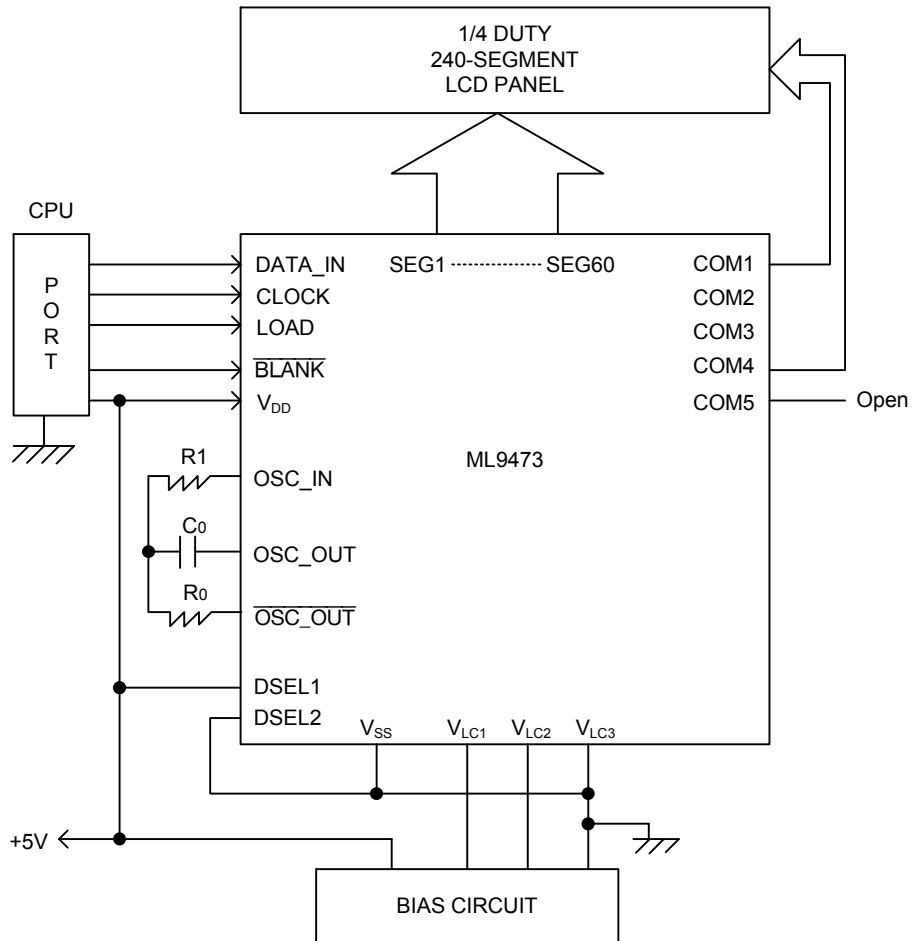
Timing Chart FOR 1/3 DUTY DRIVE MODE:

Timing Chart FOR 1/4 DUTY DRIVE MODE:
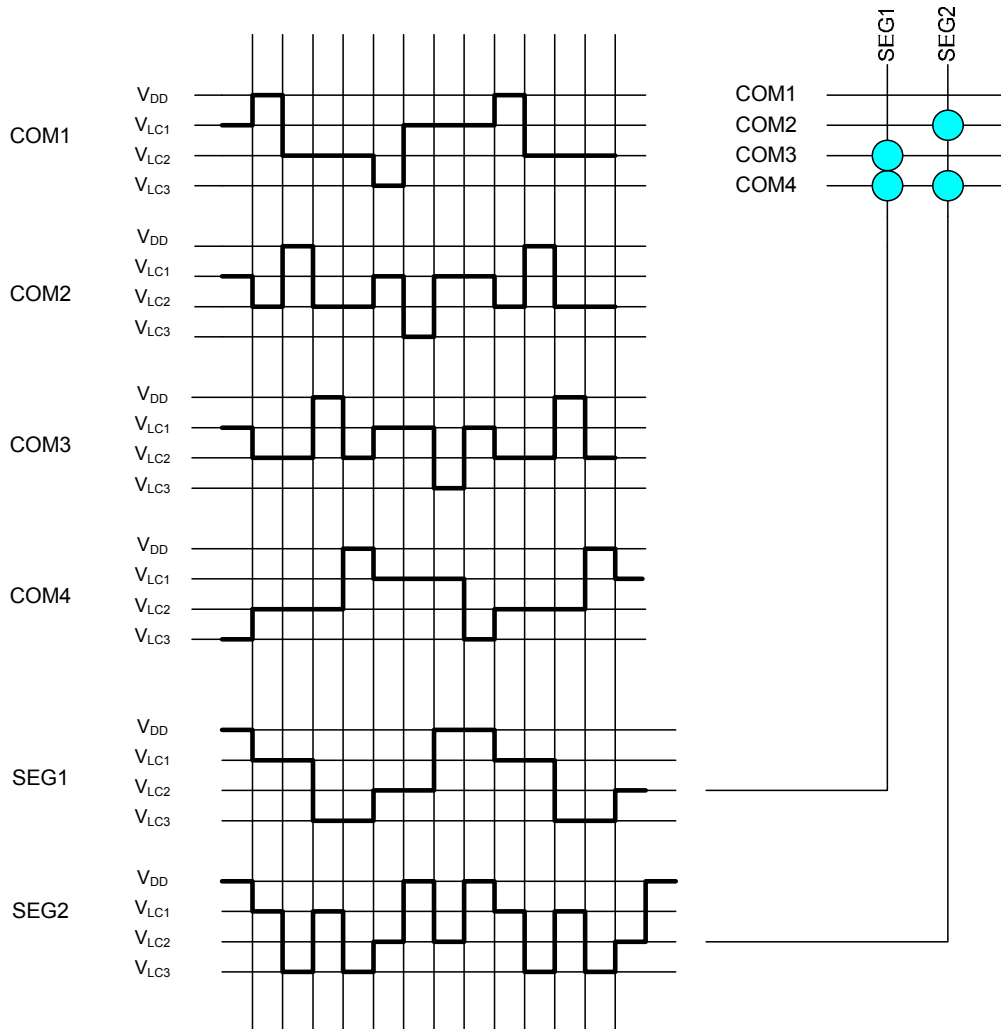
Timing Chart FOR 1/5 DUTY DRIVE MODE:

APPLICATION CIRCUITS
(For 1/4 duty)

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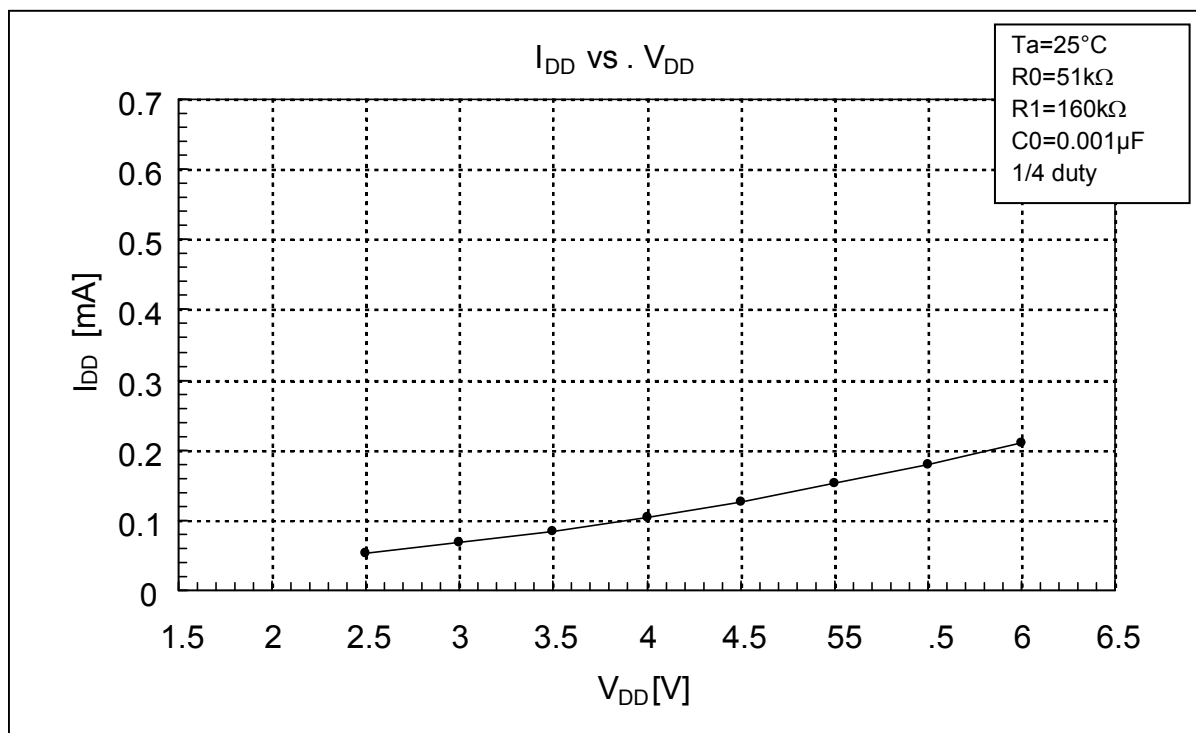
REFERENCE DATA

The data shown in this section is for reference (a metal film resistor and a film capacitor are used). Resistor and capacitor values must be determined based on experiments.
Use the following expression to convert oscillation frequency to COMMON frame frequency (or vice versa):
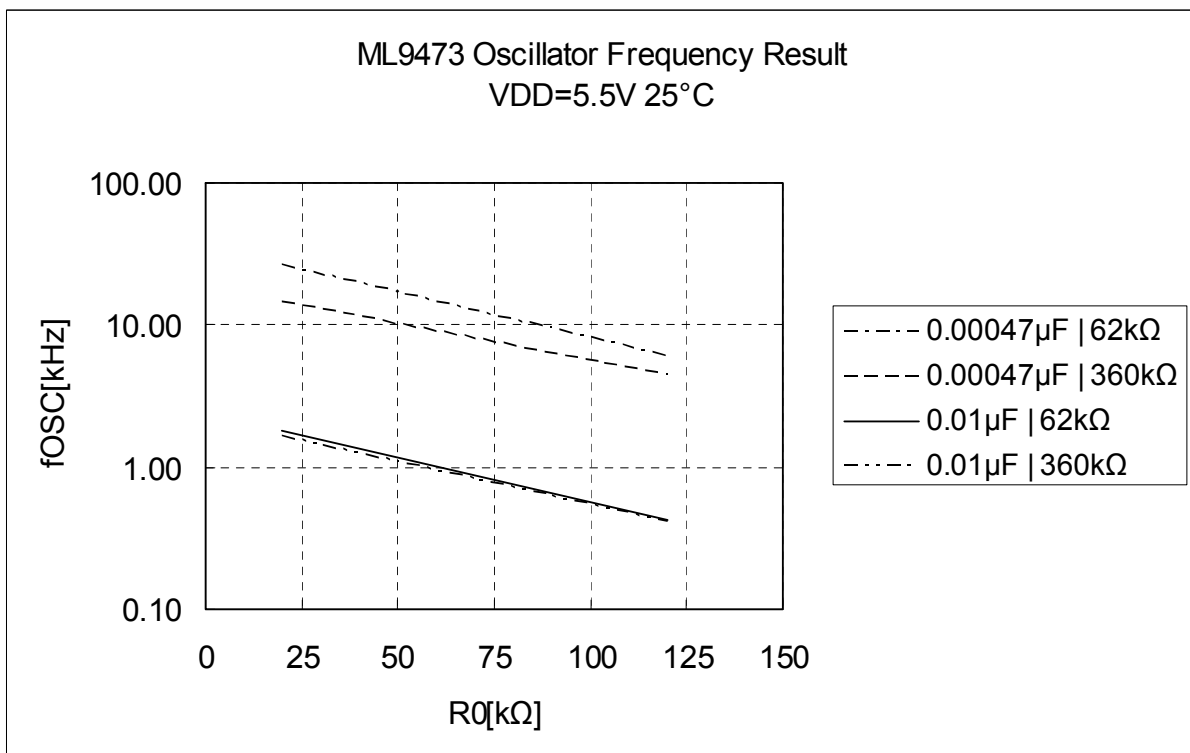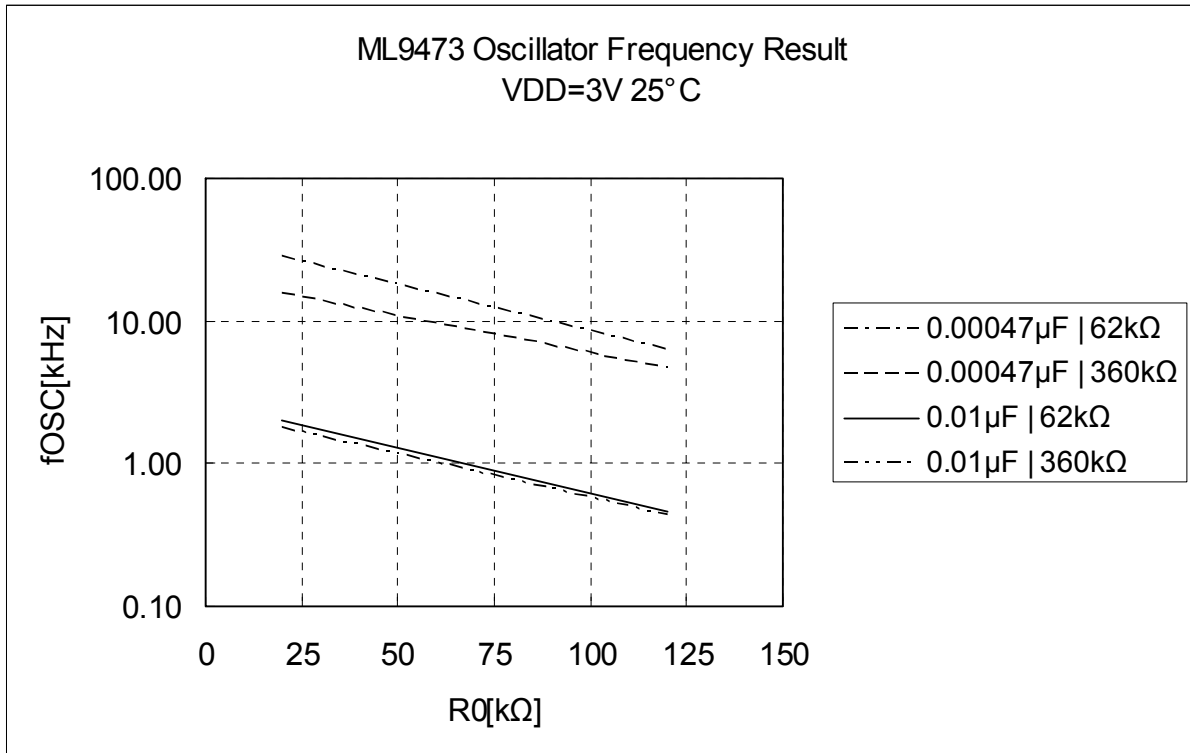
$$f_{COM} = f_{OSC} \times Duty/16$$

f_{COM} : COMMON frame frequency
f_{OSC} : Oscillation frequency
Duty : e.g., 1/4 for 1/4 duty

For example, if f_{COM}=100Hz at 1/5 duty, the oscillation frequency is f_{OSC} =8000Hz.

fOSC---R0,C0

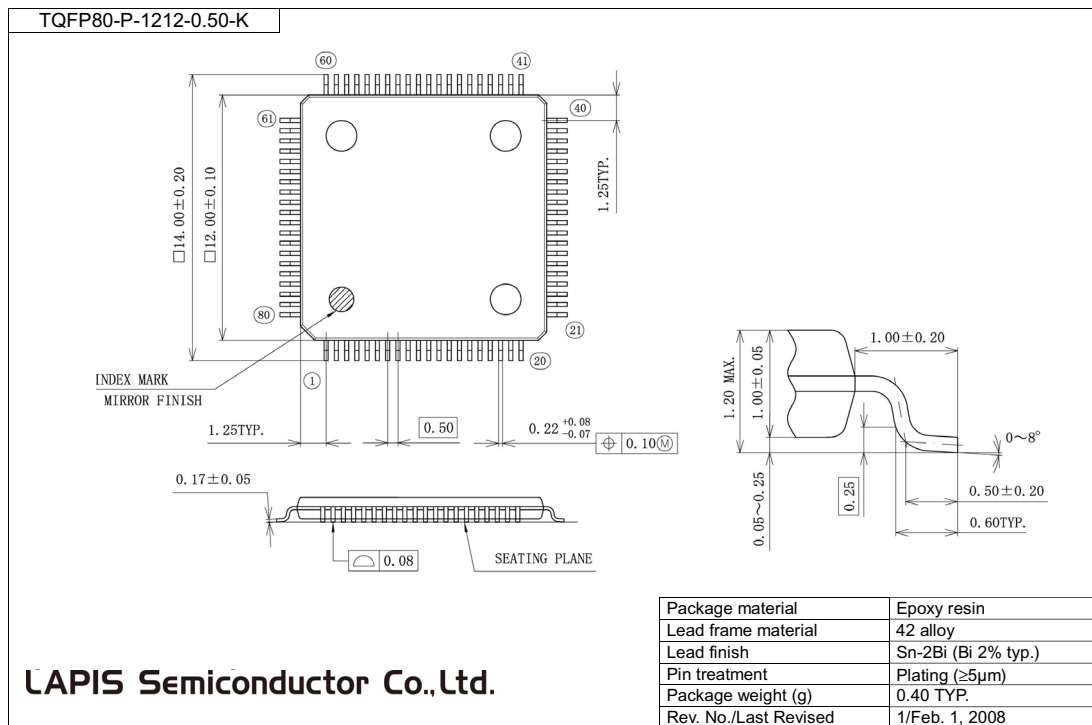ML9473 Oscillator Frequency Result
VDD=3V 25°C

ML9473 Oscillator Frequency Result
VDD=5.5V 25°C

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PACKAGE DIMENSIONS

(Unit: mm)

TQFP80-P-1212-0.50-K

Package material	Epoxy resin
Lead frame material	42 alloy
Lead finish	Sn-2Bi (Bi 2% typ.)
Pin treatment	Plating (≥5µm)
Package weight (g)	0.40 TYP.
Rev. No./Last Revised	1/Feb. 1, 2008

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Notes for Mounting the Surface Mount Type Package

The s urface mount t ype packag es are v ery s usceptible to heat in ref low mounting an d h umidity abs orbed in storage. T herefore, bef ore y ou perf orm ref low mounting, contact R OHM's res ponsible s ales pers on f or t he product n ame, pack age n ame, pi n num ber, pack age code an d des ired mounting co nditions (ref low method, temperature and times).

REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
PEDL9473-01	Dec. 15, 2006	–	–	Preliminary edition 1
PEDL9473-02	Jan. 15, 2007	–	–	Preliminary edition 2
PEDL9473-03	Jan. 9, 2008	–	–	Preliminary edition 3
FEDL9473-01	Aug. 21, 2008	–	–	Final edition 1

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