

MSM65512A/65P512A

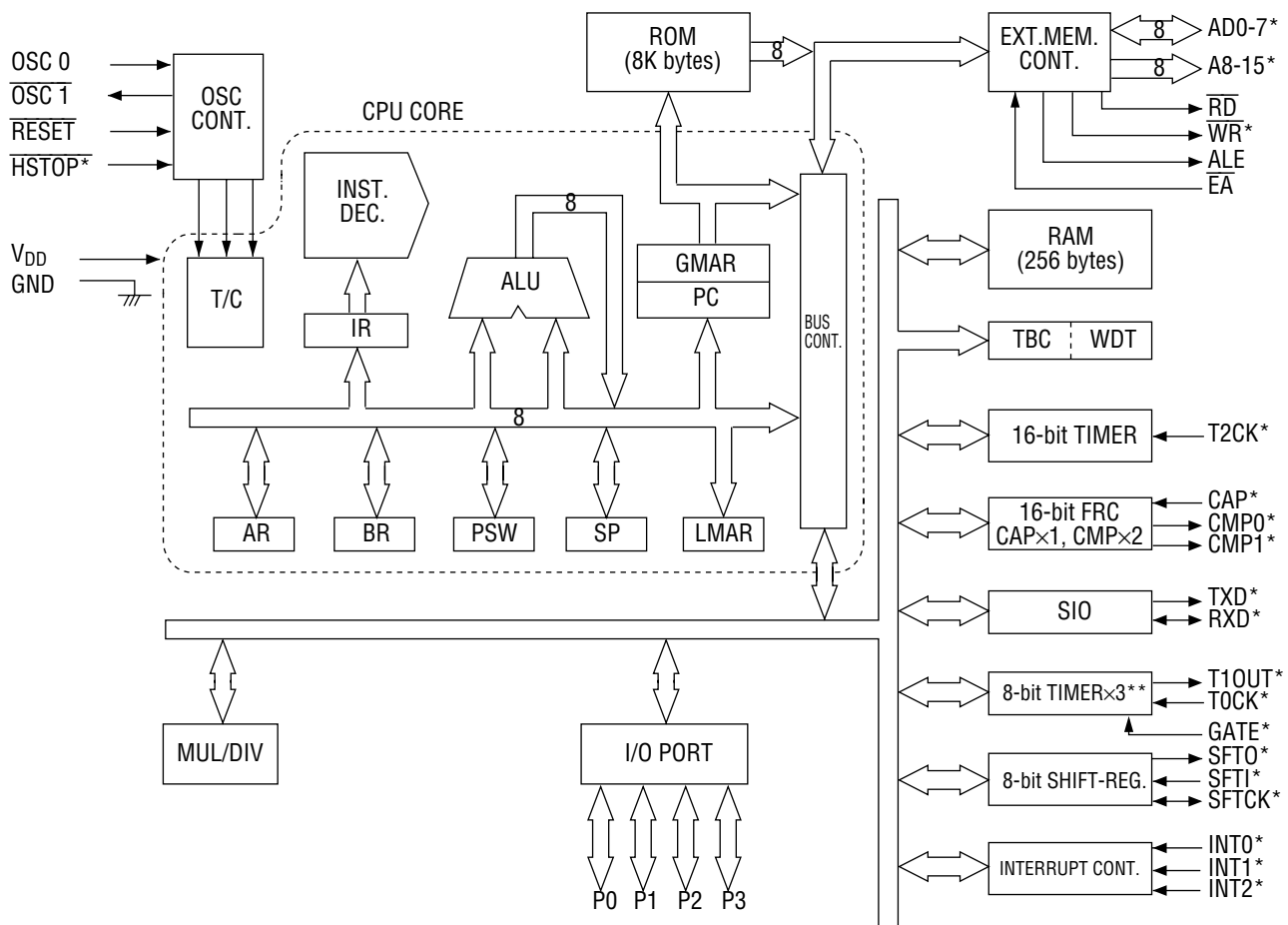
High Performance 8-Bit Microcontroller

GENERAL DESCRIPTION

The MSM65512A is a high-performance 8-bit microcontroller that employs OKI original nX-8/50 CPU core. With a minimum instruction execution time of 400 ns (10MHz clock), the MSM65512A is capable of high-speed processing, and includes 8K bytes of program memory, 256 bytes of data memory, timers and serial ports. Also available are the MSM65P512A, which replaces the MSM65512's built-in program memory with one-time PROM, and the MSM65X512A, which uses external program memory.

FEATURES

- Operating range
 - Operating frequency : 0 to 10 MHz ($V_{DD}=4.5$ to 5.5 V)
0 to 5 MHz ($V_{DD}=2.7$ to 5.5 V)
 - Operating voltage : 2.7 to 5.5 V
 - Operating temperature : -40 to +85°C (Operation at +125°C is assured by the other specification.)
- Memory space : 64K bytes
 - Internal program memory : 8K bytes
 - Internal data memory : 256 bytes
- Minimum instruction execution time : 400 ns @ 10 MHz
- Powerful instruction set : 83 basic instructions
8/16-bit operation instructions
Bit manipulation instructions
Compound function instructions
- Abundant addressing modes
- Multiplication/division operation functions : $8 \times 8 \rightarrow 16$
 $16/8 \rightarrow 16 \dots 8$
- I/O ports : 4 ports $\times$ 8 bits
- Timers : 8-bit auto-reload timer $\times$ 2
16-bit auto-reload timer $\times$ 1
Watchdog timer $\times$ 1
- Counters : Time base counter $\times$ 1
16-bit free-running counter $\times$ 1
- Capture input : 1 channel
- Compare output : 2 channels
- Serial ports : Shift register $\times$ 1
Serial port with baud rate generator (UART/synchronous) $\times$ 1
- External interrupts : 3
- Interrupt sources : 15
- Package
 - 40-pin plastic DIP (DIP40-P-600-2.54) : (MSM65512A-xxxRS,
MSM65P512A-xxxRS)
 - 44-pin plastic QFP (QFP44-P-910-0.80-2K) : (MSM65512A-xxxGS-2K,
MSM65P512A-xxxGS-2K)
 - 44-pin plastic QFJ (PLCC) (QFJ44-P-S650-1.27): (MSM65512A-xxxJS,
MSM65P512A-xxxJS)



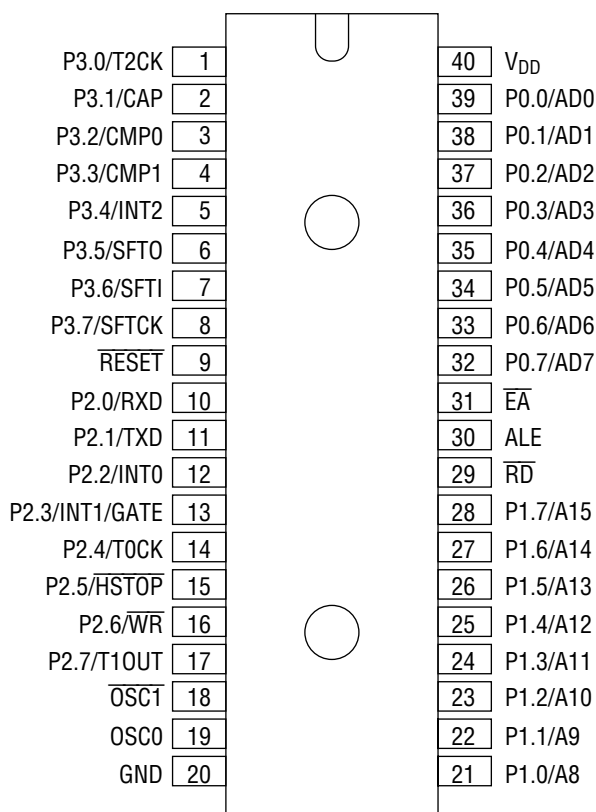
* Secondary functions of ports.

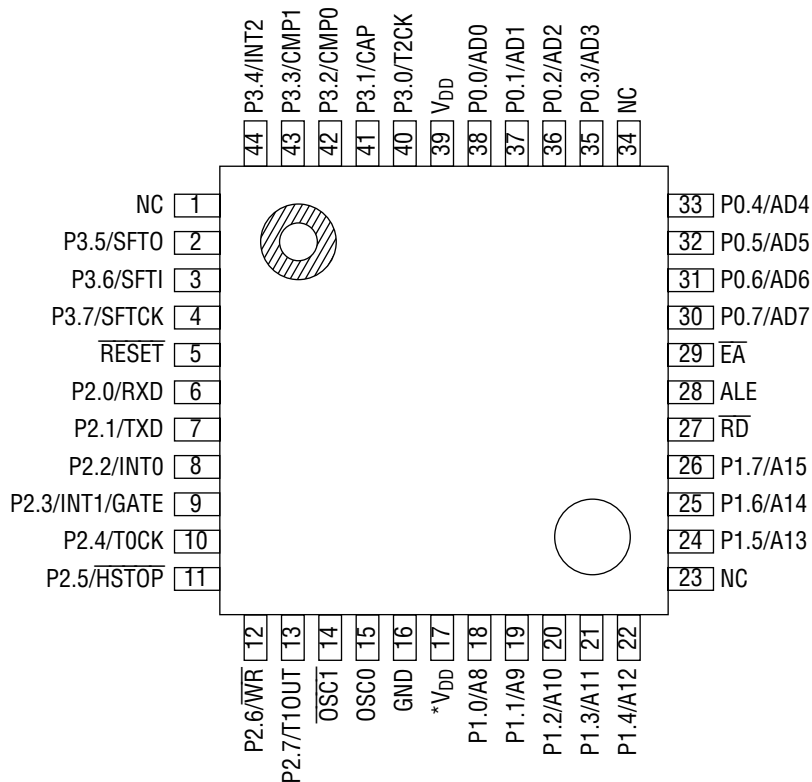
** One timer is used for the SIO baud rate generator

BLOCK DIAGRAM

OKI Semiconductor

MSM65512A/65P512A

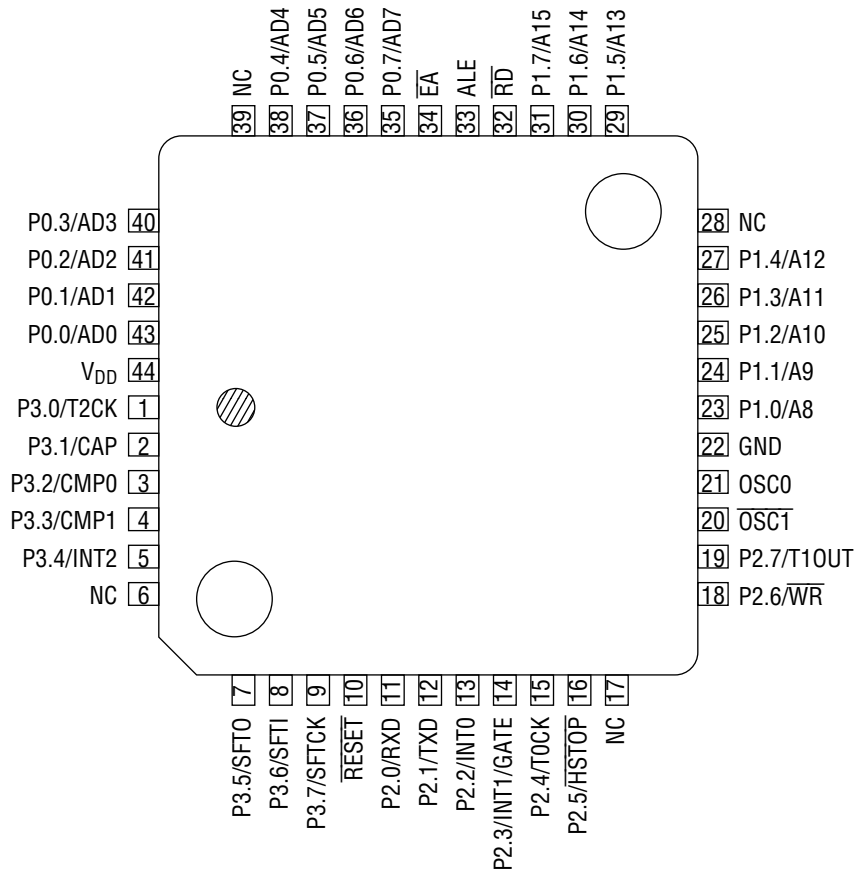
PIN CONFIGURATION (TOP VIEW)**40-Pin Plastic DIP**

PIN CONFIGURATION (TOP VIEW) (Continued)

* No-connection pin for MSM65P512A

NC: No-connection pin

44-Pin Plastic QFP

PIN CONFIGURATION (TOP VIEW) (Continued)

NC: No-connection pin

44-Pin Plastic QFJ (PLCC)

PIN DESCRIPTIONS

Basic Functions

Function	Symbol	Type	Description
Power Supply	V _{DD}	—	+5V power supply
	GND	—	0V digital ground
Oscillation	OSC0	I	Crystal oscillation input/external clock input
	OSC1	O	Crystal oscillation output
Control	RESET	I	System reset input (program starts from address 0040H); internal pull-up resistor
	EA	I	Program memory select input pin. "L" level input for external program memory; "H" level input for internal program memory.
	RD	O	Read strobe signal during external memory access
	ALE	O	Address latch signal during external memory access
Port	PORT 0	I/O	8-bit Input-output port During external memory access, becomes address/data bus for address output, instruction fetch or data read/write along with ALE, RD and WR pins
	PORT 1	I/O	8-bit Input/output port Address bus during external memory access
	PORT 2 PORT 3	I/O	8-bit Input/output port × 2. Secondary functions shown in following table are added for ports 2 and 3.

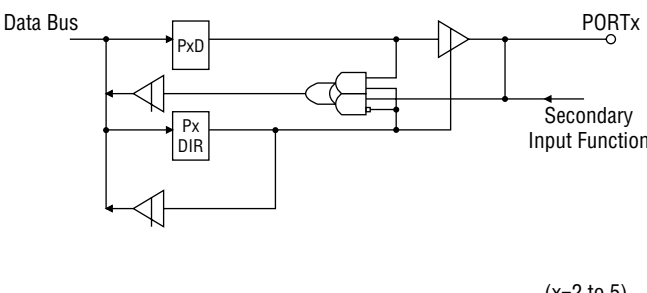
Secondary Functions

Symbol	Type	Description
RXD	I/O	P2.0 secondary functions UART: Input pin for serial port receive data. Synchronous: Input/output pin for serial port transmit/receive data.
TXD	O	P2.1 secondary functions UART: Output pin for serial port transmit data. Synchronous: Output pin for serial port synchronizing clock.
INT0	I	P2.2 secondary function External interrupt 0 input pin.
INT1/GATE	I	P2.3 secondary functions External interrupt 1 input pin. Also used as input pin for gate signal for timer 0 count enable/disable.
T0CK	I	P2.4 secondary function Timer 0 external clock input pin.
$\overline{\text{HSTOP}}$	I	P2.5 secondary function Hard stop mode input pin; stops system clock oscillation with "L" level input.
$\overline{\text{WR}}$	O	P2.6 secondary function Write strobe signal output pin during external data memory access.
T1OUT	O	P2.7 secondary function Output pin for signal obtained by dividing timer overflow by 2.
T2CK	I	P3.0 secondary function Timer 2 external clock input pin.
CAP	I	P3.1 secondary function Capture trigger input pin.
CMP0	O	P3.2 secondary function Compare output channel 0 output pin.
CMP1	O	P3.3 secondary function Compare output channel 1 output pin.
INT2	I	P3.4 secondary function External interrupt 2 input pin
SFTO	O	P3.5 secondary function Shift register data output pin.
SFTI	I	P3.6 secondary function Shift register data input pin.
SFTCK	I/O	P3.7 secondary function Shift register synchronizing clock input/output pin.

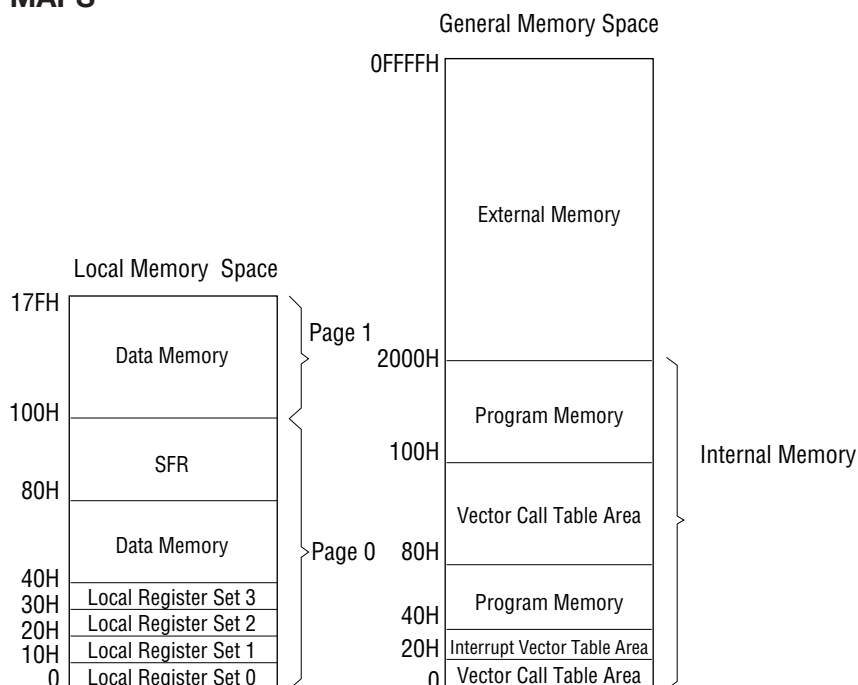
Port Circuit Configuration

Type	Port	Circuit Configuration	Electrical Characteristics (V _{DD} =5V)
1	P0.0/AD0- P0.7/AD7		"H" Input Voltage: • V_{IH}=2.4V "L" Input Voltage: • V_{IL}=0.8V "H" Output Voltage: • V_{OH}=3.75V • I_{OH}=-400μA "L" Output Voltage: • V_{OL}=0.4V • I_{OL}=3.2mA
2	P1.0/A8- P1.7/A15		"H" Input Voltage: • V_{IH}=2.4V "L" Input Voltage: • V_{IL}=0.8V "H" Output Voltage: • V_{OH}=3.75V • I_{OH}=-200μA "L" Output Voltage: • V_{OL}=0.4V • I_{OL}=1.6mA
3	P2.0/RXD, P2.1/TXD, P2.6/WR, P2.7/T1OUT, P3.2/CMP0, P3.3/CMP1, P3.5/SFT0, P3.7/SFTCK		"H" Input Voltage: • V_{IH}=2.4V "L" Input Voltage: • V_{IL}=0.8V P2.6/WR "H" Output Voltage: • V_{OH}=3.75V • I_{OH}=-400μA "L" Output Voltage: • V_{OL}=0.4V • I_{OL}=3.2mA Excluding P2.6/WR "H" Output Voltage: • V_{OH}=3.75V • I_{OH}=-200μA "L" Output Voltage: • V_{OL}=0.4V • I_{OL}=1.6mA

Port Circuit Configuration (Continued)

Type	Port	Circuit Configuration	Electrical Characteristics (V _{DD} =5V)
4	P2.2/INT0, P2.3/INT1/GATE, P2.4/T0CK, P2.5/HSTOP, P3.0/T2CK, P3.1/CAP, P3.4/INT2, P3.6/SFTI	 (x=2 to 5)	"H" Input Voltage: • V _{IH} =2.4V "L" Input Voltage: • V _{IL} =0.8V "H" Output Voltage: • V _{OH} =3.75V • I _{OH} =-200μA "L" Output Voltage: • V _{OL} =0.4V • I _{OL} =1.6mA

MEMORY MAPS



ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Supply Voltage	V_{DD}	$T_a=25^{\circ}\text{C}$	-0.3 to 7.0	V
Input Voltage	V_I		-0.3 to $V_{DD}+0.3$	
Output Voltage	V_O		-0.3 to $V_{DD}+0.3$	
Power Dissipation	P_D	$T_a=25^{\circ}\text{C}$ per package	400	mW
		$T_a=25^{\circ}\text{C}$ per output	50	
Storage Temperature	T_{STG}	—	-55 to +150	$^{\circ}\text{C}$

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Range	Unit
Supply Voltage	V_{DD}	Refer to Figure 1.	2.7 to 5.5	V
Memory Hold Voltage	V_{DDMH}	$f_{OSC}=0$ Hz	2.0 to 5.5	
Oscillation Operating Frequency *1	f_{OSC}	Refer to Figure 1.	1 to 10	MHz
External Clock Operating Frequency	f_{EXTCLK}	Refer to Figure 1.	0 to 10	MHz
Operating Temperature	T_{op}	—	-40 to +85	$^{\circ}\text{C}$

*1 This is due to the standard of a crystal oscillator or ceramic resonator.

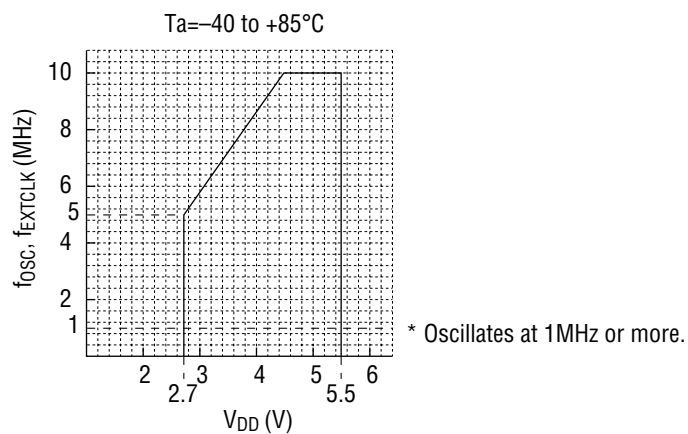


Figure 1. Operating Frequency vs. Power Supply Voltage

ELECTRICAL CHARACTERISTICS**DC Characteristics 1 ($V_{DD}=4.5$ to $5.5V$)**(GND=0V, $T_a=-40$ to $+85^{\circ}C$)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" Input Voltage 1 *1	V_{IH1}	—	2.4	—	$V_{DD}+0.3$	V
"H" Input Voltage 2 *2	V_{IH2}	—	$0.7V_{DD}$	—	$V_{DD}+0.3$	
"L" Input Voltage	V_{IL}	—	-0.3	—	0.8	
"H" Output Voltage 1 *3	V_{OH1}	$I_{OH}=-200\mu A$	$0.75V_{DD}$	—	—	
"H" Output Voltage 2 *4	V_{OH2}	$I_{OH}=-400\mu A$	$0.75V_{DD}$	—	—	
"L" Output Voltage 1 *3	V_{OL1}	$I_{OL}=1.6mA$	—	—	0.4	
"L" Output Voltage 2 *4	V_{OL2}	$I_{OL}=3.2mA$	—	—	0.4	μA
Input Leakage Current 1 *5	I_{L1}	$V_I=V_{DD}/0V$	—	—	± 1	
Input Leakage Current 2 *6	I_{L2}	$V_I=V_{DD}/0V$	—	—	± 10	
"L" Input Current *7	I_{IL}	$V_I=0V$	-40	-200	-400	
Input Capacitance	C_i	$f=1MHz, T_a=25^{\circ}C$	—	5	—	pF
Current Consumption	I_{DDS}	5V, Stop mode *8	—	—	50	μA
	I_{DDS}	10MHz, 5V, no load *9	—	20	40	mA

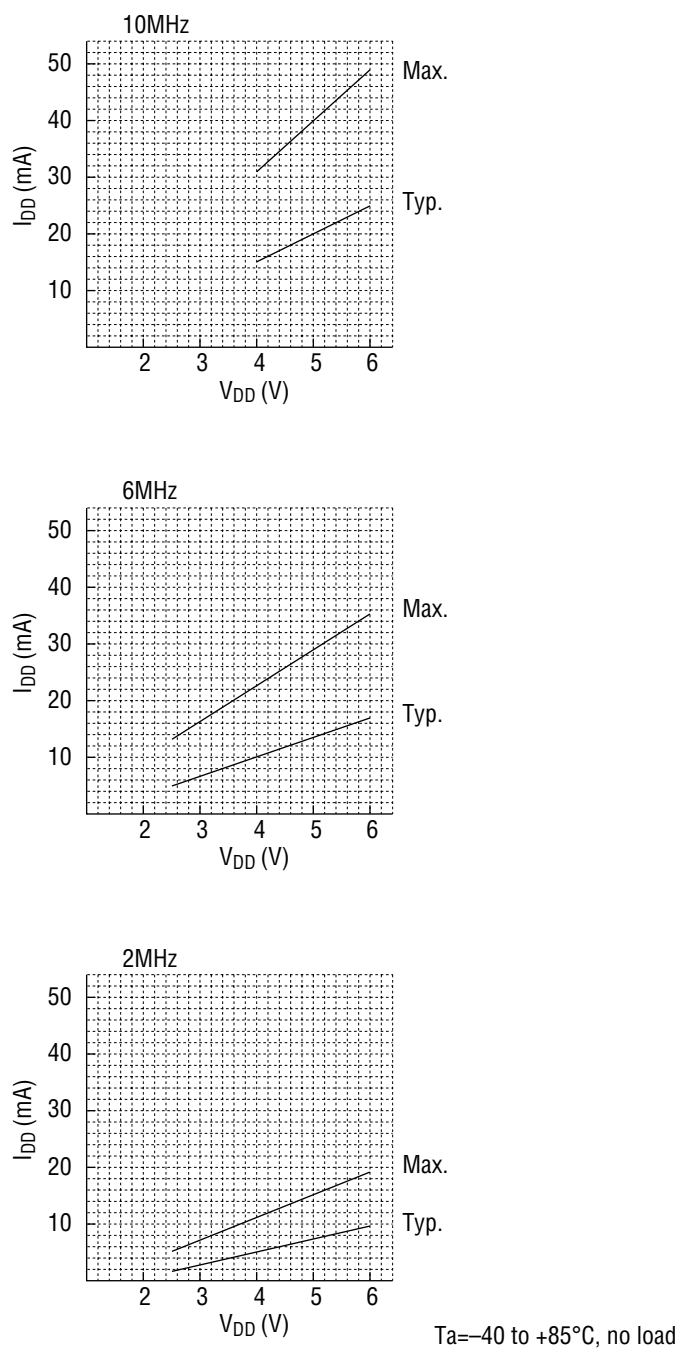
*1 Excluding OSC0 and $\overline{RESET}$ *2 OSC0 and $\overline{RESET}$ *3 Excluding P0, ALE, $\overline{RD}$, P2.6/ $\overline{WR}$ *4 P0, ALE, $\overline{RD}$, P2.6/ $\overline{WR}$ *5 $\overline{EA}$ *6 Excluding $\overline{RESET}$, $\overline{EA}$ *7 $\overline{RESET}$ *8 The ports configured as inputs should be coupled to V_{DD} or 0V. Other ports should not be loaded.

*9 Refer to Figure 2.

DC Characteristics 2 ($2.7 \leq V_{DD} < 4.5V$)(GND=0V, $T_a = -40$ to $+85^\circ C$)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" Input Voltage 1 * ¹	V_{IH1}	—	$0.5V_{DD}+0.2$	—	$V_{DD}+0.3$	V
"H" Input Voltage 2 * ²	V_{IH2}	—	$0.6V_{DD}+0.4$	—	$V_{DD}+0.3$	
"L" Input Voltage	V_{IL}	—	-0.3	—	$0.15V_{DD}+0.1$	
"H" Output Voltage 1 * ³	V_{OH1}	$I_{OH} = -10\mu A$	$0.75V_{DD}$	—	—	
"H" Output Voltage 2 * ⁴	V_{OH2}	$I_{OH} = -20\mu A$	$0.75V_{DD}$	—	—	
"L" Output Voltage 1 * ³	V_{OL1}	$I_{OL} = 10\mu A$	—	—	0.1	
"L" Output Voltage 2 * ⁴	V_{OL2}	$I_{OL} = 20\mu A$	—	—	0.1	μA
Input Leakage Current 1 * ⁵	I_{LI1}	$V_I = V_{DD}/0V$	—	—	± 1	
Input Leakage Current 2 * ⁶	I_{LI2}	$V_I = V_{DD}/0V$	—	—	± 10	
"L" Input Current * ⁷	I_{IL}	$V_{DD} = 2.7$ to $3.3V$, $V_I = 0V$	-40	-120	-240	pF
Input Capacitance	C_I	$f = 1MHz$, $T_a = 25^\circ C$	—	5	—	
Current Consumption	I_{DDs}	3V, Stop mode * ⁸	—	—	25	μA
	I_{DD}	5MHz, 3V, no load * ⁹	—	6	15	mA

*¹ Excluding $\overline{OSC0}$ and $\overline{RESET}$ *² $\overline{OSC0}$ and $\overline{RESET}$ *³ Excluding $\overline{P0}$, $\overline{ALE}$, $\overline{RD}$, $\overline{P2.6}$ / $\overline{WR}$ *⁴ $\overline{P0}$, $\overline{ALE}$, $\overline{RD}$, $\overline{P2.6}$ / $\overline{WR}$ *⁵ $\overline{EA}$ *⁶ Excluding $\overline{RESET}$, $\overline{EA}$ *⁷ $\overline{RESET}$ *⁸ The ports configured as inputs should be coupled to V_{DD} or 0V. Other ports should not be loaded.*⁹ Refer to Figure 2.

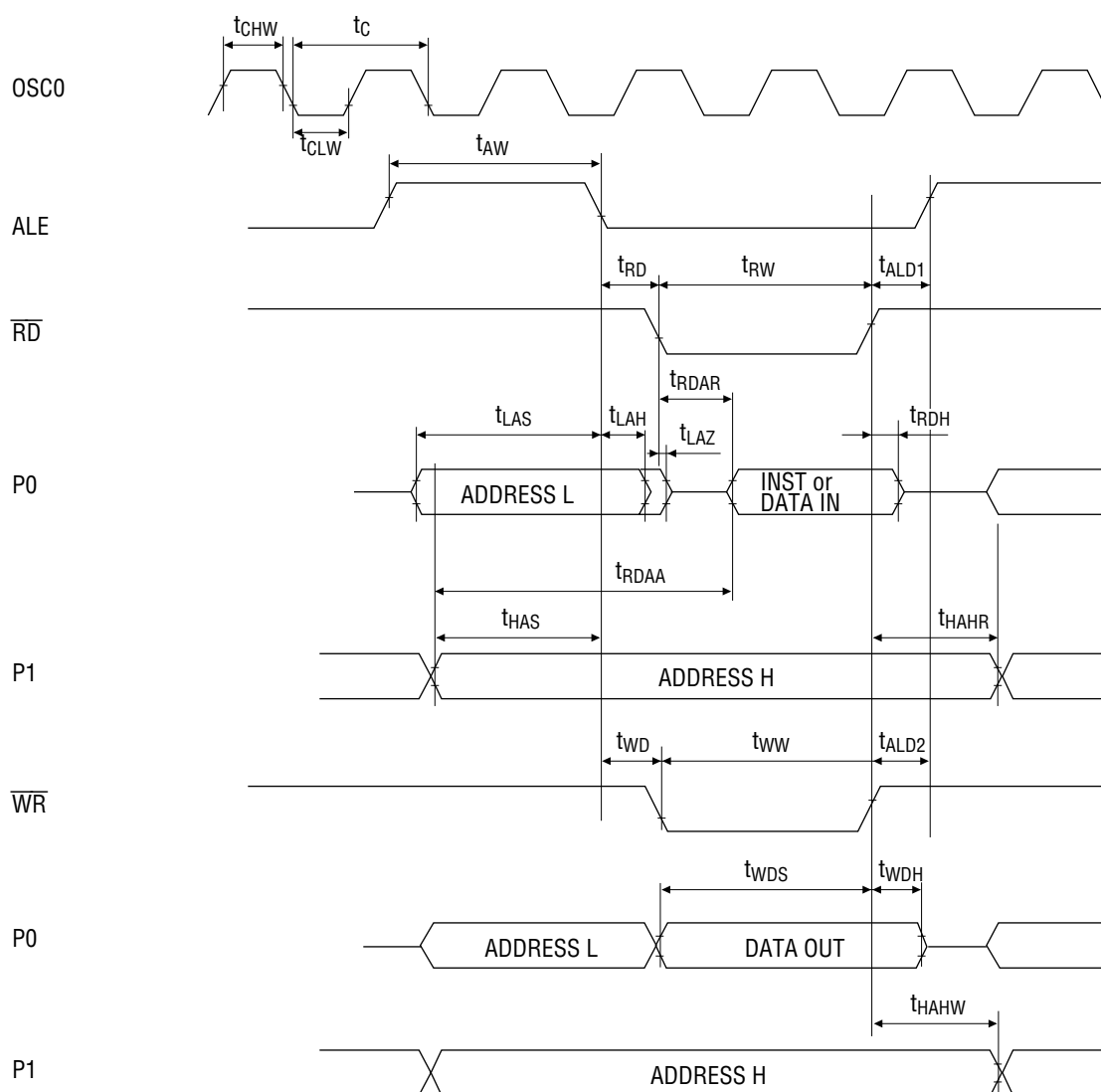
**Figure 2. Operating Current Consumption vs. Power Supply Voltage**

AC Characteristics

• External memory control

(V_{DD}=2.7 to 5.5V, GND=0V, T_a=-40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit
Clock Cycle	t _C	V _{DD} =4.5 to 5.5V	100	—	ns
"L" Clock Pulse Width	t _{CLW}		45	—	
"H" Clock Pulse Width	t _{CHW}		45	—	
Clock Cycle	t _C	V _{DD} =2.7 to 5.5V	200	—	
"L" Clock Pulse Width	t _{CLW}		90	—	
"H" Clock Pulse Width	t _{CHW}		90	—	
ALE Pulse Width	t _{AW}	C _L =100pF	t _C +t _{CHW} -20	—	
ALE Pulse Delay Time 1	t _{ALD1}		t _{CLW} -20	—	
ALE Pulse Delay Time 2	t _{ALD2}		t _{CLW} -20	—	
RD Pulse Width	t _{RW}		t _C +t _{CHW} -40	—	
RD Pulse Delay Time	t _{RD}		t _{CLW} -40	t _{CLW} +20	
$\overline{WR}$ Pulse Width	t _{WW}		t _C +t _{CHW} -40	—	
$\overline{WR}$ Pulse Delay Time	t _{WD}		t _{CLW} -20	t _{CLW} +40	
"L" Address Setup Time	t _{LAS}		t _C -40	—	
"H" Address Setup Time	t _{HAS}		t _C -40	—	
"L" Address Hold Time	t _{LAH}		t _{CLW} -20	—	
Bus Float Time	t _{LAZ}		—	20	
"H" Address Hold Time	t _{HAHR}		t _C -20	—	
"H" Address Hold Time	t _{HAHW}		t _C -20	—	
Read Data Access Time	t _{RDAA}		—	t _C +t _{CLW} -15	
Read Data Access Time	t _{RDAR}		—	t _{CHW} +10	
Read Data Hold Time	t _{RDH}		0	—	
Write Data Setup Time	t _{WDS}		t _C +t _{CLH} -40	—	
Write Data Hold Time	t _{WDH}		t _{CLW} -20	—	



• CPU control

(V_{DD}=2.7 to 5.5V, GND=0V, Ta=-40 to +85°C)

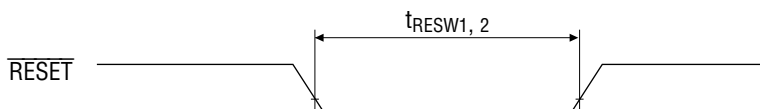
Parameter	Symbol	Condition	Min.	Max.	Unit
RESET Pulse Width *1	t _{RESW1}	—	20	—	ns
RESET Pulse Width *2	t _{RESW2}	—	*3	—	—

*1 Excluding power ON, stop mode and hard stop mode.

*2 During power ON, in stop mode and hard stop mode.

*3 Oscillation stabilization time depends on resonator.

RESET pulse width

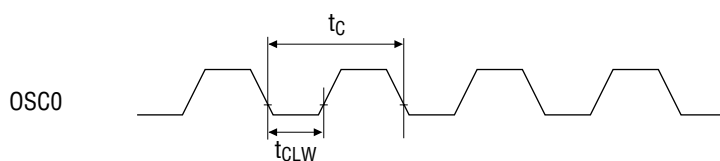


• Peripheral control 1

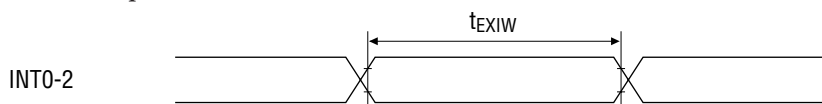
(V_{DD}=2.7 to 5.5V, GND=0V, Ta=-40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit
OSC	Clock Cycle	V _{DD} =4.5 to 5.5V	100	—	ns
		V _{DD} =2.7 to 5.5V	200	—	
EXI	External Interrupt Pulse Width	—	4 t _C	—	
T0	External Clock Pulse Width		4 t _C	—	
	GATE Pulse Width		1 t _{TOCLK} *	—	
T2	External Clock Pulse Width		4 t _C	—	
CAP	CAP Pulse Width		12 t _C	—	

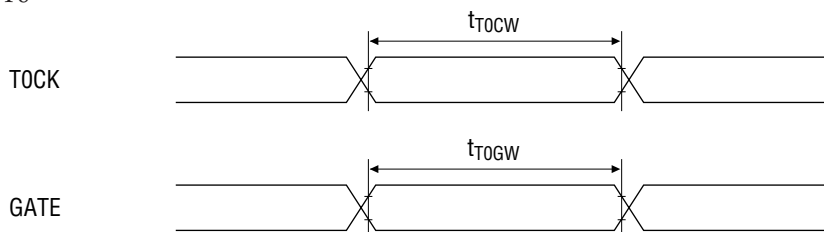
* t_{TOCLK} : Timer 0 count clock cycle selected by T0CON.



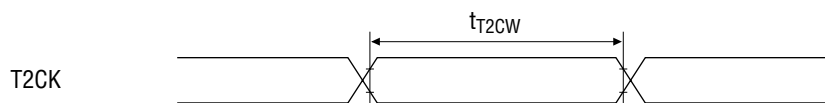
1) EXI pulse width



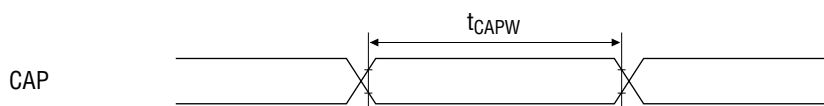
2) T0



3) T2



4) CAP

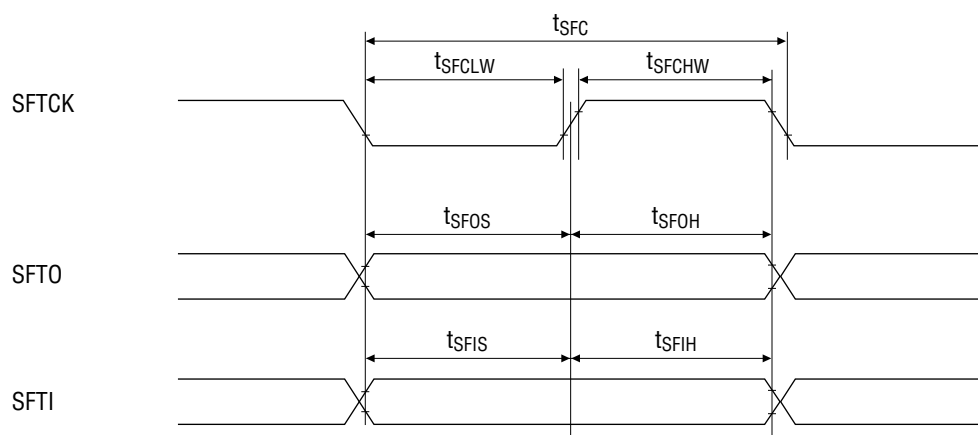


• Peripheral control 2

(V_{DD}=2.7 to 5.5V, GND=0V, Ta=-40 to +85°C)

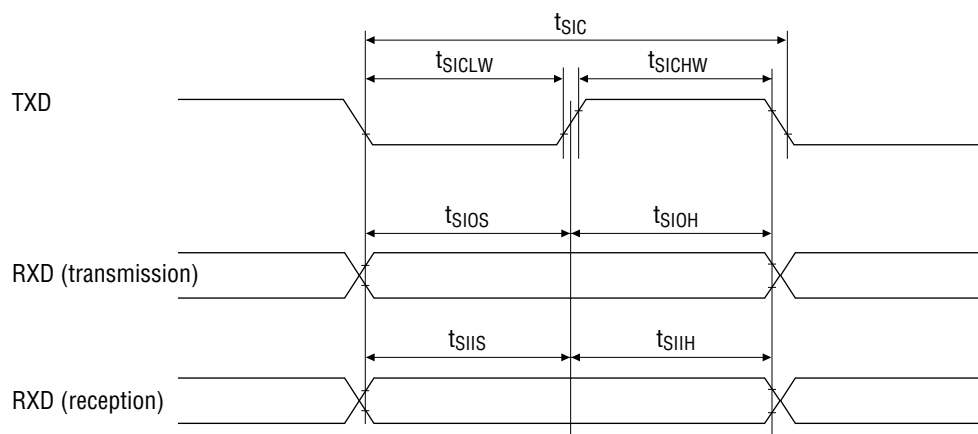
Parameter		Symbol	Condition	Min.	Max.	Unit
OSC	Clock Cycle	t _C	V _{DD} =4.5 to 5.5V	100	—	ns
			V _{DD} =2.7 to 5.5V	200	—	
SFT	SFTCK Cycle	t _{SFC}	C _L =100pF	8 t _C	—	
	SFTCK "L" Pulse Width	t _{SFCLW}		4 t _C -20	—	
	SFTCK "H" Pulse Width	t _{SFCHW}		4 t _C -20	—	
	SFTCK Setup Time	t _{SFOS}		t _{SFCLW} -100	—	
	SFTO Hold Time	t _{SFOH}		t _{SFCHW} -100	—	
	SFTI Setup Time	t _{SFIS}		100	—	
	SFTI Hold Time	t _{SFIH}		100	—	
SIO (Clock Syn- chro- nous)	Synchronous Clock Cycle	t _{SIC}		8 t _C	—	
	Synchronous Clock "L" Pulse Width	t _{SICLW}		4 t _C -20	—	
	Synchronous Clock "H" Pulse Width	t _{SICHW}		4 t _C -20	—	
	Output Data Setup Time	t _{SIOS}		6 t _C -100	—	
	Output Data Hold Time	t _{SIOH}		2 t _C -100	—	
	Input Data Setup Time	t _{SIIS}		t _C +t _{CLW} +100	—	
	Input Data Hold Time	t _{SIIH}		0	—	

1) SFT



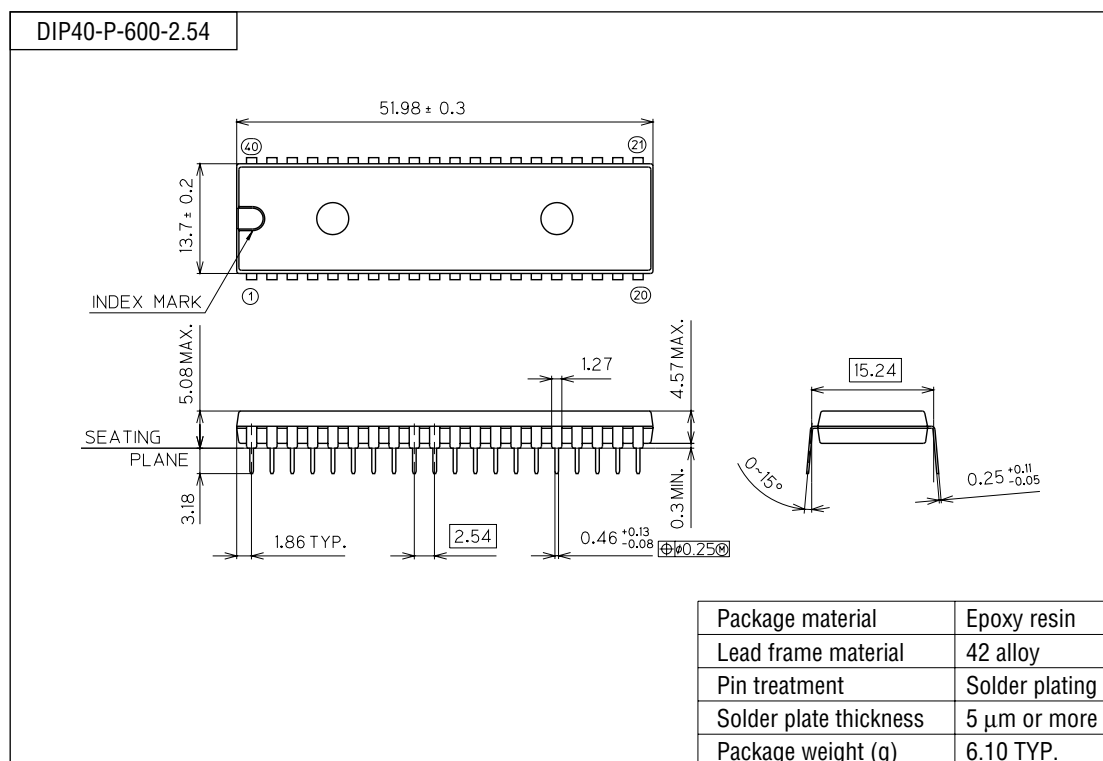
2) SIO

(Clock synchronous mode)



PACKAGE DIMENSIONS

(Unit : mm)

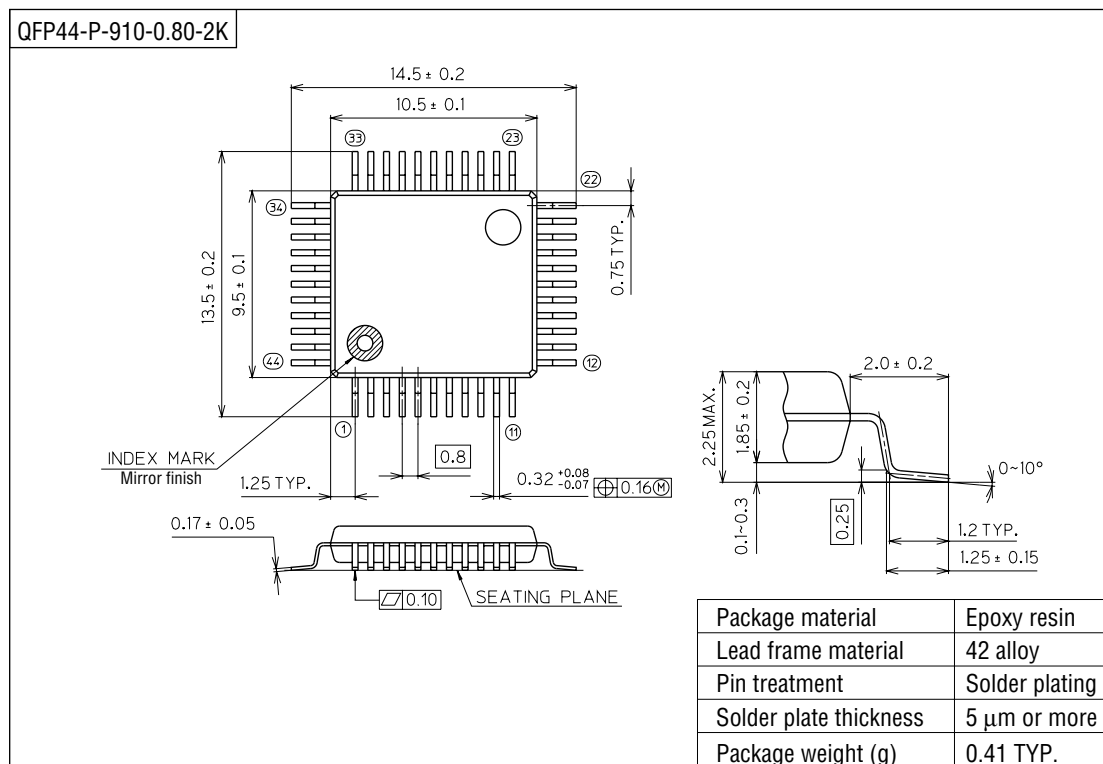


Notes for Mounting the Surface Mount Type Package

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).

(Unit : mm)

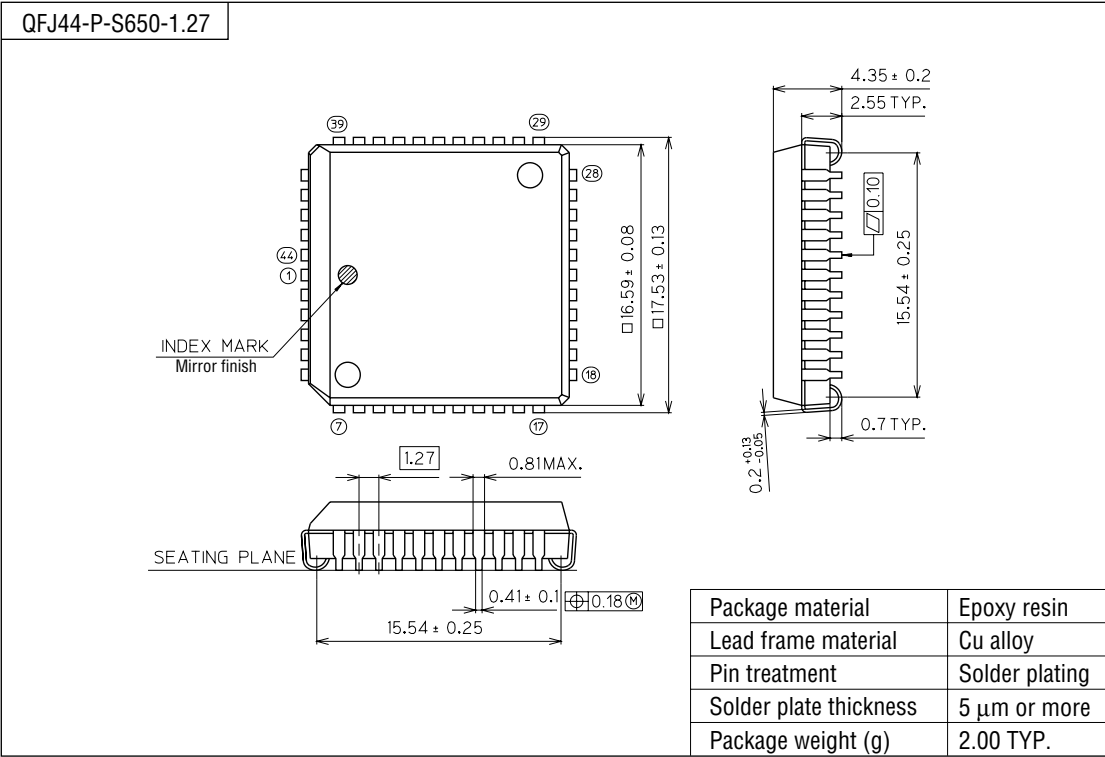


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Notes for Mounting the Surface Mount Type Package

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