
GC221-S016IP

8-bit Turbo Microcontroller

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1 GC221-SO16IP Overview

1.1 General Description

GC221-SO16IP is a high-speed 80C52 compatible Microcontroller. It executes all of the conventional 80C52 instructions.

GC221-SO16IP has three timer/counters, 14 programmable I/O ports, Watchdog timer, Stop timer, POR (Power-On Reset), UARTs, I²Cs, and LVD (Low Voltage Detector) as peripherals. In addition, it contains an internal precision oscillator, which can generate the 12 MHz system clock signal instead of a crystal oscillator.

GC221-SO16IP operates over the extended -40°C to +85°C temperature range, and is available in the 16-pin SOP package.

1.2 Features

- ◆ CPU
 - ✓ 8-bit turbo 80C52 architecture
 - ✓ 4 cycles/1 machine cycle
 - ✓ instruction level compatible with Intel 80C52
- ◆ 4 KB FLASH (Including 128B User EEPROM)
- ◆ Supporting ISP/IAP/MDS
- ◆ 128B Internal RAM
- ◆ Operating Voltage : +2.2V to +5.5V
- ◆ Operating Frequency (F_{sys})
 - ✓ 3.68 MHz (Internal POSC Clock, Default)
 - ✓ Max. 12 / 11.06 MHz @2.2V ~ 3.3V (External/Internal POSC Clock)
 - ✓ Max. 24 MHz @4.5V ~ 5.5V (External Clock)
- ◆ Operating temperature : -40 °C ~ 85 °C
- ◆ 14 Programmable I/O Pins
 - ✓ Pull-up control, Open drain, & Push-Pull output
 - ✓ TTL and CMOS compatible logic levels

- ◆ **Configurable Low Voltage Detector (LVD)**
- ◆ **Internal Precision OSC with Calibration function**
 - ✓ 11.06 MHz @+2.2V to +5.5V (Typ. +/- 1%)
 - ✓ 32kHz @+2.7V (+/- 10%) : Low Power OSC.
- ◆ **12-channel 10-bit ADC**
 - ✓ Max. 120k SPS @ $F_{ADC} = 12$ MHz ($F_{SYS} = 12$ MHz)
 - ✓ Programmable Input Clock Frequency
- ◆ **23-bit Programmable Watchdog Timer**
- ◆ **16-bit Stop Timer**
- ◆ **Two 16-bit Timer/Counters**
- ◆ **Full-Duplex 1-channel UART Comm.**
- ◆ **1-channel I2C Comm. (I2C Slave)**
- ◆ **1-channel 10-bit high speed PWM**
- ◆ **12 Interrupt Sources**
 - ✓ Timer0/1, WDT, LVD, ADC, UART, PWM, I2C1
 - ✓ 4 External Interrupt Sources: Both Edge/Level
 - ✓ Two-level Interrupt Priority
- ◆ **Reset Sources**
 - ✓ On-chip Power-On-Reset (POR/LVR)
 - ✓ External Reset
 - ✓ Configurable Low Voltage Detector Reset
 - ✓ Watchdog Timer Reset
- ◆ **Power Down Wake-up Sources**
 - ✓ Reset Sources + 4 External Interrupt (Both Levels)
 - ✓ I2C Interrupt or WDT Interrupt
 - ✓ Stop Timer wake-up
- ◆ **Power Consumption**
 - ✓ Active Current: Max. 2mA @+3.0V, 2MHz
 - ✓ Stop Current1: Max. 1uA @+5.0V (All Clock OFF)
 - ✓ Stop Current2: Max. 450uA @+3.0V, 461kHz (Only WDT is on)
 - ✓ Stop Current3: Max. 5uA @+3.0V (Only ST is ON)
- ◆ **E.S.D. Protection up to 2,000 V**
- ◆ **Latch-up Protection Up to ± 200 mA**
- ◆ **Package**
 - ✓ 16-SOP

1.3 Applications

- ◆ Mobile Devices
- ◆ Multimedia
- ◆ Navigation Systems
- ◆ Home Appliance
- ◆ Other Electronic Devices

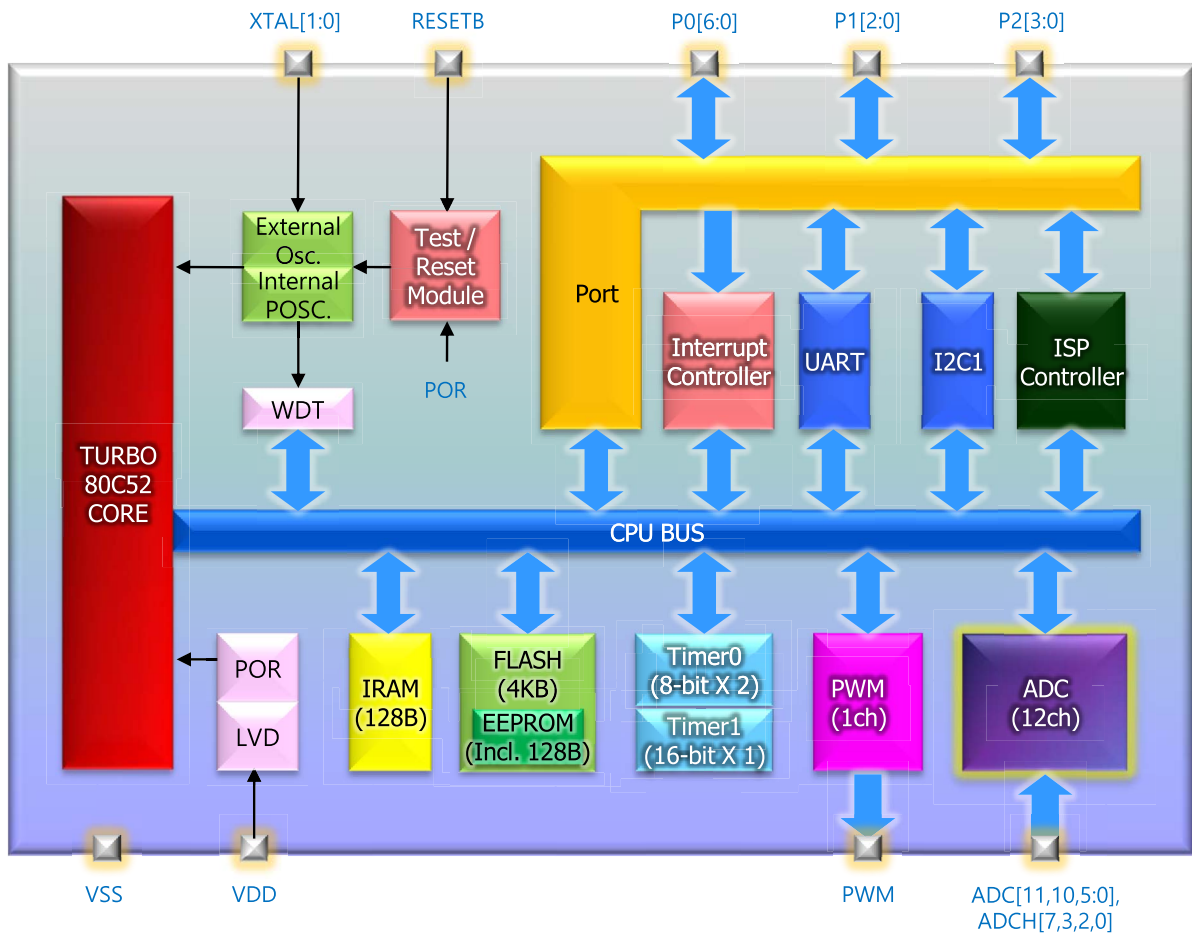
1.4 Product Family Guide

Product	Flash [Byte]	RAM [Byte]	Package	Programmable I/O	Other Peripherals
GC220	8K	128	20-TSSOP	18	3 Timer/Counters UART I2C WDT IAP ISP EJTAG LVD POR Precision Oscillator Stop Timer 16-channel 10-bit ADC 1-channel 10-bit PWM
GC221	4K	128	20-TSSOP 16-SOP 8-SOP	18 14 6	
GC222	2K	128	20-TSSOP	18	

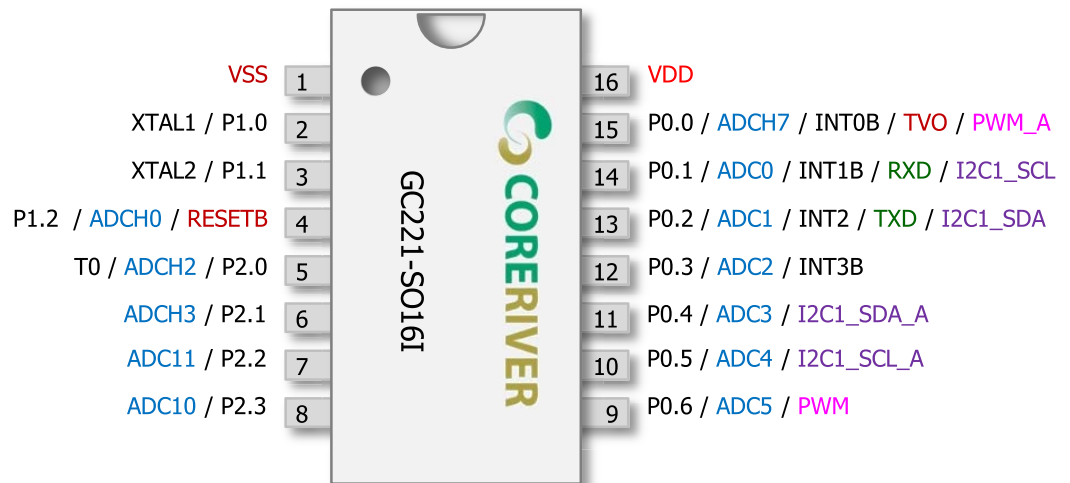
2 Block Diagram

Figure shows the block diagram of **GC221-SO16IP**. Programs reside in the internal program memory (Embedded Flash Memory). Data are read from or written to data memory (SRAM) or special function registers (SFRs).

The internal registers of **GC221-SO16IP** are configured as part of the on-chip RAM: therefore each register has an address. This is reasonable for **GC221-SO16IP**, since it has so many registers.



3 Pin Configuration



16-pin SOP Package Diagram

4 Pin Description

Pin No.	Name	Type	Description	Share Pins
1	VSS	GND		
2	XTAL1	I/O	Crystal Input	P1.0
3	XTAL2	I/O	Crystal Output	P1.1
4	RESETB	I/O	External Reset Input	P1.2 / ADCH0
5	P2.0	I/O	General I/O	T0 / ADCH2
6	P2.1	I/O	General I/O	ADCH3
7	P2.2	I/O	General I/O	ADC11
8	P2.3	I/O	General I/O	ADC10
9	P0.6	I/O	General I/O	ADC5 / PWM
10	P0.5	I/O	General I/O	ADC4 / I2C1_SCL_A
11	P0.4	I/O	General I/O	ADC3 / I2C1_SDA_A
12	P0.3	I/O	General I/O	ADC2 / INT3B
13	P0.2	I/O	General I/O	ADC1 / INT2 / TXD / I2C1_SDA
14	P0.1	I/O	General I/O	ADC0 / INT1B / RXD / I2C1_SCL
15	P0.0	I/O	General I/O	ADCH7 / INT0B / TVO / PWM_A
16	VDD	PWR		

5 Absolute Maximum Ratings

Item	Conditions	Range
Voltage on any pin relative to Ground	-	-0.5 V to ($V_{DDIO}+0.5V$)
Voltage in V_{DD} relative to Ground	-	-0.5V to 6.5V
Output Voltage	-	-0.5 V to ($V_{DDIO}+0.5V$)
Output Current High	One I/O pin active	-25mA
	All I/O pin active	-100mA
Output Current Low	One I/O pin active	+30mA
	All I/O pin active	+150mA
Storage Temperature	-	< 40°C
Soldering Temperature	-	260°C, 10 seconds within 5°C of actual peak temperature

6 DC Characteristics

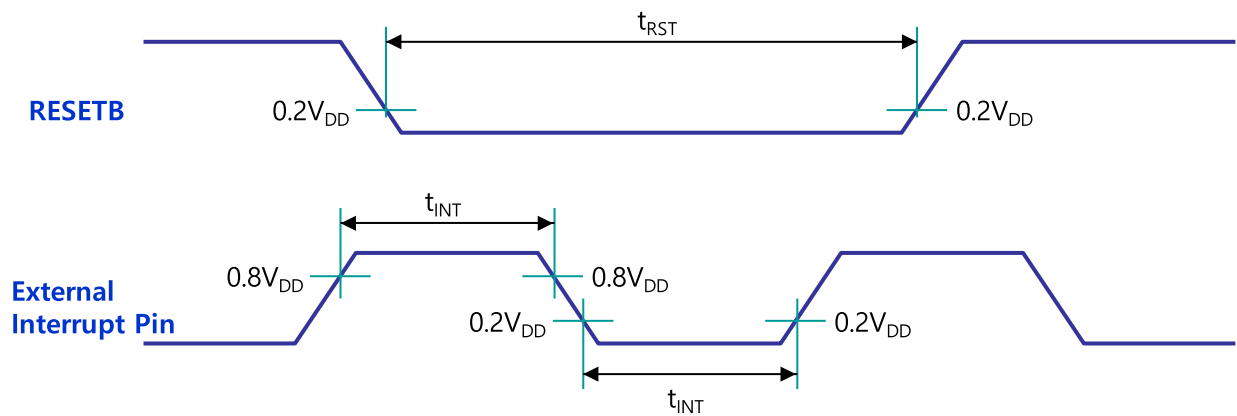
* $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$, $V_{DD} = 2.2\text{V} \sim 5.5\text{V}$ unless otherwise specified

Parameter	Symbol	Pin	Conditions	Value			Unit
				Min.	Typ.	Max.	
Input Low Voltage	V_{IL1}	RESETB ,P0, P1, P2	$V_{DD} = 2.2\text{V} \sim 5.5\text{V}$	-0.5	-	$0.2V_{DD} - 0.1$	V
	V_{IL2}	XTAL1, XTAL2		0.5		$0.3V_{DD}$	
Input high Voltage	V_{IH1}	RESETB ,P0, P1, P2	$V_{DD} = 2.2\text{V} \sim 5.5\text{V}$	$0.2V_{DD} + 1.0$	-	$V_{DD} + 0.5$	V
	V_{IH2}	XTAL1, XTAL2		$0.7V_{DD}$	-	$V_{DD} + 0.5$	
Output Low Voltage	V_{OL}	All Pins	$I_{OL} = 17\text{mA} @V_{DD}=5\text{V}$ $I_{OL} = 7\text{mA} @V_{DD}=3\text{V}$ $I_{OL} = 4\text{mA} @V_{DD}=2.4\text{V}$	-	-	$0.3V_{DDIO}$	V
	V_{OL2}	P0[3:0] when high drive is enabled.	$I_{OL} = 50\text{mA} @V_{DD}=5\text{V}$ $I_{OL} = 20\text{mA} @V_{DD}=3\text{V}$ $I_{OL} = 12\text{mA} @V_{DD}=2.4\text{V}$	-	-	$0.3V_{DDIO}$	V
Output High Voltage	V_{OH}	All Pins	$I_{OH} = -18\text{mA} @V_{DD}=5\text{V}$ $I_{OH} = -6\text{mA} @V_{DD}=3\text{V}$ $I_{OH} = -3\text{mA} @V_{DD}=2.4\text{V}$	$0.7V_{DDIO}$	-	-	V
	V_{OH2}	P0[3:0] when high drive is enabled.	$I_{OH} = -26\text{mA} @V_{DD}=5\text{V}$ $I_{OH} = -8\text{mA} @V_{DD}=3\text{V}$ $I_{OH} = -4\text{mA} @V_{DD}=2.4\text{V}$	$0.7V_{DDIO}$	-	-	V
	V_{OHP}	ALL Pins (Pull-up Resistor Only)	$I_{OHP} = -49\mu\text{A} @V_{DD}=5\text{V}$ $I_{OHP} = -28\mu\text{A} @V_{DD}=3\text{V}$ $I_{OHP} = -22\mu\text{A} @V_{DD}=2.4\text{V}$	$0.7V_{DDIO}$	-	-	V
Input Leakage Current	I_{IL}	All Pins Except of XTAL1, XTAL2	$V_{IN} = V_{IH}$ or V_{IL}	-	-	± 1	μA
Pin Capacitance	C_{IO}	All Pins	$V_{DD} = 5\text{V}$	-	10	-	pF

7 AC Characteristics

* $T_A = -40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$ unless otherwise specified

Parameter	Symbol	Pin	Conditions	Value			Unit
				Min.	Typ.	Max.	
Operating Frequency	F_{SYS}	Internal Oscillator XTAL1, XTAL2	$V_{\text{DD}} = 5\text{V} \pm 10\%$	-	-	24	MHz
			$V_{\text{DD}} = 3\text{V} \pm 10\%$	-	-	12	
RESETB Input Width	t_{RST}	RESETB	$V_{\text{DD}} = 5\text{V} \pm 10\%$	20	-	-	F_{SYS}
			$V_{\text{DD}} = 3\text{V} \pm 10\%$	20	-	-	
External Interrupt Input Width	t_{INT}	External Interrupt	$V_{\text{DD}} = 5\text{V} \pm 10\%$	4	-	-	F_{SYS}
			$V_{\text{DD}} = 3\text{V} \pm 10\%$	4	-	-	

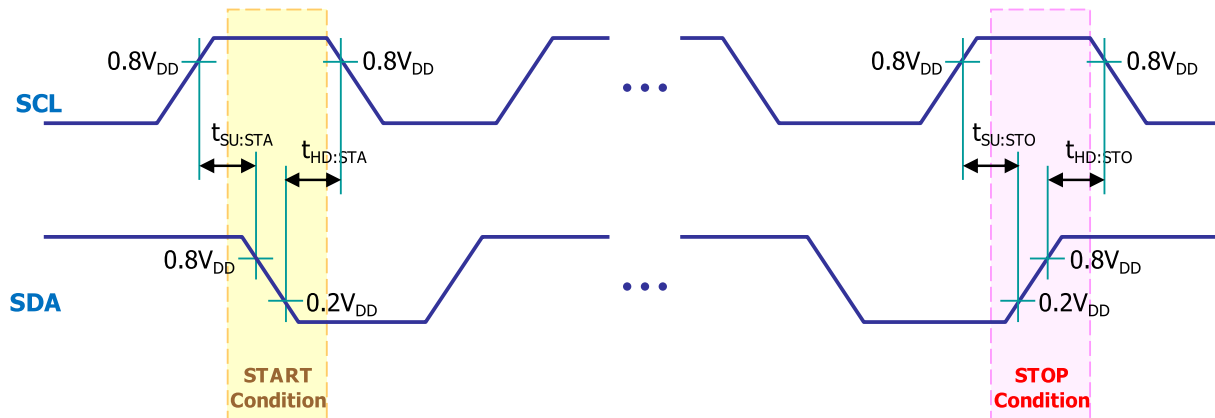


8 ADC Specifications

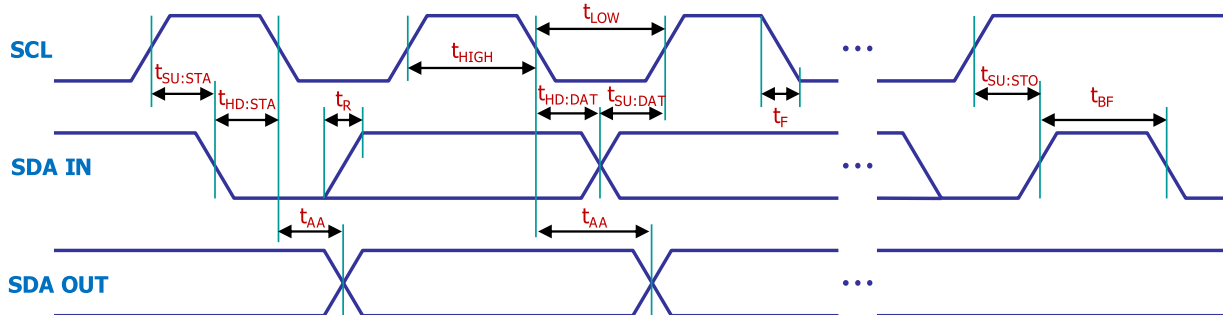
* $T_A = -40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$ unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit	
			Min.	Typ.	Max.		
Supply Voltage	V_{DDADC}	$V_{DDADC} = V_{DD}$	2.4	-	5.5	V	
Input Voltage	V_{INADC}	-	V_{SS}	-	V_{DD}	V	
Resolution	RES_{ADC}	-	-	10	-	bit	
Operating Frequency	F_{ADC}	$V_{DD} = 4.5V \sim 5.5V$ $V_{DD} = 2.4V \sim 3.3V$	-	-	10 5	MHz	
Conversion Time	t_{ADC}	-	-	$96 / F_{ADC}$	-	s	
Overall Accuracy	OA_{ADC}	$V_{DD} = 5V, F_{ADC} = 10MHz$ $V_{DD} = 3V, F_{ADC} = 5MHz$	-	± 2	± 4	LSB	
Integral Nonlinearity	INL_{ADC}	$V_{DD} = 5V, F_{ADC} = 10MHz$ $V_{DD} = 3V, F_{ADC} = 5MHz$	-	± 2	± 4	LSB	
Differential Nonlinearity	DNL_{ADC}	$V_{DD} = 5V, F_{ADC} = 10MHz$ $V_{DD} = 3V, F_{ADC} = 5MHz$	-	± 0.5	± 1	LSB	
Zero Input Error	ZIE_{ADC}	$V_{DD} = 5V, F_{ADC} = 10MHz$ $V_{DD} = 3V, F_{ADC} = 5MHz$	-	± 2	± 4	LSB	
Full Scale Error	FSE_{ADC}	$V_{DD} = 5V, F_{ADC} = 10MHz$ $V_{DD} = 3V, F_{ADC} = 5MHz$	-	± 2	± 4	LSB	
Analog Input Capacitance	C_{INADC}	-	-	10	15	pF	
ADC Current	Active	I_{ADC}	$V_{DD} = 5V, F_{ADC} = 10MHz$	-	1	2	mA
			$V_{DD} = 3V, F_{ADC} = 5MHz$	-	0.3	0.6	
	Power-down	$V_{DD} = 5V$	-	-	100	nA	

9 I2C Timing Characteristics

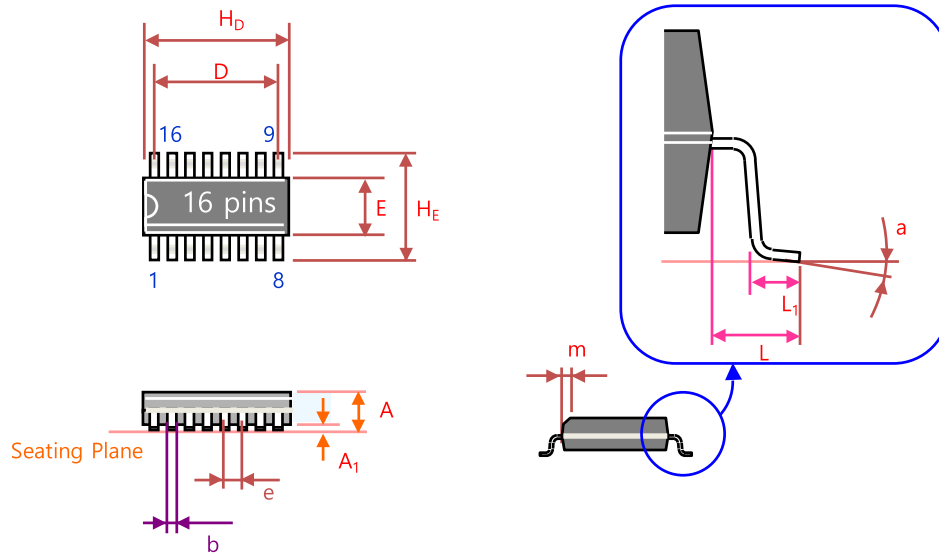


Symbol	Characteristics		Min. [ns]	Max. [ns]	Conditions
$t_{SU:STA}$	START Condition Setup Time	100kHz Mode	4,700	-	Only relevant for repeated START condition
		400kHz Mode	600	-	
$t_{HD:STA}$	START Condition Hold Time	100kHz Mode	4,700	-	After this period, the first clock pulse is generated
		400kHz Mode	600	-	
$t_{SU:STO}$	STOP Condition Setup Time	100kHz Mode	4,700	-	
		400kHz Mode	600	-	
$t_{HD:STO}$	STOP Condition Hold Time	100kHz Mode	4,700	-	
		400kHz Mode	600	-	



Symbol	Characteristics	Min. [ns]	Max. [ns]	Conditions	
t_{HIGH}	Clock High Time	100kHz Mode	4,000	-	Minimum Frequency : 1MHz
		400kHz Mode	600	-	Minimum Frequency : 5MHz
t_{LOW}	Clock Low Time	100kHz Mode	4,700	-	Minimum Frequency : 1MHz
		400kHz Mode	1,300	-	Minimum Frequency : 5MHz
$t_{SU:DAT}$	Data Input Setup Time	100kHz Mode	250	-	
		400kHz Mode	100	-	
$t_{HD:DAT}$	Data Input Hold Time	100kHz Mode	0	-	
		400kHz Mode	0	900	
t_{AA}	Data Valid from Clock	100kHz Mode	-	3,500	
		400kHz Mode	-	-	
t_{BF}	BUS Free Time	100kHz Mode	4,700	-	
		400kHz Mode	1,300	-	
t_R	SDA & SCL Rising Time	100kHz Mode	-	1,000	The Range of Cb is from 10pF to 400pF
		400kHz Mode	$2.0 + 0.1C_b$	300	
t_F	SDA & SCL Falling Time	100kHz Mode	-	300	The Range of Cb is from 10pF to 400pF
		400kHz Mode	$2.0 + 0.1C_b$	300	

10 16-pin SOP Package Dimension



Symbol	Dimension in Inches			Dimension in mm		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.093	0.099	0.104	2.35	2.45	2.65
A_1	0.004	0.008	0.012	0.10	0.20	0.30
b	0.014	0.016	0.019	0.35	0.42	0.49
D	-	.350	-	-	8.89	-
E	0.150	0.153	0.157	3.80	3.90	4.00
H_D	0.398	0.405	0.413	10.10	10.29	10.50
H_E	0.234	0.239	0.244	5.95	6.07	6.20
L	0.038	0.043	0.048	0.97	1.08	1.2
L_1	0.022	0.027	0.032	0.58	0.70	0.82
a	0 [°]	-	8 [°]	0 [°]	-	8 [°]
e	0.050 BSC			1.27 BSC		
m	0.010	0.015	0.020	0.25	0.37	0.50

Notes:

1. Dimension D & E include mold mismatch and are determined at the mold parting line.
2. General appearance spec. should be based on final visual inspection spec.