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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	-
Core Size	8-Bit
Speed	12MHz
Connectivity	SIO, UART/USART
Peripherals	LVD, POR, PWM, WDT
Number of I/O	25
Program Memory Size	8KB (8K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	256 x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 11x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	36-LQFP
Supplier Device Package	36-QFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/onsemi/lc87fbh08au-eb-3h

■AD converter: 12 bits/8 bits × 11 channels
- Successive approximation
- 12 bits/8 bits AD converter resolution selectable
- Port input: 10 channels, Reference voltage input: 1 channel

■PWM: Multifrequency 12-bit PWM × 2 channels

■Reference voltage generator circuit (VREF17)
- Capable of monitoring the power supply voltage by AD conversion of frequency variable RC oscillator circuit's reference voltage.

■Remote Control Receiver Circuit (sharing pins with P73, INT3, and T0IN)
- Noise rejection function (noise filter time constant selectable from 1 tCYC, 32 tCYC, and 128 tCYC)

■Clock Output Function
- Capable generating clock outputs with a frequency of 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64 of the source clock selected as the system clock.
- Capable of generating the source clock for the subclock.

■Watchdog Timer
- Capable of generating an internal reset on an overflow of a timer running on the low-speed RC oscillator clock or subclock.
- Operating mode at standby is selectable from 3 modes (continue counting/stop operation/stop counting with a count value held).

■Interrupts
- 20 sources, 10 vector addresses
  1) Provides three levels (low (L), high (H), and highest (X)) of multiplex interrupt control. Any interrupt requests of the level equal to or lower than the current interrupt are not accepted.
  2) When interrupt requests to two or more vector addresses occur at the same time, the interrupt of the highest level takes precedence over the other interrupts. For interrupts of the same level, the interrupt into the smallest vector address takes precedence.

No.	Vector Address	Level	Interrupt Source
1	00003H	X or L	INT0
2	0000BH	X or L	INT1
3	00013H	H or L	INT2/T0L/INT4
4	0001BH	H or L	INT3/INT5/base timer
5	00023H	H or L	T0H
6	0002BH	H or L	T1L/T1H
7	00033H	H or L	SIO0/UART1 receive
8	0003BH	H or L	SIO1/UART1 transmit
9	00043H	H or L	ADC/T6/T7/ PWM4, PWM5
10	0004BH	H or L	Port 0

- Priority levels X > H > L
- Of interrupts of the same level, the one with the smallest vector address takes precedence.

■Subroutine Stack Levels: 128levels (The stack is allocated in RAM.)

■High-speed Multiplication/Division Instructions
- 16 bits × 8 bits (5 tCYC execution time)
- 24 bits × 16 bits (12 tCYC execution time)
- 16 bits ÷ 8 bits (8 tCYC execution time)
- 24 bits ÷ 16 bits (12 tCYC execution time)

■Oscillation Circuits

- Internal oscillation circuits

  Low-speed RC oscillation circuit (SRC): For system clock / For Watchdog timer (100kHz)
  Medium-speed RC oscillation circuit (RC): For system clock (1MHz)
  Frequency variable RC oscillation circuit (MRC): For system clock (8MHz ± 1.5%, Ta=–10°C to +85°C)
- External oscillation circuits

  Hi-speed CF oscillation circuit (CF): For system clock, with internal Rf
  Low speed crystal oscillation circuit (X'tal): For low-speed system clock / For Watchdog timer, with internal Rf

  1) The CF and crystal oscillation circuits share the same pins. The active circuit is selected under program control.
  2) Both the CF and crystal oscillator circuits stop operation on a system reset. After reset is released, oscillation is stopped so start the oscillation operation by program.

■System Clock Divider Function

- Can run on low current.
- The minimum instruction cycle selectable from 300ns, 600ns, 1.2μs, 2.4μs, 4.8μs, 9.6μs, 19.2μs, 38.4μs, and 76.8μs (at a main clock rate of 10MHz).

■Internal Reset Function

- Power-on reset (POR) function
  1) POR reset is generated only at power-on time.
  2) The POR release level can be selected from 8 levels (1.67V, 1.97V, 2.07V, 2.37V, 2.57V, 2.87V, 3.86V, and 4.35V) through option configuration.
- Low-voltage detection reset (LVD) function
  1) LVD and POR functions are combined to generate resets when power is turned on and when power voltage falls below a certain level.
  2) The use or disuse of the LVD function and the low voltage threshold level (7 levels: 1.91V, 2.01V, 2.31V, 2.51V, 2.81V, 3.79V, 4.28V) can be selected by optional configuration.

■Standby Function

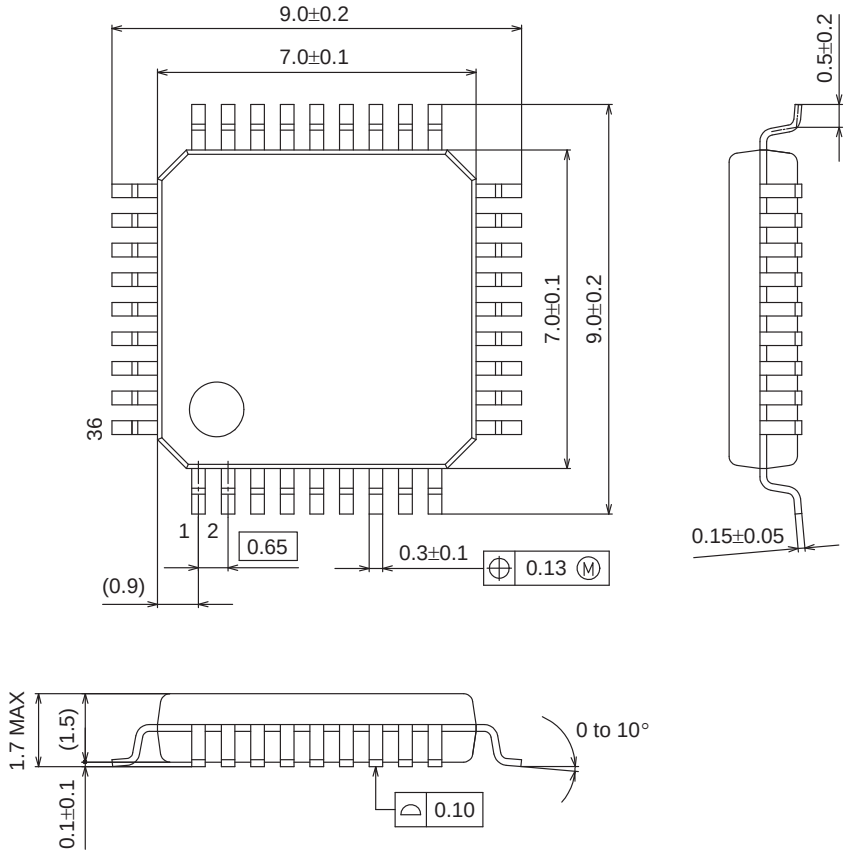
- HALT mode: Halts instruction execution while allowing the peripheral circuits to continue operation.
  1) Oscillation is not halted automatically.
  2) There are four ways of resetting the HALT mode.
     (1) Setting the reset pin to the low level
     (2) System resetting by low-voltage detection
     (3) System resetting by watchdog timer
     (4) Occurrence of an interrupt
- HOLD mode: Suspends instruction execution and the operation of the peripheral circuits.
  1) The CF, low-/medium-/ Frequency variable RC, and crystal oscillators automatically stop operation.
     Note: The oscillation of the low-speed RC oscillator is also controlled directly by the watchdog timer and its standby-mode-time oscillation is also controlled.
  2) There are five ways of resetting the HOLD mode.
     (1) Setting the reset pin to the lower level.
     (2) System resetting by low-voltage detection
     (3) System resetting by watchdog timer
     (4) Having an interrupt source established at either INT0, INT1, INT2, INT4, INT5
        * INT0 and INT1 HOLD mode reset is available only when level detection is set.
     (5) Having an interrupt source established at port 0.

Continued on next page.

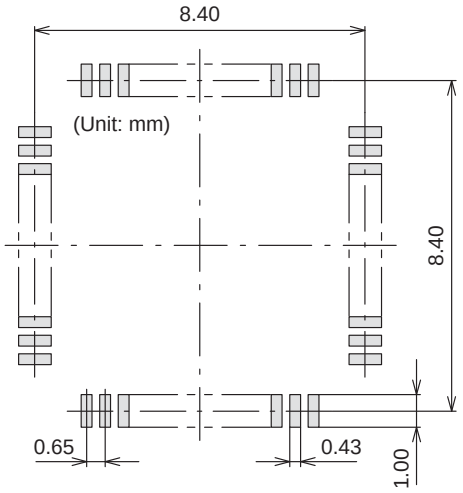
Package Dimensions

unit : mm

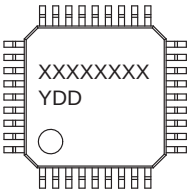
LQFP36 7x7 / QFP36
CASE 561AV
ISSUE A



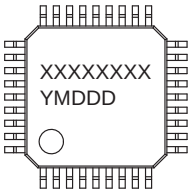
SOLDERING FOOTPRINT*



GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
Y = Year
DD = Additional Traceability Data



XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, “G” or microdot “▪”, may or may not be present.

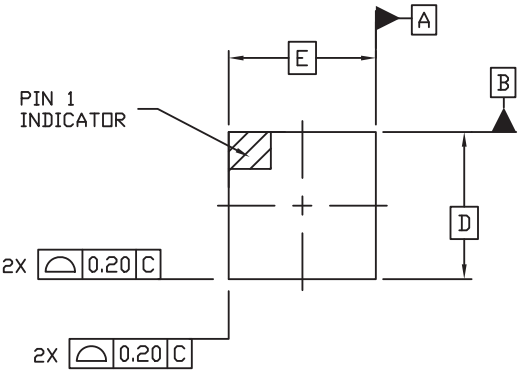
NOTE: The measurements are not to guarantee but for reference only.

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

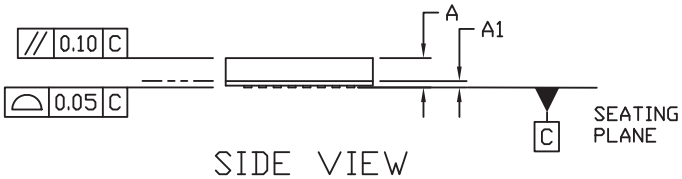
Package Dimensions

unit : mm
[Build to order]

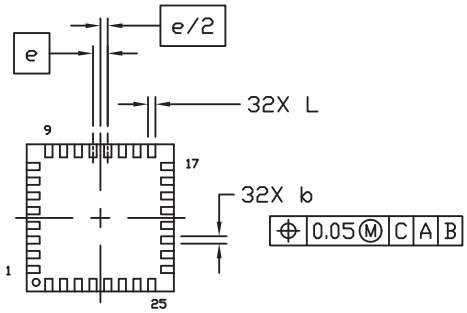
VQLP32 4x4
CASE 602AE
ISSUE A



TOP VIEW



SIDE VIEW

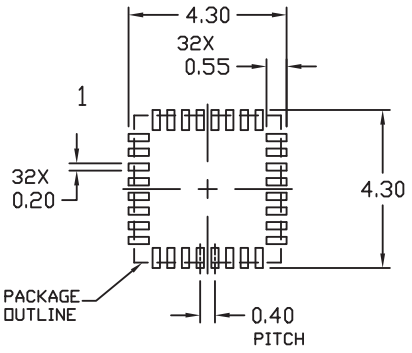


BOTTOM VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS

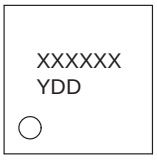
DIM	MILLIMETERS	
	MIN.	MAX.
A	---	0.85
A1	---	0.05
b	0.15	0.25
D	4.00 BSC	
E	4.00 BSC	
e	0.40 BSC	
L	0.30	0.40



RECOMMENDED
MOUNTING FOOTPRINT

GENERIC MARKING DIAGRAM*

XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

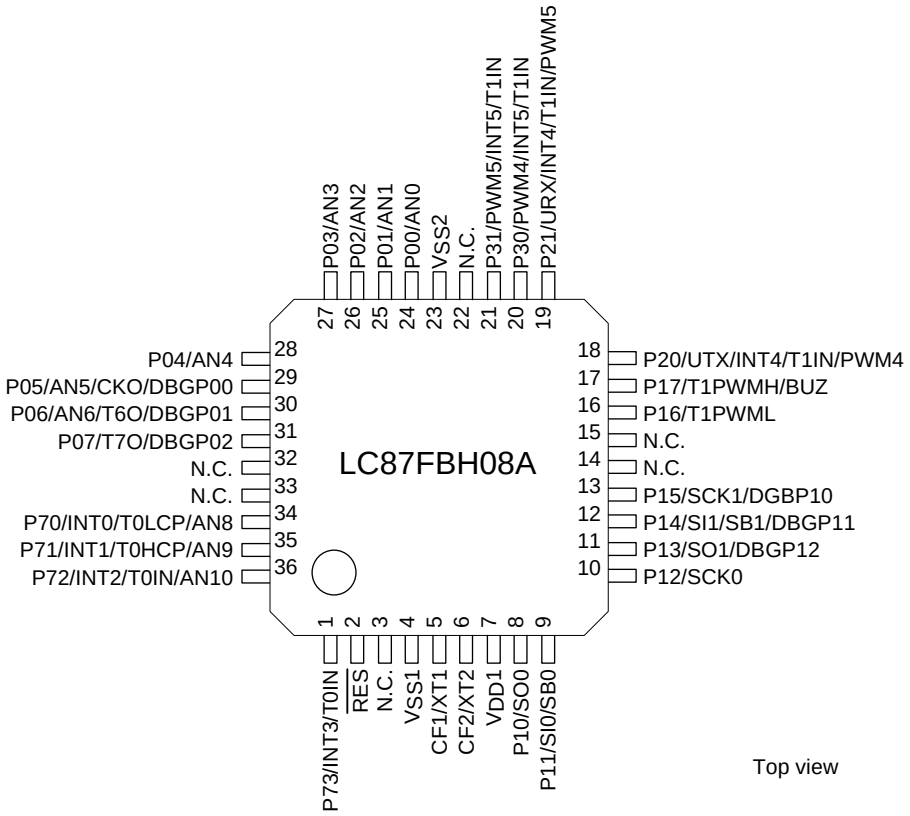


XXXXX = Specific Device Code
Y = Year
DD = Additional Traceability Data

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, “G” or microdot “▪”, may or may not be present.

Pin Assignment

LQFP36 7x7 / QFP36



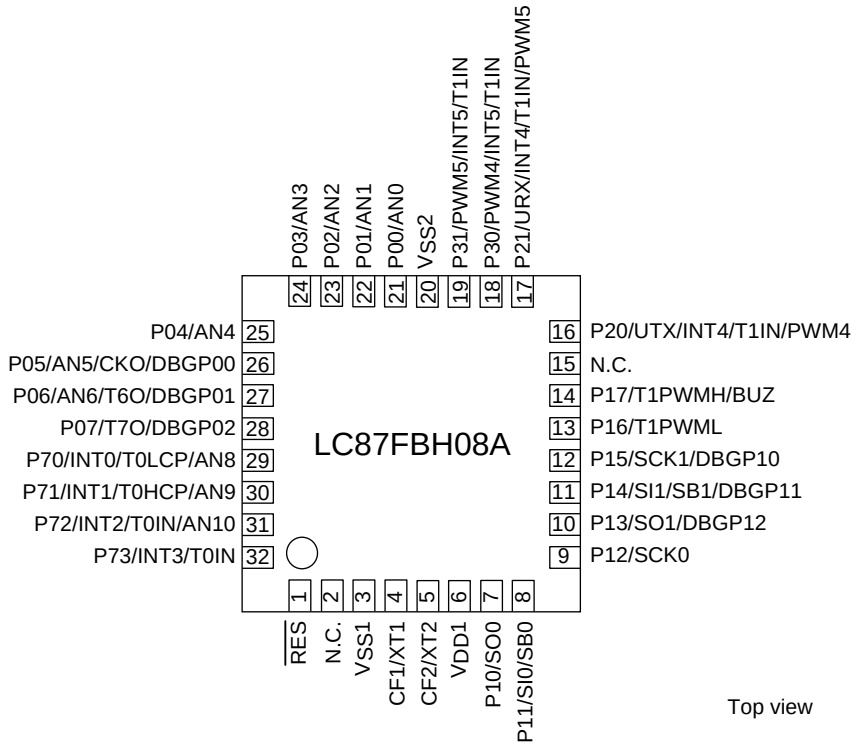
QFP36	NAME
1	P73/INT3/T0IN
2	$\overline{\text{RES}}$
3	N.C.
4	$V_{SS}1$
5	CF1/XT1
6	CF2/XT2
7	$V_{DD}1$
8	P10/SO0
9	P11/SI0/SB0
10	P12/SCK0
11	P13/SO1/DBGP12
12	P14/SI1/SB1/DBGP11
13	P15/SCK1/DBGP10
14	N.C.
15	N.C.
16	P16/T1PWML
17	P17/T1PWMH/BUZ
18	P20/UTX/INT4/T1IN/PWM4

QFP36	NAME
19	P21/URX/INT4/T1IN/PWM5
20	P30/PWM4/INT5/T1IN
21	P31/PWM5/INT5/T1IN
22	N.C.
23	$V_{SS}2$
24	P00/AN0
25	P01/AN1
26	P02/AN2
27	P03/AN3
28	P04/AN4
29	P05/AN5/CKO/DBGP00
30	P06/AN6/T6O/DBGP01
31	P07/T7O/DBGP02
32	N.C.
33	N.C.
34	P70/INT0/T0LCP/AN8
35	P71/INT1/T0HCP/AN9
36	P72/INT2/T0IN/AN10

Note: N.C. pins must be held open (disconnected).

Pin Assignment

VQLP32 4x4 [Buitd to order]



Top view

VQLP32	NAME
1	$\overline{\text{RES}}$
2	N.C.
3	$V_{SS}1$
4	CF1/XT1
5	CF2/XT2
6	$V_{DD}1$
7	P10/SO0
8	P11/SI0/SB0
9	P12/SCK0
10	P13/SO1/DBGP12
11	P14/SI1/SB1/DBGP11
12	P15/SCK1/DBGP10
13	P16/T1PWML
14	P17/T1PWMH/BUZ
15	N.C.
16	P20/UTX/INT4/T1IN/PWM4

VQLP32	NAME
17	P21/URX/INT4/T1IN/PWM5
18	P30/PWM4/INT5/T1IN
19	P31/PWM5/INT5/T1IN
20	$V_{SS}2$
21	P00/AN0
22	P01/AN1
23	P02/AN2
24	P03/AN3
25	P04/AN4
26	P05/AN5/CKO/DBGP00
27	P06/AN6/T6O/DBGP01
28	P07/T7O/DBGP02
29	P70/INT0/T0LCP/AN8
30	P71/INT1/T0HCP/AN9
31	P72/INT2/T0IN/AN10
32	P73/INT3/T0IN

Note: N.C. pins must be held open (disconnected).

Pin Function Chart

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Description</th><th>Option</th></tr>
<tr><td>$V_{SS}1$, $V_{SS}2$</td><td>-</td><td>- Power supply pin</td><td>No</td></tr>
<tr><td>$V_{DD}1$</td><td>-</td><td>+ Power supply pin</td><td>No</td></tr>
<tr><td>Port 0
P00 to P07</td><td>I/O</td><td>• 8-bit I/O port
• I/O specifiable in 4-bit units
• Pull-up resistors can be turned on and off in 4-bit units.
• HOLD reset input
• Port 0 interrupt input
• Pin functions
P05: System clock output
P06: Timer 6 toggle output
P07: Timer 7 toggle output
P00(AN0) to P06(AN6): AD converter input
P05(DBGP00) to P07(DBGP02): On-chip debugger 0 port</td><td>Yes</td></tr>
<tr><td>Port 1
P10 to P17</td><td>I/O</td><td>• 8-bit I/O port
• I/O specifiable in 1-bit units
• Pull-up resistors can be turned on and off in 1-bit units.
• Pin functions
P10: SIO0 data output
P11: SIO0 data input/bus I/O
P12: SIO0 clock I/O
P13: SIO1 data output
P14: SIO1 data input / bus I/O
P15: SIO1 clock I/O
P16: Timer 1PWML output
P17: Timer 1PWMH output / beeper output
P15(DBGP10) to P13(DBGP12): On-chip-debugger 1 port</td><td>Yes</td></tr>
<tr><td>Port 2
P20 to P21</td><td>I/O</td><td>• 2-bit I/O port
• I/O specifiable in 1-bit units
• Pull-up resistors can be turned on and off in 1-bit units.
• Pin functions
P20: UART transmit / PWM4 output
P21: UART receive / PWM5 output
P20 to P21: INT4 input / HOLD reset input / timer 1 event input / timer 0L capture input / timer 0H capture input
Interrupt acknowledge types
<table>
<tr><th></th><th>Rising</th><th>Falling</th><th>Rising & Falling</th><th>H level</th><th>L level</th></tr>
<tr><td>INT4</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td></tr>
</table></td><td>Yes</td></tr>
<tr><td>Port 3
P30 to P31</td><td>I/O</td><td>• 2-bit I/O port
• I/O specifiable in 1 bit units
• Pull-up resistors can be turned on and off in 1 bit units.
• Pin functions
P30: PWM4 output
P31: PWM5 output
P30 to P31: INT5 input/HOLD reset input / timer 1 event input / timer 0L capture input / timer 0H capture input
Interrupt acknowledge types
<table>
<tr><th></th><th>Rising</th><th>Falling</th><th>Rising & Falling</th><th>H level</th><th>L level</th></tr>
<tr><td>INT5</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td></tr>
</table></td><td>Yes</td></tr>
</table>

Continued on next page.

Continued from preceding page.

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Description</th><th>Option</th></tr>
<tr><td>Port 7
P70 to P73</td><td>I/O</td><td>• 4-bit I/O port
• I/O specifiable in 1 bit units
• Pull-up resistors can be turned on and off in 1 bit units.
• Pin functions
P70: INT0 input / HOLD reset input / timer 0L capture input
P71: INT1 input / HOLD reset input / timer 0H capture input
P72: INT2 input / HOLD reset input / timer 0 event input / timer 0L capture input
P73: INT3 input (with noise filter) / timer 0 event input / timer 0H capture input
P70(AN8) to P72(AN10): AD converter input
Interrupt acknowledge types
<table>
<tr><th></th><th>Rising</th><th>Falling</th><th>Rising & Falling</th><th>H level</th><th>L level</th></tr>
<tr><td>INT0</td><td>enable</td><td>enable</td><td>disable</td><td>enable</td><td>enable</td></tr>
<tr><td>INT1</td><td>enable</td><td>enable</td><td>disable</td><td>enable</td><td>enable</td></tr>
<tr><td>INT2</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td></tr>
<tr><td>INT3</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td></tr>
</table></td><td>No</td></tr>
<tr><td>$\overline{\text{RES}}$</td><td>I/O</td><td>External reset input / internal reset output</td><td>No</td></tr>
<tr><td>CF1/XT1</td><td>I</td><td>• Ceramic resonator or 32.768kHz crystal oscillator input pin
• Pin function
General-purpose input port</td><td>No</td></tr>
<tr><td>CF2/XT2</td><td>I/O</td><td>• Ceramic resonator or 32.768kHz crystal oscillator output pin
• Pin function
General-purpose I/O port</td><td>No</td></tr>
</table>

Port Output Types

The table below lists the types of port outputs and the presence/absence of a pull-up resistor.
Data can be read into any input port even if it is in the output mode.

Port Name	Option selected in units of	Option type	Output type	Pull-up resistor
P00 to P07	1 bit	1	CMOS	Programmable (Note 1)
		2	Nch-open drain	No
P10 to P17	1 bit	1	CMOS	Programmable
		2	Nch-open drain	Programmable
P20 to P21	1 bit	1	CMOS	Programmable
		2	Nch-open drain	Programmable
P30 to P31	1 bit	1	CMOS	Programmable
		2	Nch-open drain	Programmable
P70	-	No	Nch-open drain	Programmable
P71 to P73	-	No	CMOS	Programmable
CF2/XT2	-	No	Ceramic resonator/32.768kHz crystal resonator output Nch-open drain (N-channel open drain when set to general-purpose output port)	No

Note 1: The control of the presence or absence of the programmable pull-up resistors for port 0 and the switching between low-and high-impedance pull-up connection is exercised in nibble (4-bit) units (P00 to 03 or P04 to 07).

Absolute Maximum Ratings at Ta = 25°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter		Symbol	Pin/Remarks	Conditions	Specification				
					V_{DD}[V]	min	typ	max	unit
Maximum supply voltage		V_{DD} max	$V_{DD}1$			−0.3		+6.5	V
Input voltage		V_I	CF1			−0.3		V_{DD}+0.3	
Input/output voltage		V_{IO}	Ports 0, 1, 2, 3, Port 7, CF2, $\overline{RES}$			−0.3		V_{DD}+0.3	
High level output current	Peak output current	IOPH(1)	Ports 0, 1, 2, 3	CMOS output select Per 1 applicable pin		−10			mA
		IOPH(2)	P71 to P73	Per 1 applicable pin		-5			
	Mean output current (Note 1-1)	IOMH(1)	Ports 0, 1, 2, 3	CMOS output select Per 1 applicable pin		−7.5			
		IOMH(2)	P71 to P73	Per 1 applicable pin		−3			
	Total output current	ΣIOAH(1)	Ports 0, 1, 2, 3, P71 to P73	Total of all applicable pins		−25			
Low level output current	Peak output current	IOPL(1)	P02 to P07, Ports 1, 2, 3	Per 1 applicable pin				20	
		IOPL(2)	P00, P01	Per 1 applicable pin				30	
		IOPL(3)	Port 7, CF2	Per 1 applicable pin				10	
	Mean output current (Note 1-1)	IOML(1)	P02 to P07 Ports 1, 2, 3	Per 1 applicable pin				15	
		IOML(2)	P00, P01	Per 1 applicable pin				20	
		IOML(3)	Port 7, CF2	Per 1 applicable pin				7.5	
	Total output current	ΣIOAL(1)	Ports 0, 1, Ports 2, 3, CF2	Total of all applicable pins				70	
		ΣIOAL(2)	Port 7	Total of all applicable pins				15	
Power dissipation		Pd max(1)	QFP36(7×7)	Ta=−40 to +85°C Package only				120	mW
		Pd max(2)		Ta=−40 to +85°C Package with thermal resistance board (Note 1-2)				275	
Operating ambient temperature		Topr				−40		+85	°C
Storage ambient temperature		Tstg				−55		+125	

Note 1-1: The mean output current is a mean value measured over 100ms.

Note 1-2: SEMI standards thermal resistance board (size: 76.1×114.3×1.6tmm, glass epoxy) is used.

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Allowable Operating Conditions at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions	V_{DD}[V]	Specification min	typ	max	unit
Operating supply voltage (Note 2-1)	$V_{DD}(1)$	$V_{DD}1$	0.245μs ≤ tCYC ≤ 200μs		2.7		5.5	V
	$V_{DD}(2)$		0.294μs ≤ tCYC ≤ 200μs		2.2		5.5	
	$V_{DD}(3)$		0.735μs ≤ tCYC ≤ 200μs		1.8		5.5	
Memory sustaining supply voltage	VHD	$V_{DD}1$	RAM and register contents sustained in HOLD mode.		1.6			
High level input voltage	$V_{IH}(1)$	Ports 1, 2, 3, 7		1.8 to 5.5	$0.3V_{DD}+0.7$		V_{DD}	
	$V_{IH}(2)$	Ports 0		1.8 to 5.5	$0.3V_{DD}+0.7$		V_{DD}	
	$V_{IH}(3)$	CF1, CF2, $\overline{RES}$		1.8 to 5.5	$0.75V_{DD}$		V_{DD}	
Low level input voltage	$V_{IL}(1)$	Ports 1, 2, 3, 7		4.0 to 5.5	V_{SS}		$0.1V_{DD}+0.4$	
				1.8 to 4.0	V_{SS}		$0.2V_{DD}$	
	$V_{IL}(2)$	Ports 0		4.0 to 5.5	V_{SS}		$0.15V_{DD}+0.4$	
				1.8 to 4.0	V_{SS}		$0.2V_{DD}$	
	$V_{IL}(3)$	CF1, CF2, $\overline{RES}$		1.8 to 5.5	V_{SS}		$0.25V_{DD}$	
High level output current	$I_{OH}(1)$	Ports 0, 1, 2, P71 to P73	Per 1 applicable pin	4.5 to 5.5	–1.0			mA
	$I_{OH}(2)$			2.7 to 4.5	–0.35			
	$I_{OH}(3)$			1.8 to 2.7	–0.15			
	$I_{OH}(4)$	Ports 3, P05 (System clock output function used)	Per 1 applicable pin	4.5 to 5.5	–6.0			
	$I_{OH}(5)$			2.7 to 4.5	–1.4			
	$I_{OH}(6)$			1.8 to 2.7	–0.8			
	$\Sigma I_{OH}(1)$	Ports 0, 1, 2, 3, 7	Total of all applicable pins	4.5 to 5.5	–25			
	$\Sigma I_{OH}(2)$			2.7 to 4.5	–11.2			
	$\Sigma I_{OH}(3)$			1.8 to 2.7	–5.4			
Low level output current	$I_{OL}(1)$	Ports 0, 1, 2, 3	Per 1 applicable pin	4.5 to 5.5			10	
	$I_{OL}(2)$			2.7 to 4.5			1.4	
	$I_{OL}(3)$			1.8 to 2.7			0.8	
	$I_{OL}(4)$	Port 7, CF2	Per 1 applicable pin	2.7 to 5.5			1.4	
	$I_{OL}(5)$			1.8 to 2.7			0.8	
	$I_{OL}(6)$	P00, P01	Per 1 applicable pin	4.5 to 5.5			25	
	$I_{OL}(7)$			2.7 to 4.5			4	
	$I_{OL}(8)$			1.8 to 2.7			2	
	$\Sigma I_{OL}(1)$	Ports 0, 1, 2, 3, CF2	Total of all applicable pins	4.5 to 5.5			70	
	$\Sigma I_{OL}(2)$			2.7 to 4.5			34.6	
	$\Sigma I_{OL}(3)$			1.8 to 2.7			19.2	
	$\Sigma I_{OL}(4)$	Ports 7	Total of all applicable pins	2.7 to 5.5			5.6	
	$\Sigma I_{OL}(5)$			1.8 to 2.7			3.2	
Instruction cycle time (Note 2-2)	tCYC			2.7 to 5.5	0.245		200	μs
				2.2 to 5.5	0.294		200	
				1.8 to 5.5	0.735		200	
External system clock frequency	FEXCF	CF1	• CF2 pin open • System clock frequency division ratio=1/1 • External system clock duty=50±5%	2.7 to 5.5	0.1		12	MHz
				1.8 to 5.5	0.1		4	
			• CF2 pin open • System clock frequency division ratio=1/2 • External system clock duty=50±5%	3.0 to 5.5	0.2		24.4	
				2.0 to 5.5	0.2		8	

Note 2-1: V_{DD} must be held greater than or equal to 2.2V in the flash ROM onboard programming mode.
Note 2-2: Relationship between tCYC and oscillation frequency is 3/FmCF at a division ratio of 1/1 and 6/FmCF at a division ratio of 1/2.

Continued on next page.

Electrical Characteristics at Ta = −40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions		Specification			
				V_{DD}[V]	min	typ	max	unit
High level input current	I_{IH}(1)	Ports 0, 1, 2, 3, Ports 7, $\overline{RES}$	Output disabled Pull-up resistor off $V_{IN}=V_{DD}$ (Including output Tr's off leakage current)	1.8 to 5.5			1	μA
	I_{IH}(2)	CF1, CF2	Input port selected $V_{IN}=V_{DD}$	1.8 to 5.5			1	
	IIH(3)	CF1	Reset state $V_{IN}=V_{DD}$	1.8 to 5.5			15	
Low level input current	I_{IL}(1)	Ports 0, 1, 2, 3, Ports 7, $\overline{RES}$	Output disabled Pull-up resistor off $V_{IN}=V_{SS}$ (Including output Tr's off leakage current)	1.8 to 5.5	−1			
	I_{IL}(2)	CF1, CF2	Input port selected $V_{IN}=V_{SS}$	1.8 to 5.5	−1			
High level output voltage	V_{OH}(1)	Ports 0, 1, 2 P71 to P73	I_{OH}=-1mA	4.5 to 5.5	V_{DD}−1			V
	V_{OH}(2)		I_{OH}=-0.35mA	2.7 to 5.5	V_{DD}−0.4			
	V_{OH}(3)		I_{OH}=-0.15mA	1.8 to 5.5	V_{DD}−0.4			
	V_{OH}(4)	Ports 3 P05 (System clock output function used)	I_{OH}=-6mA	4.5 to 5.5	V_{DD}−1			
	V_{OH}(5)		I_{OH}=-1.4mA	2.7 to 5.5	V_{DD}−0.4			
	V_{OH}(6)		I_{OH}=-0.8mA	1.8 to 5.5	V_{DD}−0.4			
Low level output voltage	V_{OL}(1)	Ports 0, 1, 2, 3	I_{OL}=10mA	4.5 to 5.5			1.5	
	V_{OL}(2)		I_{OL}=1.4mA	2.7 to 5.5			0.4	
	V_{OL}(3)		I_{OL}=0.8mA	1.8 to 5.5			0.4	
	V_{OL}(4)	Port 7, CF2	I_{OL}=1.4mA	2.7 to 5.5			0.4	
	V_{OL}(5)		I_{OL}=0.8mA	1.8 to 5.5			0.4	
	V_{OL}(6)	P00, P01	I_{OL}=25mA	4.5 to 5.5			1.5	
	V_{OL}(7)		I_{OL}=4mA	2.7 to 5.5			0.4	
	V_{OL}(8)		I_{OL}=2mA	1.8 to 5.5			0.4	
Pull-up resistance	Rpu(1)	Ports 0, 1, 2, 3, Ports 7	$V_{OH}=0.9V_{DD}$ When Port 0 selected low-impedance pull-up.	4.5 to 5.5	15	35	80	kΩ
	Rpu(2)			1.8 to 4.5	18	50	230	
	Rpu(3)	Port 0	$V_{OH}=0.9V_{DD}$ When Port 0 selected high-impedance pull-up.	1.8 to 5.5	100	200	400	
Hysteresis voltage	VHYS(1)	Ports 1, 2, 3, Ports 7, $\overline{RES}$		2.7 to 5.5		$0.1V_{DD}$		V
	VHYS(2)			1.8 to 2.7		$0.07V_{DD}$		
Pin capacitance	CP	All pins	For pins other than that under test: $V_{IN}=V_{SS}$ f=1MHz Ta=25°C	1.8 to 5.5		10		pF

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

SIO0 Serial I/O Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$ (Note 4-1-1)

Parameter			Symbol	Pin/ Remarks	Conditions	V_{DD}[V]	Specification min	typ	max	unit
Serial clock	Input clock	Frequency	tSCK(1)	SCK0(P12)	• See Fig. 5.	1.8 to 5.5	2			tCYC
		Low level pulse width	tSCKL(1)				1			
		High level pulse width	tSCKH(1)				1			
			tSCKHA(1)		• Continuous data transmission/reception mode • See Fig. 5. (Note 4-1-2)		4			
	Output clock	Frequency	tSCK(2)	SCK0(P12)	• CMOS output selected • See Fig. 5.	1.8 to 5.5	4/3			
		Low level pulse width	tSCKL(2)				1/2			tSCK
		High level pulse width	tSCKH(2)				1/2			
			tSCKHA(2)		• Continuous data transmission/reception mode • CMOS output selected • See Fig. 5.		tSCKH(2) +2tCYC		tSCKH(2) +(10/3) tCYC	tCYC
Serial input	Data setup time		tsDI(1)	SB0(P11), SI0(P11)	• Must be specified with respect to rising edge of SIOCLK. • See Fig. 5.	1.8 to 5.5	0.05			µs
	Data hold time		thDI(1)				0.05			
Serial output	Input clock	Output delay time	tdD0(1)	SO0(P10), SB0(P11)	• Continuous data transmission/reception mode (Note 4-1-3)	1.8 to 5.5			(1/3)tCYC +0.08	
			tdD0(2)		• Synchronous 8-bit mode (Note 4-1-3)				1tCYC +0.08	
	Output clock		tdD0(3)		(Note 4-1-3)				(1/3)tCYC +0.08	

Note 4-1-1: These specifications are theoretical values. Add margin depending on its use.

Note 4-1-2: To use serial-clock-input in continuous trans/rec mode, a time from SI0RUN being set when serial clock is "H" to the first negative edge of the serial clock must be longer than tSCKHA.

Note 4-1-3: Must be specified with respect to falling edge of SIOCLK. Must be specified as the time to the beginning of output state change in open drain output mode. See Fig. 5.

AD Converter Characteristics at $V_{SS}1 = V_{SS}2 = 0V$

<12bits AD Converter Mode at Ta = −40°C to +85°C >

Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Resolution	N	AN0(P00) to AN6(P06), AN8(P70) to AN10(P72)		1.8 to 5.5		12		bit
Absolute accuracy	ET		(Note 6-1)	2.7 to 5.5			±16	LSB
				1.8 to 5.5			±20	
Conversion time	TCAD		• See Conversion time calculation formulas. (Note 6-2)	2.7 to 5.5	32		115	µs
				2.2 to 5.5	134		215	
				1.8 to 5.5	400		430	
Analog input voltage range	VAIN			1.8 to 5.5	V_{SS}		V_{DD}	V
Analog port input current	IAINH		VAIN=V_{DD}	1.8 to 5.5			1	µA
	IAINL		VAIN=V_{SS}	1.8 to 5.5	−1			

<8bits AD Converter Mode at Ta = −40°C to +85°C >

Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Resolution	N	AN0(P00) to AN6(P06), AN8(P70) to AN10(P72)		1.8 to 5.5		8		bit
Absolute accuracy	ET		(Note 6-1)	1.8 to 5.5			±1.5	LSB
Conversion time	TCAD		• See Conversion time calculation formulas. (Note 6-2)	2.7 to 5.5	20		90	µs
				2.2 to 5.5	80		135	
				1.8 to 5.5	245		265	
Analog input voltage range	VAIN			1.8 to 5.5	V_{SS}		V_{DD}	V
Analog port input current	IAINH		VAIN=V_{DD}	1.8 to 5.5			1	µA
	IAINL		VAIN=V_{SS}	1.8 to 5.5	−1			

Note 6-1: The quantization error (±1/2LSB) must be excluded from the absolute accuracy. The absolute accuracy must be measured in the microcontroller's state in which no I/O operations occur at the pins adjacent to the analog input channel.

Note 6-2: The conversion time refers to the period from the time an instruction for starting a conversion process till the time the conversion results register(s) are loaded with a complete digital conversion value corresponding to the analog input value.

The conversion time is 2 times the normal-time conversion time when:

- The first AD conversion is performed in the 12-bit AD conversion mode after a system reset.
- The first AD conversion is performed after the AD conversion mode is switched from 8-bit to 12-bit conversion mode.

Conversion time calculation formulas:

12bits AD Converter Mode: TCAD(Conversion time) = ((52/(AD division ratio))+2)×(1/3)×tCYC

8bits AD Converter Mode: TCAD(Conversion time) = ((32/(AD division ratio))+2)×(1/3)×tCYC

External oscillation (FmCF)	Operating supply voltage range (V_{DD})	System division ratio (SYSDIV)	Cycle time (tCYC)	AD division ratio (ADDIV)	AD conversion time (TCAD)	
					12bit AD	8bit AD
CF-12MHz	2.7V to 5.5V	1/1	250ns	1/8	34.8µs	21.5µs
CF-8MHz	2.7V to 5.5V	1/1	375ns	1/8	52.25µs	32.25µs
	2.2V to 5.5V	1/1	375ns	1/32	208.25µs	128.25µs
CF-4MHz	2.7V to 5.5V	1/1	750ns	1/8	104.5µs	64.5µs
	2.2V to 5.5V	1/1	750ns	1/16	208.5µs	128.5µs
	1.8V to 5.5V	1/1	750ns	1/32	416.5µs	256.5µs

Reference voltage (VREF17) Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions		Specification			
				V_{DD}[V]	min	typ	max	unit
Output voltage	VOVREF			2.0 to 5.5	1.67	1.75	1.83	V
Reference voltage operation current (Note 7-1)	IDDVREF			2.0 to 5.5		110		μA
Operation stabilization time (Note 7-2)	tVRW			2.0 to 5.5			100	μs

Note 7-1: IDDVREF denotes the currents that only flow to multivariable RC oscillator circuit's reference voltage circuit.
Note 7-2: tVRW denotes the stabilization time from starting multivariable RC oscillator.

Power-on Reset (POR) Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				Option selected voltage	min	typ	max	unit
POR release voltage	PORRL		• Select from option. (Note 8-1)	1.67V	1.55	1.66	1.77	V
				1.97V	1.85	1.96	2.07	
				2.07V	1.93	2.05	2.17	
				2.37V	2.23	2.35	2.47	
				2.57V	2.43	2.55	2.67	
				2.87V	2.71	2.85	2.99	
				3.86V	3.65	3.83	4.00	
				4.35V	4.12	4.32	4.50	
Detection voltage unknown state	POUKS		• See Fig. 7. (Note 8-2)			0.7	0.95	
Power supply rise time	PORIS		• Power supply rise time from 0V to 1.6V.				100	ms

Note8-1: The POR release level can be selected out of 8 levels only when the LVD reset function is disabled.
Note8-2: POR is in an unknown state before transistors start operation.

Low Voltage Detection Reset (LVD) Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				Option selected voltage	min	typ	max	unit
LVD reset voltage (Note 9-2)	LVDET		• Select from option. (Note 9-1) (Note 9-3) • See Fig. 8.	1.91V	1.81	1.91	2.01	V
				2.01V	1.90	2.00	2.10	
				2.31V	2.20	2.30	2.40	
				2.51V	2.40	2.50	2.60	
				2.81V	2.68	2.80	2.92	
				3.79V	3.62	3.78	3.94	
				4.28V	4.09	4.27	4.45	
LVD hysteresis width	LVHYS			1.91V		50		mV
				2.01V		50		
				2.31V		50		
				2.51V		50		
				2.81V		50		
				3.79V		50		
				4.28V		50		
Detection voltage unknown state	LVUKS		• See Fig. 8. (Note 9-4)			0.7	0.95	V
Low voltage detection minimum width (Reply sensitivity)	TLVDW		• LVDET-0.5V • See Fig. 9.		0.2			ms

Note9-1: The LVD reset level can be selected out of 7 levels only when the LVD reset function is enabled.
Note9-2: LVD reset voltage specification values do not include hysteresis voltage.
Note9-3: LVD reset voltage may exceed its specification values when port output state changes and/or when a large current flows through port.
Note9-4: LVD is in an unknown state before transistors start operation.

Consumption Current Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

Parameter	Symbol	Pin/ Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Normal mode consumption current (Note 10-1) (Note 10-2)	IDDOP(1)	$V_{DD}1$	• FmCF=12MHz ceramic oscillation mode • System clock set to 12MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.7 to 5.5		5.1	9.3	mA
				2.7 to 3.6		3.1	5.6	
	IDDOP(2)		• CF1=24MHz external clock • System clock set to CF1 side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	3.0 to 5.5		5.2	10	
				3.0 to 3.6		3.3	6.2	
	IDDOP(3)		• FmCF=10MHz ceramic oscillation mode • System clock set to 10MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.2 to 5.5		4.4	8.4	
				2.2 to 3.6		2.8	5.5	
	IDDOP(4)		• FmCF=4MHz ceramic oscillation mode • System clock set to 4MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	1.8 to 5.5		2.3	5.3	
				1.8 to 3.6		1.6	3.0	
	IDDOP(5)		• CF oscillation low amplifier size selected. (CFLAMP=1) • FmCF=4MHz ceramic oscillation mode • System clock set to 4MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/4 frequency division ratio	2.2 to 5.5		0.97	2.4	
				2.2 to 3.6		0.55	1.2	
	IDDOP(6)		• FsX'tal=32.768kHz crystal oscillation mode • Internal low speed RC oscillation stopped. • System clock set to internal medium speed RC oscillation. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	1.8 to 5.5		0.44	1.5	
				1.8 to 3.6		0.28	0.80	
	IDDOP(7)		• FsX'tal=32.768kHz crystal oscillation mode • Internal low speed and medium speed RC oscillation stopped. • System clock set to 8MHz with frequency variable RC oscillation • 1/1 frequency division ratio	1.8 to 5.5		3.4	5.5	
				1.8 to 3.6		2.4	4.6	
	IDDOP(8)		• External FsX'tal and FmCF oscillation stopped. • System clock set to internal low speed RC oscillation. • Internal medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	1.8 to 5.5		51	163	μA
				1.8 to 3.6		38	103	
	IDDOP(9)		• External FsX'tal and FmCF oscillation stopped. • System clock set to internal low speed RC oscillation. • Internal medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio • Ta=-10 to +50°C	5.0		51	136	
				3.3		38	99	
				2.5		36	94	

Note10-1: Values of the consumption current do not include current that flows into the output transistors and internal pull-up resistors.

Note10-2: The consumption current values do not include operational current of LVD function if not specified.

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Parameter	Symbol	Pin/ Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Normal mode consumption current (Note 10-1) (Note 10-2)	IDDOP(10)	V_{DD}1	• FsX'tal=32.768kHz crystal oscillation mode • System clock set to 32.768kHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	1.8 to 5.5		34	97	μA
				1.8 to 3.6		14	44	
	IDDOP(11)		• FsX'tal=32.768kHz crystal oscillation mode • System clock set to 32.768kHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio • Ta=-10 to +50°C	5.0		34	88	
				3.3		14	36	
				2.5		9.1	22	
HALT mode consumption current (Note 10-1) (Note 10-2)	IDDHALT(1)		• HALT mode • FmCF=12MHz ceramic oscillation mode • System clock set to 12MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.7 to 5.5		2.6	4.8	mA
				2.7 to 3.6		1.4	2.4	
	IDDHALT(2)		• HALT mode • CF1=24MHz external clock • System clock set to CF1 side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	3.0 to 5.5		2.7	5.3	
				3.0 to 3.6		1.6	2.9	
	IDDHALT(3)		• HALT mode • FmCF=10MHz ceramic oscillation mode • System clock set to 10MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.2 to 5.5		2.2	4.3	
				2.2 to 3.6		1.2	2.2	
	IDDHALT(4)		• HALT mode • FmCF=4MHz ceramic oscillation mode • System clock set to 4MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	1.8 to 5.5		1.3	3.3	
				1.8 to 3.6		0.56	1.2	
	IDDHALT(5)		• HALT mode • CF oscillation low amplifier size selected. (CFLAMP=1) • FmCF=4MHz ceramic oscillation mode • System clock set to 4MHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/4 frequency division ratio	2.2 to 5.5		0.74	1.8	
				2.2 to 3.6		0.34	0.68	
	IDDHALT(6)		• HALT mode • FsX'tal=32.768kHz crystal oscillation mode • Internal low speed RC oscillation stopped. • System clock set to internal medium speed RC oscillation • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	1.8 to 5.5		0.32	0.90	
				1.8 to 3.6		0.21	0.44	

Note10-1: Values of the consumption current do not include current that flows into the output transistors and internal pull-up resistors.

Note10-2: The consumption current values do not include operational current of LVD function if not specified.

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Parameter	Symbol	Pin/ remarks	Conditions	V_{DD}[V]	Specification min	typ	max	unit
HALT mode consumption current (Note 10-1) (Note 10-2)	IDDHALT(7)	V_{DD}1	• HALT mode • FsX'tal=32.768kHz crystal oscillation mode • Internal low speed and medium speed RC oscillation stopped. • System clock set to 8MHz with frequency variable RC oscillation • 1/1 frequency division ratio	1.8 to 5.5		1.3	2.3	mA
				1.8 to 3.6		0.91	1.5	
	IDDHALT(8)		• HALT mode • External FsX'tal and FmCF oscillation stopped. • System clock set to internal low speed RC oscillation. • Internal medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	1.8 to 5.5		18	68	μA
				1.8 to 3.6		11	35	
	IDDHALT(9)		• HALT mode • External FsX'tal and FmCF oscillation stopped. • System clock set to internal low speed RC oscillation. • Internal medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio • Ta=-10 to +50°C	5.0		18	46	
				3.3		11	27	
				2.5		7.4	19	
	IDDHALT(10)		• HALT mode • FsX'tal=32.768kHz crystal oscillation mode • System clock set to 32.768kHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	1.8 to 5.5		24	98	
				1.8 to 3.6		8.0	35	
	IDDHALT(11)		• HALT mode • FsX'tal=32.768kHz crystal oscillation mode • System clock set to 32.768kHz side • Internal low speed and medium speed RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio • Ta=-10 to +50°C	5.0		24	63	
				3.3		8.0	23	
				2.5		3.5	11	
HOLD mode consumption current (Note 10-1) (Note 10-2)	IDDHOLD(1)		HOLD mode • CF1=V_{DD} or open (External clock mode)	1.8 to 5.5		0.019	23	
				1.8 to 3.6		0.011	11	
	IDDHOLD(2)		HOLD mode • CF1=V_{DD} or open (External clock mode) • Ta=-10 to +50°C	5.0		0.019	1.2	
				3.3		0.011	0.59	
				2.5		0.010	0.30	
	IDDHOLD(3)		HOLD mode • CF1=V_{DD} or open (External clock mode) • LVD option selected	1.8 to 5.5		2.6	26	
				1.8 to 3.6		2.0	13	
	IDDHOLD(4)		HOLD mode • CF1=V_{DD} or open (External clock mode) • Ta=-10 to +50°C • LVD option selected	5.0		2.6	3.8	
				3.3		2.0	2.8	
				2.5		1.7	2.5	
Timer HOLD mode consumption current (Note 10-1) (Note 10-2)	IDDHOLD(5)		Timer HOLD mode • FsX'tal=32.768kHz crystal oscillation mode	1.8 to 5.5		22	84	
				1.8 to 3.6		6.5	30	
	IDDHOLD(6)		Timer HOLD mode • FsX'tal=32.768kHz crystal oscillation mode • Ta=-10 to +50°C	5.0		22	53	
				3.3		6.5	16	
				2.5		2.7	7.2	

Note10-1: Values of the consumption current do not include current that flows into the output transistors and internal pull-up resistors.

Note10-2: The consumption current values do not include operational current of LVD function if not specified.

F-ROM Programming Characteristics at Ta = +10°C to +55°C, $V_{SS}1 = V_{SS}2 = 0V$

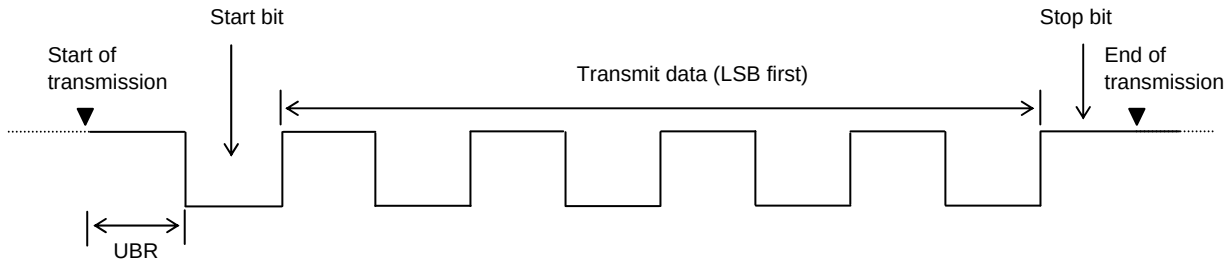
Parameter	Symbol	Pin/Remarks	Conditions		Specification			
				V_{DD}[V]	min	typ	max	unit
Onboard programming current	IDDFW(1)	$V_{DD}1$	• Only current of the Flash block.	2.2 to 5.5		5	10	mA
Programming time	tFW(1)		• Erasing time	2.2 to 5.5		20	30	ms
	tFW(2)		• Programming time			40	60	μs

UART (Full Duplex) Operating Conditions at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = 0V$

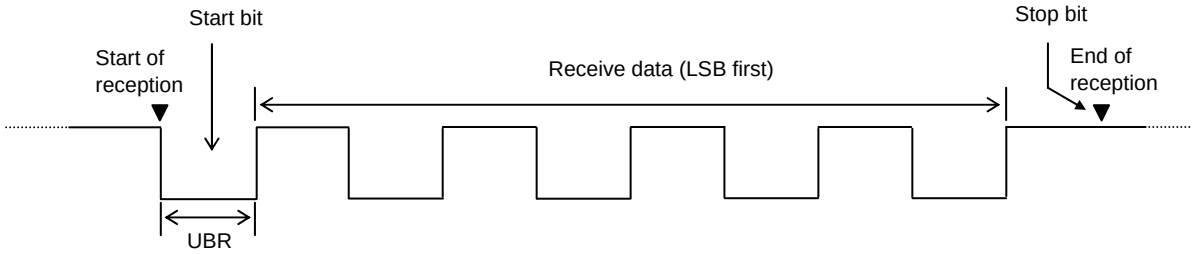
Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Transfer rate	UBR	P20, P21		1.8 to 5.5	16/3		8192/3	tCYC

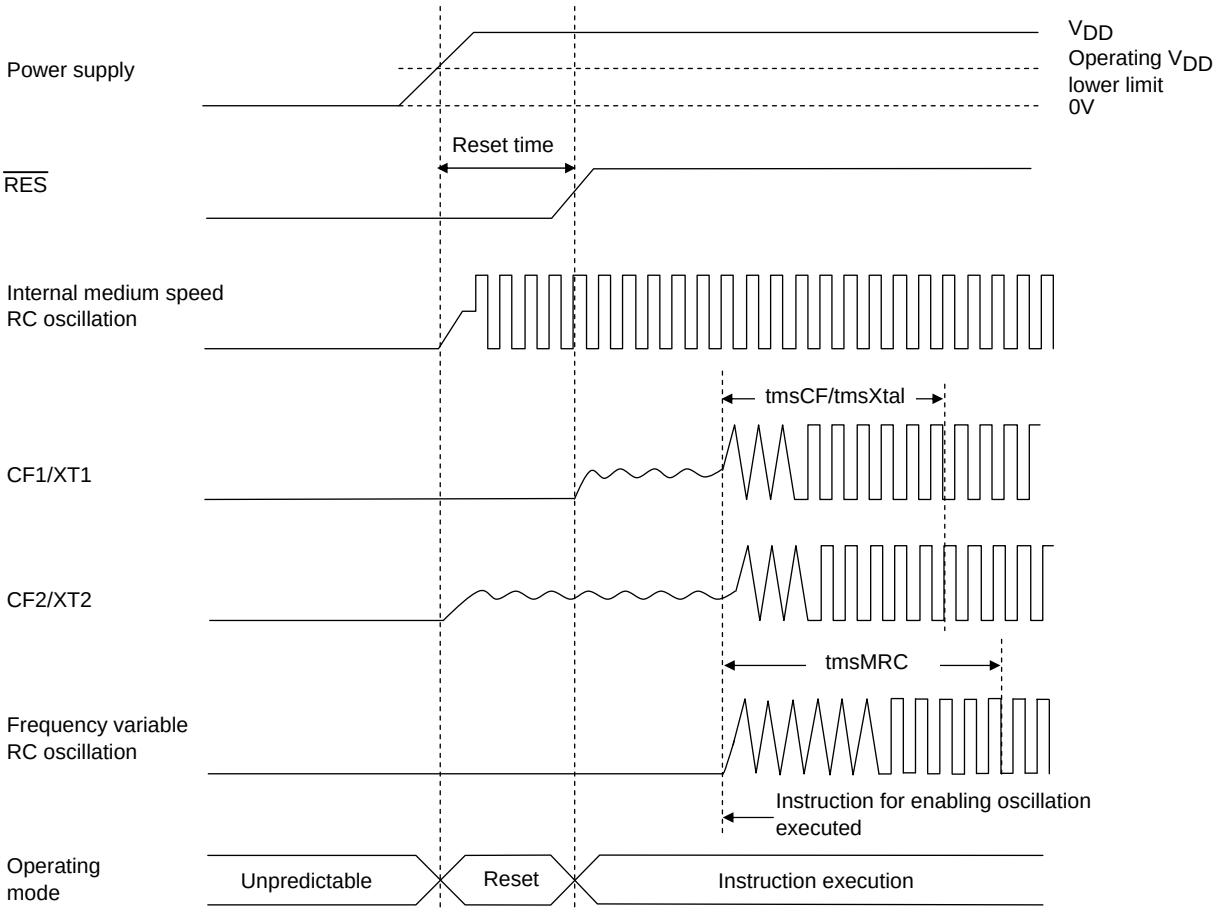
Data length: 7/8/9 bits (LSB first)
Stop bits: 1 bit (2-bit in continuous data transmission)
Parity bits: None

Example of Continuous 8-bit Data Transmission Mode Processing (First Transmit Data=55H)

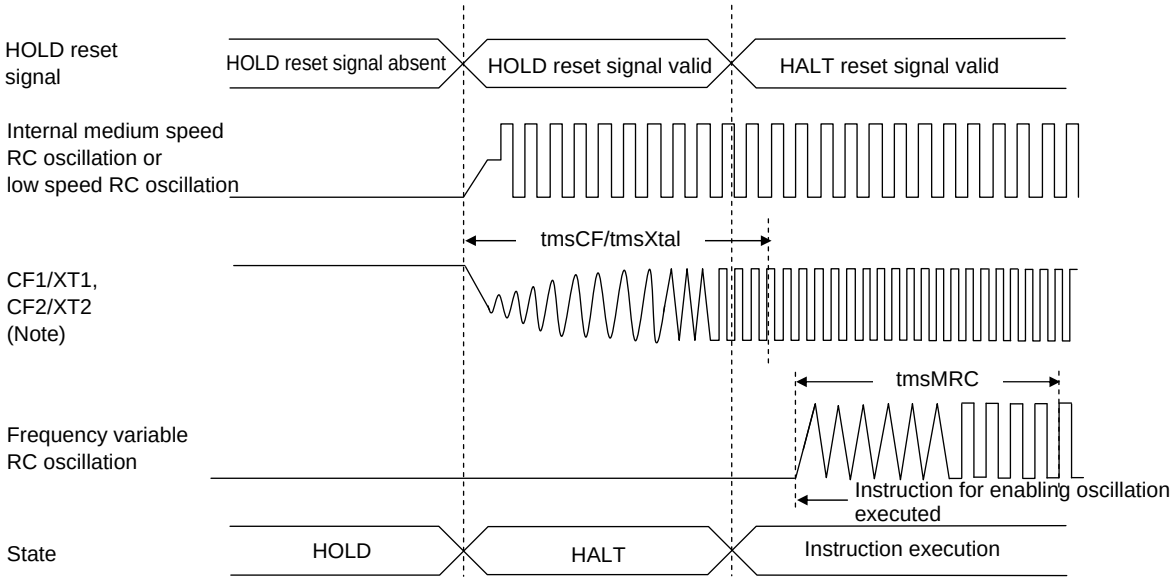


Example of Continuous 8-bit Data Reception Mode Processing (First Receive Data=55H)





Reset Time and Oscillation Stabilization Time



HOLD Reset Signal and Oscillation Stabilization Time

Note: External oscillation circuit is selected.

Figure 3 Oscillation Stabilization Times

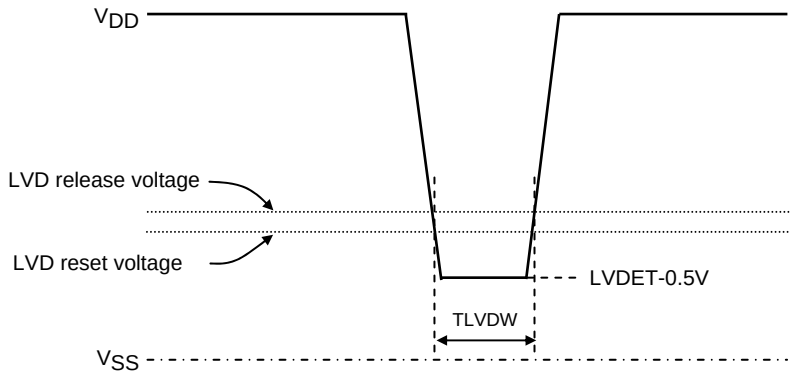


Figure 9 Low voltage detection minimum width
(Example of momentary power loss/Voltage variation waveform)

ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LC87FBH08AU-EB-3H	LQFP36 7x7 / QFP36 (Pb-Free / Halogen Free)	500 / Tray Foam
LC87FBH08AU-EB-NH	LQFP36 7x7 / QFP36 (Pb-Free / Halogen Free)	1000 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D. http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF