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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	18MHz
Connectivity	SIO, UART/USART
Peripherals	LCD, PWM, WDT
Number of I/O	29
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 3.6V
Data Converters	A/D 15x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-BQFP
Supplier Device Package	100-PQFP/QIP (20x14)
Purchase URL	https://www.e-xfl.com/product-detail/onsemi/lc87f7nc8avuej-2h

Function Details

■ Ports

- Normal withstand voltage I/O ports
  Ports whose I/O direction can be designated in 1 bit units : 29 (P0n, P1n, P70 to P73, P8n, XT2)
- Normal withstand voltage input port : 1 (XT1)
- LCD ports
  Segment output : 54 (S00 to S53)
  Common output : 4 (COM0 to COM3)
  Bias power sources for LCD driver : 3 (V1 to V3)
  Other functions
  Input/output ports : 54 (P3n, PAn, PBn, PCn, PDn, PEn, PFn)
  Input ports : 7 (PLn)
- Dedicated oscillator ports : 2 (CF1, CF2)
- Reset pins : 1 ($\overline{\text{RES}}$)
- Power pins : 6 ($V_{SS}1$ to $V_{SS}3$, $V_{DD}1$ to $V_{DD}3$)

■ LCD Controller

1) Seven display modes are available (static, 1/2, 1/3, 1/4 duty × 1/2, 1/3 bias)
2) Segment output and common output can be switched to general-purpose input/output ports

■ Small Signal Detection (MIC signals etc.)

1) Counts pulses with a level which is greater than a preset value
2) 2-bit counter

■ Timers

- Timer 0: 16-bit timer/counter with two capture registers.
  Mode 0: 8-bit timer with an 8-bit programmable prescaler (with two 8-bit capture registers) × 2 channels
  Mode 1: 8-bit timer with an 8-bit programmable prescaler (with two 8-bit capture registers) + 8-bit counter (with two 8-bit capture registers)
  Mode 2: 16-bit timer with an 8-bit programmable prescaler (with two 16-bit capture registers)
  Mode 3: 16-bit counter (with two 16-bit capture registers)
- Timer1: 16-bit counter timer that supports PWM/toggle outputs
  Mode 0: 8-bit timer with an 8-bit prescaler (with toggle outputs) + 8-bit timer counter with an 8-bit prescaler (with toggle outputs)
  Mode 1: 8-bit PWM with an 8-bit prescaler × 2 channels
  Mode 2: 16-bit counter timer with an 8-bit prescaler (with toggle outputs)
  (toggle outputs also possible from the lower-order 8 bits)
  Mode 3: 16-bit timer with an 8-bit prescaler (with toggle outputs) (The lower-order 8 bits can be used as PWM.)
- Timer4: 8-bit timer with a 6-bit prescaler
- Timer5: 8-bit timer with a 6-bit prescaler
- Timer6: 8-bit timer with a 6-bit prescaler (with toggle output)
- Timer7: 8-bit timer with a 6-bit prescaler (with toggle output)
- Timer8: 16-bit timer
  Mode 0: 8-bit timer with an 8-bit prescaler × 2 channels
  Mode 1: 16-bit timer with an 8-bit prescaler
- Base Timer
  1) The clock is selectable from the subclock (32.768kHz crystal oscillation), system clock, and timer 0 prescaler output.
  2) Interrupts programmable in 5 different time schemes
- Day and time counter
  1) Used with a base timer, the day and time counter can be used as a 65000 day + minute + second counter.

■ High-speed Clock Counter
1) Can count clocks with a maximum clock rate of 20MHz (at a main clock of 10MHz).
2) Can generate output real-time.

■ Serial Interfaces
- SIO0: 8-bit synchronous serial interface
  1) LSB first/MSB first made selectable
  2) Built-in 8-bit baudrate generator (maximum transfer clock cycle = 4/3tCYC)
  3) Automatic continuous data transmission (1 to 256 bits specifiable in 1-bit units, suspension and resumption of data transmission possible in 1-byte units)
- SIO1: 8-bit asynchronous/synchronous serial interface
  Mode 0: Synchronous 8-bit serial I/O (2- or 3-wire configuration, 2 to 512 tCYC transfer clocks)
  Mode 1: Asynchronous serial I/O (half-duplex, 8 data bits, 1 stop bit, 8 to 2048 tCYC baudrates)
  Mode 2: Bus mode 1 (start bit, 8 data bits, 2 to 512 tCYC transfer clocks)
  Mode 3: Bus mode 2 (start detect, 8 data bits, stop detect)

■ UART1
- Full duplex
- 7/8/9 bit data bits selectable
- 1 stop bit (2 bits in continuous data transmission)
- Built-in baudrate generator

■ UART2
- Full duplex
- 7/8/9 bit data bits selectable
- 1 stop bit (2 bits in continuous data transmission)
- Built-in baudrate generator

■ AD Converter : 12 bits × 15 channels

■ PWM : Multi frequency 12-bit PWM × 2 channels

■ Infrared Remote Control Receiver Circuit1
1) Noise reduction function (Time constant of noise reduction filter: approx. 120μs, when selecting a 32.768kHz crystal oscillator as a reference clock)
2) Supporting reception formats with a guide-pulse of half-clock/clock/none.
3) Determines a end of reception by detecting a no-signal periods (No carrier).
   (Supports same reception format with a different bit length.)
4) X'tal HOLD mode cancellation function

■ Infrared Remote Control Receiver Circuit2
1) Noise reduction function
   (Time constant of noise reduction filter: approx. 120μs, when selecting a 32.768kHz crystal oscillator as a reference clock.)
2) Supporting reception formats with a guide-pulse of half-clock/clock/none.
3) Determines a end of reception by detecting a no-signal periods (No carrier).
   (Supports same reception format with a different bit length.)
4) X'tal HOLD mode cancellation function

■ Watchdog Timer
1) External RC watchdog timer
2) Interrupt and reset signals selectable

■ Clock Output Function
1) Can output selected oscillation clock 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, or 1/64 as a system clock.
2) Can output the source oscillation clock for the sub clock.

■ Interrupt Source Flags

- 31 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/remote control receiver1
4	0001BH	H or L	INT3/base timer/INT5/ remote control receiver2
5	00023H	H or L	T0H/INT6
6	0002BH	H or L	T1L/T1H/INT7
7	00033H	H or L	SIO0/UART1 receive/ UART2 receive/T8L/T8H
8	0003BH	H or L	SIO1/UART1 transmit/ UART2 transmit
9	00043H	H or L	ADC/MIC/T6/T7/PWM4/PWM5
10	0004BH	H or L	Port 0/T4/T5

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

- IFLG (List of interrupt source flag function)
  1) Shows a list of interrupt source flags that caused a branching to a particular vector address.

■ Subroutine Stack Levels

- 4096/2048 levels maximum (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

- RC oscillation circuit (internal): For system clock
- CF oscillation circuit: For system clock, with internal Rf and external Rd
- Crystal oscillation circuit: For low-speed system clock, with internal Rf and external Rd
- Multifrequency RC oscillation circuit (internal): For system clock
  1) Adjustable in ±4% (typ) increments from the selected center frequency.
  2) Measures the frequency of the source oscillation clock using the input signal from XT1 as the reference.

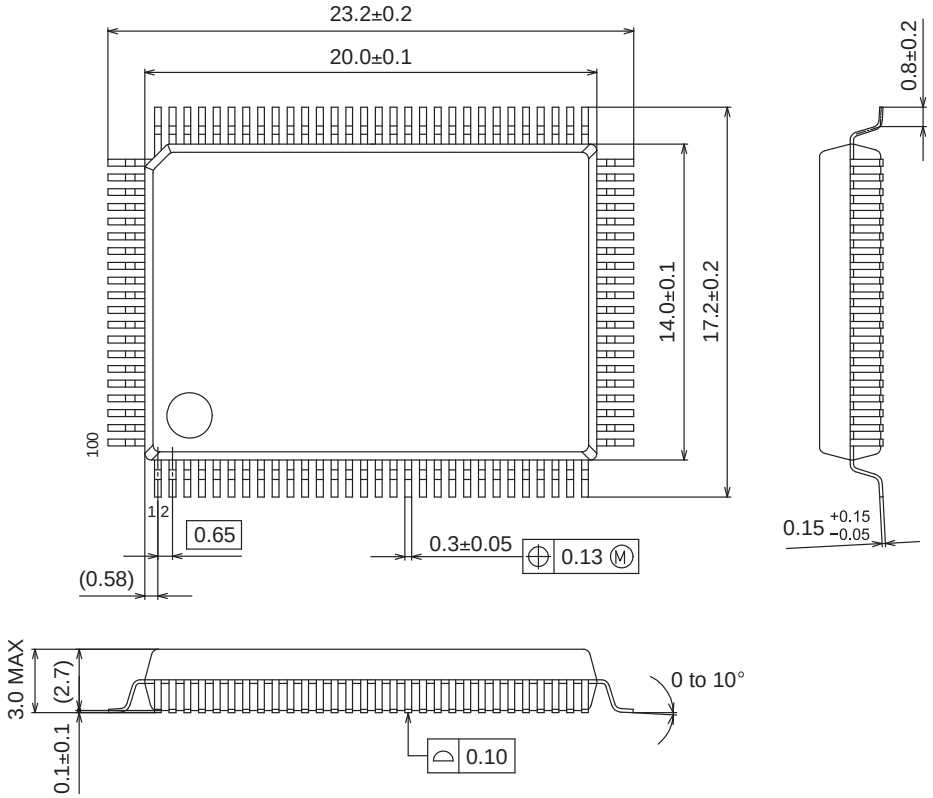
■ System Clock Divider Function

- 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).

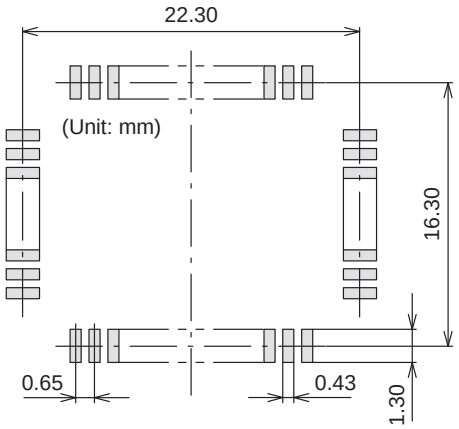
Package Dimensions

unit : mm

PQFP100 14x20 / QIP100E
CASE 122BV
ISSUE A



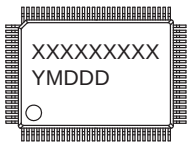
SOLDERING FOOTPRINT*



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.

GENERIC MARKING DIAGRAM*



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

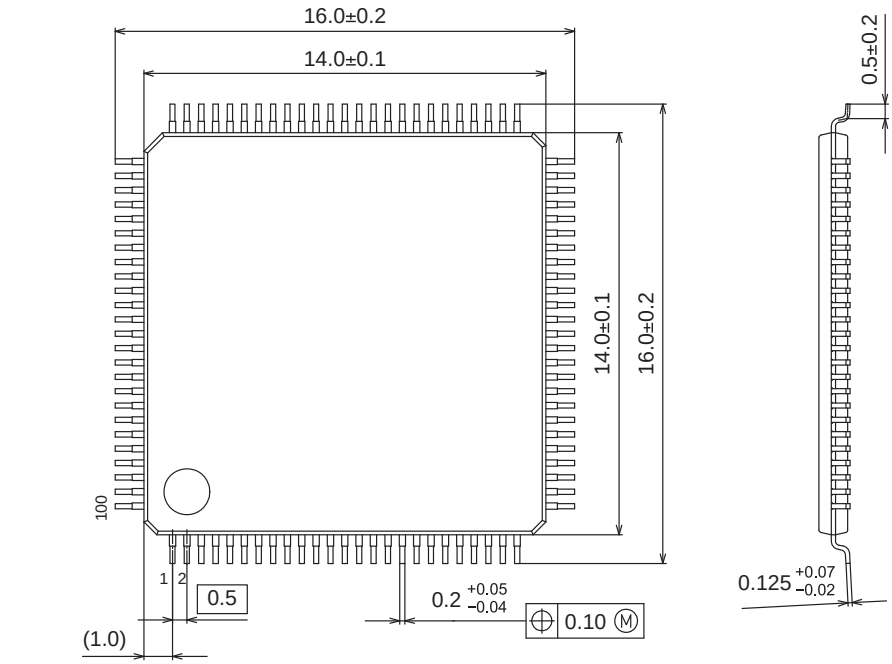
*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, “G” or microdot “ ▪ ”, may or may not be present.

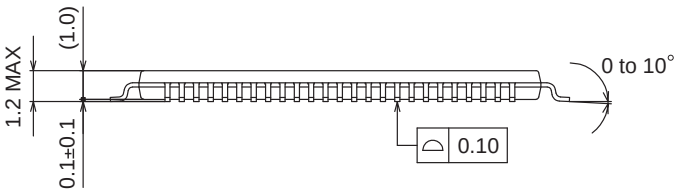
Package Dimensions

unit : mm

*Package TQFP100(14×14) type is Under Development.

TQFP100 14x14 / TQFP100
CASE 932AY
ISSUE A





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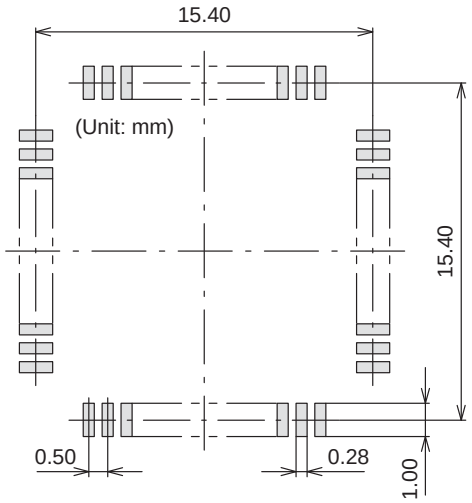

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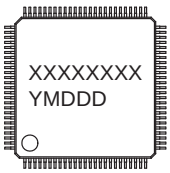

XXXXX = Specific Device Code
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*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, “G” or microdot “▪”, may or may not be present.

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

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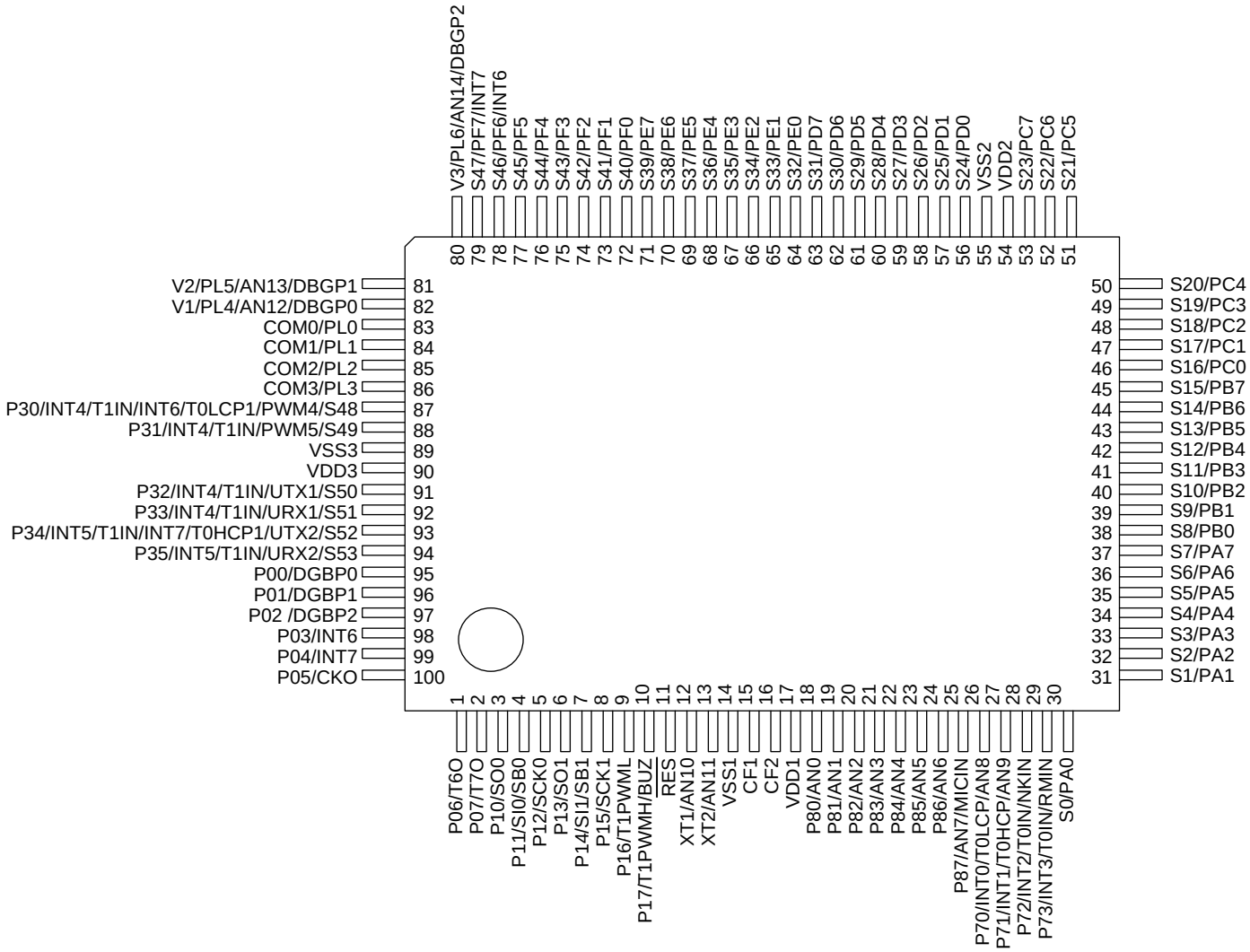
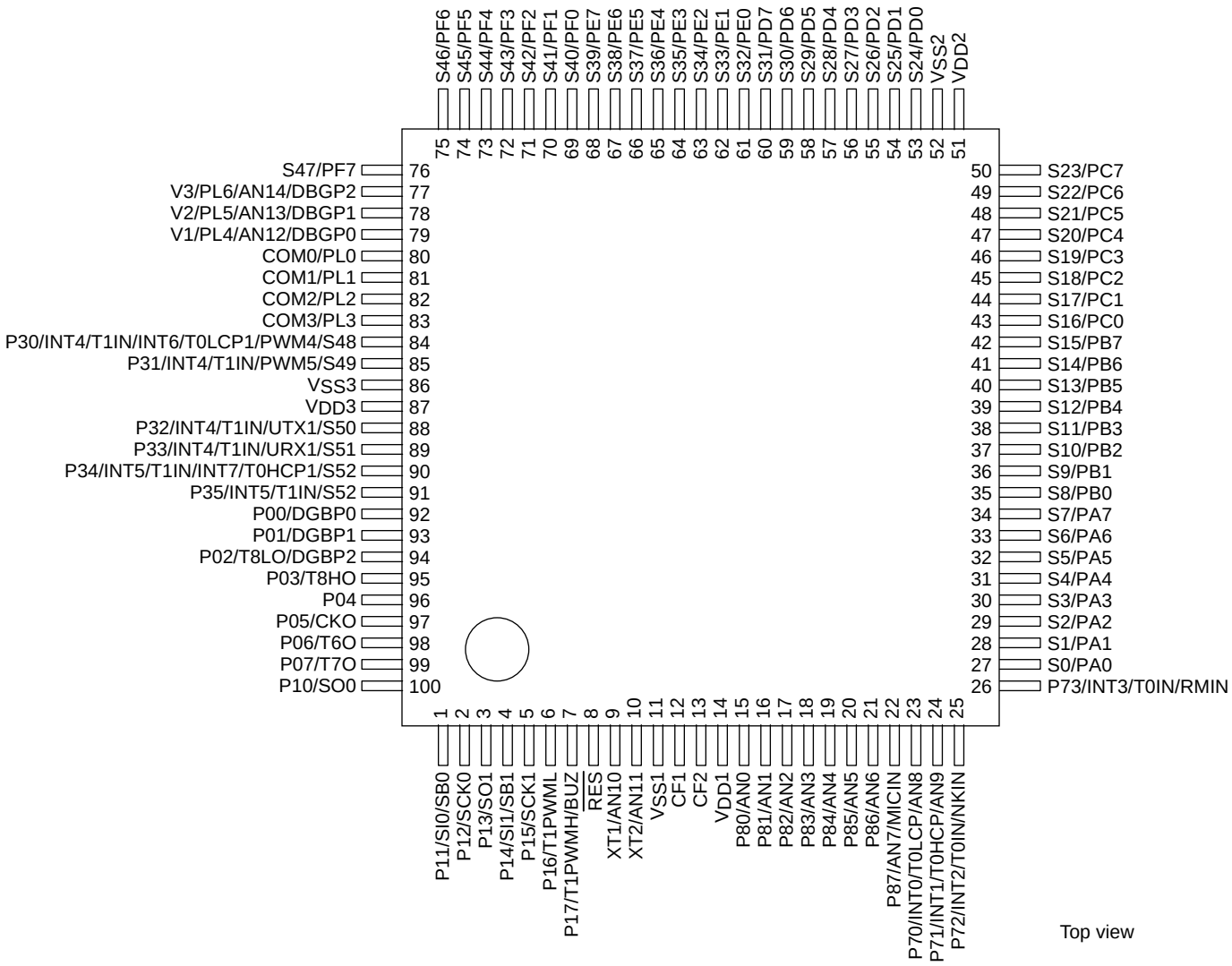
Pin Assignment

QIP100E(14×20), Pb-Free/Halogen Free type

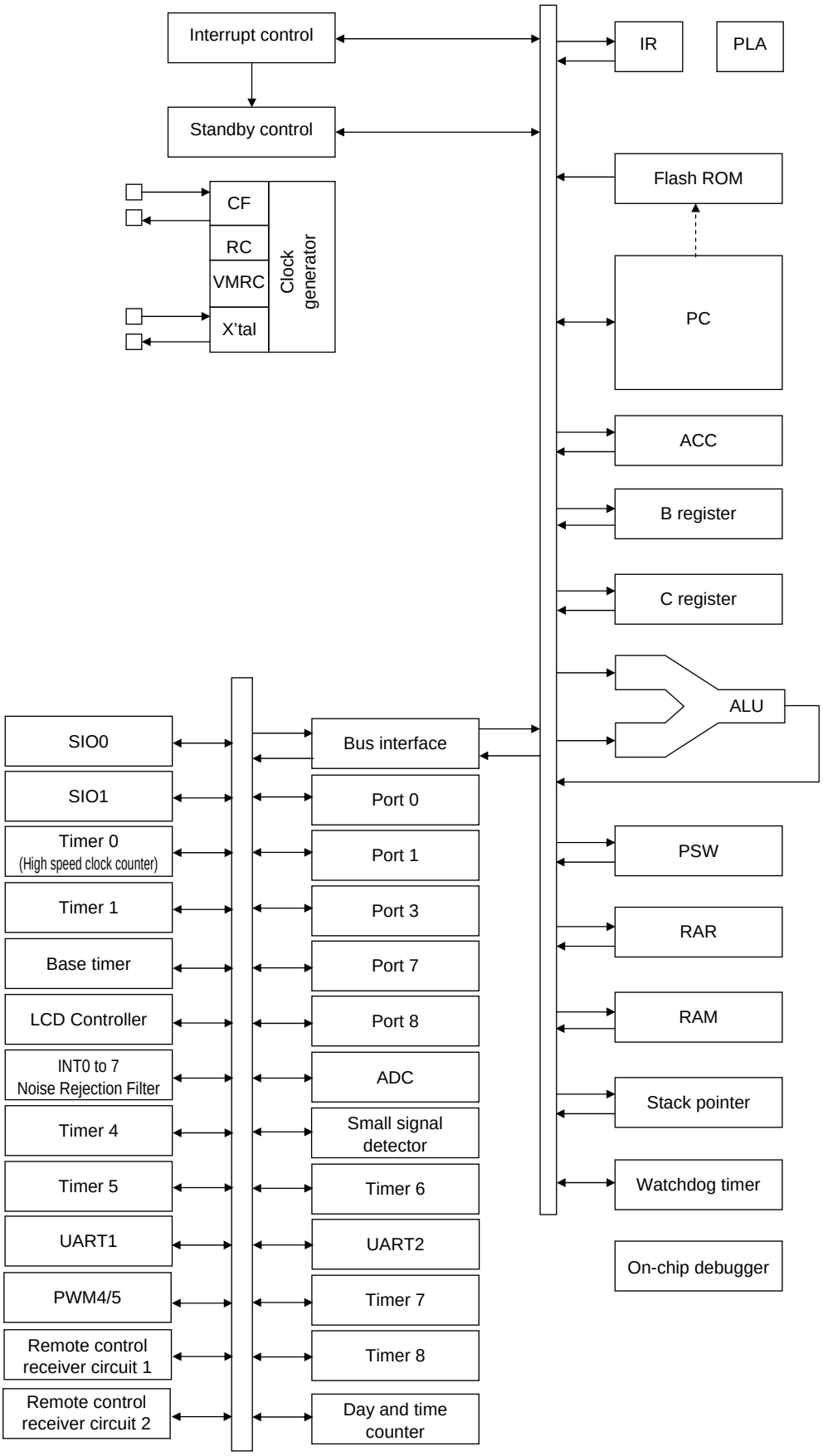


TQFIP100(14×14), Pb-Free/Halogen Free type [Under Development]



Top view

System Block Diagram



Pin Description

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Description</th><th>Option</th></tr>
<tr><td>$V_{SS}1$
$V_{SS}2$
$V_{SS}3$</td><td>-</td><td>– power supply pin</td><td>No</td></tr>
<tr><td>$V_{DD}1$
$V_{DD}2$
$V_{DD}3$</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 1-bit units
• Pull-up resistors can be turned on and off in 1-bit units.
• Input for HOLD release
• Input for port 0 interrupt
• Shared pins
P03: INT6 input
P04: INT7 input
P05: Clock output (system clock/can selected from sub clock)
P06: Timer 6 toggle output
P07: Timer 7 toggle output
On chip debugger pins: DBGP0 to DBGP2(P00 to P02)</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.
• Shared pins
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</td><td>Yes</td></tr>
<tr><td>Port 3
P30 to P35</td><td>I/O</td><td>• 6-bit I/O port
• Segment output for LCD
• I/O specifiable in 1-bit units
• Pull-up resistors can be turned on and off in 1-bit units.
• Shared pins
P30 to P33: INT4 input/HOLD release input/timer 1 event input/timer 0L capture input/ timer 0H capture input
P34 to P35: INT5 input/HOLD release input/timer 1 event input/timer 0L capture input/ timer 0H capture input
P30: PWM4 output/INT6 input/timer 0L capture 1 input
P31: PWM5 output
P32: UART1 transmit
P33: UART1 receive
P34: UART2 transmit/INT7 input/timer 0H capture 1 input
P35: UART2 receive
Interrupt acknowledge type
<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>
<tr><td>INT5</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td></tr>
<tr><td>INT6</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td></tr>
<tr><td>INT7</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.

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<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.
• Shared pins
P70: INT0 input/HOLD release input/timer 0L capture input/watchdog timer output
P71: INT1 input/HOLD release input/timer 0H capture input
P72: INT2 input/HOLD release input/timer 0 event input/timer 0L capture input/
high speed clock counter input
P73: INT3 input (with noise filter)/timer 0 event input/timer 0H capture input/
remote control receiver input
AD converter input ports: AN8 (P70), AN9 (P71)
Interrupt acknowledge type
<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>Port 8
P80 to P87</td><td>I/O</td><td>• 8-bit I/O port
• I/O specifiable in 1-bit units
• Shared pins
AD converter input ports: AN0 to AN7
Small signal detector input port: MICIN (P87)</td><td>No</td></tr>
<tr><td>S0/PA0 to
S7/PA7</td><td>I/O</td><td>• Segment output for LCD
• Can be used as general-purpose I/O port (PA)</td><td>No</td></tr>
<tr><td>S8/PB0 to
S15/PB7</td><td>I/O</td><td>• Segment output for LCD
• Can be used as general-purpose I/O port (PB)</td><td>No</td></tr>
<tr><td>S16/PC0 to
S23/PC7</td><td>I/O</td><td>• Segment output for LCD
• Can be used as general-purpose I/O port (PC)</td><td>No</td></tr>
<tr><td>S24/PD0 to
S31/PD7</td><td>I/O</td><td>• Segment output for LCD
• Can be used as general-purpose I/O port (PD)</td><td>No</td></tr>
<tr><td>S32/PE0 to
S39/PE7</td><td>I/O</td><td>• Segment output for LCD
• Can be used as general-purpose I/O port (PE)</td><td>No</td></tr>
<tr><td>S40/PF0 to
S47/PF7</td><td>I/O</td><td>• Segment output for LCD
• Can be used as general-purpose I/O port (PF)
PF6: INT6 input
PF7: INT7 input</td><td>No</td></tr>
<tr><td>COM0/PL0 to
COM3/PL3</td><td>I/O</td><td>• Common output for LCD
• Can be used as general-purpose input port (PL)</td><td>No</td></tr>
<tr><td>V1/PL4 to
V3/PL6</td><td>I/O</td><td>• LCD output bias power supply
• Can be used as general-purpose input port (PL)
• Shared pins
AD converter input ports: AN12 (V1) to AN14 (V3)
On-chip debugger pins: DBGP0 (V1) to DBGP2 (V3)</td><td>No</td></tr>
<tr><td>$\overline{\text{RES}}$</td><td>Input</td><td>Reset pin</td><td>No</td></tr>
<tr><td>XT1</td><td>Input</td><td>• 32.768kHz crystal oscillator input pin
• Shared pins
General-purpose input port
Must be connected to $V_{DD}1$ if not to be used.
AD converter input port: AN10</td><td>No</td></tr>
<tr><td>XT2</td><td>I/O</td><td>• 32.768kHz crystal oscillator output pin
• Shared pins
General-purpose I/O port
Must be set for oscillation and kept open if not to be used.
AD converter input port: AN11</td><td>No</td></tr>
<tr><td>CF1</td><td>Input</td><td>Ceramic resonator input pin</td><td>No</td></tr>
<tr><td>CF2</td><td>Output</td><td>Ceramic resonator output pin</td><td>No</td></tr>
</table>

Port Output Types

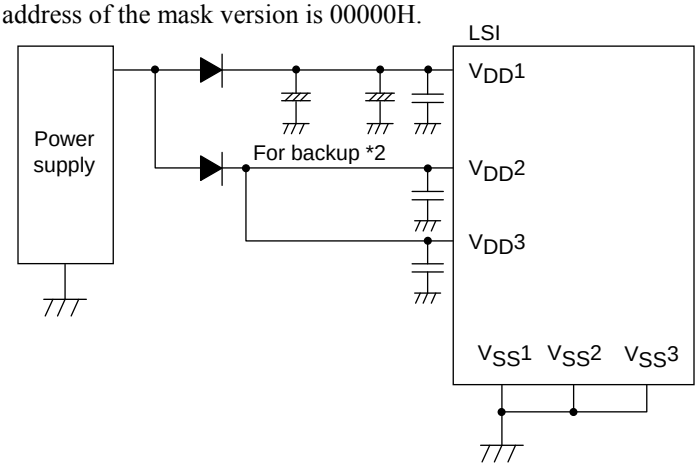
The table below lists the types of port outputs and the presence/absence of a pull-up resistor.
Data can be read into any input port even if it is in the output mode

Port Name	Option Selected in Units of	Option Type	Output Type	Pull-up Resistor
P00 to P07	each bit	1	CMOS	Programmable (Note)
		2	Nch-open drain	Programmable
P10 to P17	each bit	1	CMOS	Programmable
		2	Nch-open drain	Programmable
P30 to P35	each bit	1	CMOS	Programmable
		2	Nch-open drain	Programmable
P70	-	No	Nch-open drain	Programmable
P71 to P73	-	No	CMOS	Programmable
P80 to P87	-	No	Nch-open drain	No
S0/PA0 to S47/PF7	-	No	CMOS	Programmable
COM0/PL0 to COM3/PL3	-	No	Input only	No
V1/PL4 to V3/PL6	-	No	Input only	No
XT1	-	No	Input only	No
XT2	-	No	Output for 32.768kHz crystal oscillator (Nch-open drain when in general-purpose output mode)	No

User Option List

Option Name	Option Type	Mask Version *1	Flash Version	Option Selected in Units of	Specified Item
Port output form	P00 to P07	○	○	each bit	CMOS
					Nch-open drain
	P10 to P17	○	○	each bit	CMOS
					Nch-open drain
	P30 to P35	○	○	each bit	CMOS
					Nch-open drain
Program start address	-	× *2	○	-	00000H
					1FF00H

*1: Mask option selection - No change possible after the mask is completed.
*2: Program start address of the mask version is 00000H.



*1: Connect the IC as shown below to minimize the noise input to the $V_{DD}1$ pin.
Be sure to electrically short the $V_{SS}1$, $V_{SS}2$, and $V_{SS}3$ pins.

*2: The internal memory is sustained by $V_{DD}1$. If none of $V_{DD}2$ and $V_{DD}3$ are backed up, the high level output at the ports are unstable in the HOLD backup mode, allowing through current to flow into the input buffer and thus shortening the backup time.
Make sure that the port outputs are held at the low level in the HOLD backup mode.

Absolute Maximum Ratings at Ta = 25°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

Parameter		Symbol	Pin/Remarks	Conditions	V_{DD} [V]	Specification min	typ	max	unit
Maximum supply voltage		V_{DD} max	$V_{DD}1$, $V_{DD}2$, $V_{DD}3$	$V_{DD}1=V_{DD}2=V_{DD}3$		−0.3		+4.6	V
supply voltage for LCD		VLCD	V1/PL4, V2/PL5, V3/PL6	$V_{DD}1=V_{DD}2=V_{DD}3$		−0.3		V_{DD}	
Input voltage		V_I(1)	Port L XT1, CF1, $\overline{RES}$			−0.3		V_{DD}+0.3	
		V_I(2)	$V_{DD}2$, $V_{DD}3$			V_{SS}		V_{DD}+0.1	
Input/output voltage		V_{IO}(1)	Ports 0, 1, 3, 7, 8 Ports A, B, C, D, E, F, XT2			−0.3		V_{DD}+0.3	
High level output current	Peak output current	IOPH(1)	Ports 0, 1, 32 to 35	• CMOS output selected • Current at each pin		−10			mA
		IOPH(2)	Ports 30, 31	• CMOS output selected • Current at each pin		−20			
		IOPH(3)	Ports 71 to 73	Current at each pin		−5			
		IOPH(4)	Ports A, B, C, D, E, F	Current at each pin		−5			
	Mean output current (Note 1-1)	IOMH(1)	Ports 0, 1, 32 to 35	• CMOS output selected • Current at each pin		−7.5			
		IOMH(2)	Ports 30, 31	• CMOS output selected • Current at each pin		−15			
		IOMH(3)	Ports 71 to 73	Current at each pin		−3			
		IOMH(4)	Ports A, B, C, D, E, F	Current at each pin		−3			
	Total output current	ΣIOAH(1)	Ports 0, 1, 32 to 35	Total of all pins		−25			
		ΣIOAH(2)	Ports 30, 31	Total of all pins		−25			
		ΣIOAH(3)	Ports 0, 1, 3	Total of all pins		−45			
		ΣIOAH(4)	Ports 71 to 73	Total of all pins		−5			
		ΣIOAH(5)	Ports A, B, C	Total of all pins		−25			
		ΣIOAH(6)	Ports D, E, F	Total of all pins		−25			
		ΣIOAH(7)	Ports A, B, C, D, E, F	Total of all pins		−45			
Low level output current	Peak output current	IOPL(1)	Ports 0, 1, 32 to 35	Current at each pin				20	
		IOPL(2)	Ports 30, 31	Current at each pin				30	
		IOPL(3)	Ports 7, 8 XT2	Current at each pin				10	
		IOPL(4)	Ports A, B, C, D, E, F	Current at each pin				10	
	Mean output current (Note 1-1)	IOML(1)	Ports 0, 1, 32 to 35	Current at each pin				15	
		IOML(2)	Ports 30, 31	Current at each pin				20	
		IOML(3)	Ports 7, 8 XT2	Current at each pin				7.5	
		IOML(4)	Ports A, B, C, D, E, F	Current at each pin				7.5	
	Total output current	ΣOAL(1)	Ports 0,1,32 to 35	Total of all pins				45	
		ΣIOAL(2)	Ports 30, 31	Total of all pins				45	
		ΣIOAL(3)	Ports 0, 1, 3	Total of all pins				80	
		ΣIOAL(4)	Ports 7, 8 XT2	Total of all pins				20	
		ΣIOAL(5)	Ports A, B, C	Total of all pins				45	
		ΣIOAL(6)	Ports D, E, F	Total of all pins				45	
		ΣIOAL(7)	Ports A, B, C, D, E, F	Total of all pins				80	
Maximum power dissipation		Pd max	QIP100E(14×20)	Ta=−40 to +85°C				215	mW
			TQFP100(14×14)	Ta=−40 to +85°C				under	
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.

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 Range at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions	V_{DD} [V]	Specification min	typ	max	unit
Operating supply voltage (Note 2-1)	$V_{DD}(1)$	$V_{DD}1=V_{DD}2=V_{DD}3$	0.167μs≤tCYC≤200μs		2.7		3.6	V
			0.356μs≤tCYC≤200μs		2.5		3.6	
Memory sustaining supply voltage	VHD	$V_{DD}1$	RAM and register contents sustained in HOLD mode.		2.0		3.6	
High level input voltage	$V_{IH}(1)$	Ports 0, 3, 8 Ports A, B, C, D, E, F Port L	Output disabled	2.5 to 3.6	$0.3V_{DD}$ +0.7		V_{DD}	
	$V_{IH}(2)$	Port 1 Ports 71 to 73 P70 port input/ interrupt side	• Output disabled • When INT1VTSL=0 (P71 only)	2.5 to 3.6	$0.3V_{DD}$ +0.7		V_{DD}	
	$V_{IH}(3)$	P71 interrupt side	• Output disabled • When INT1VTSL=1	2.5 to 3.6	$0.85V_{DD}$		V_{DD}	
	$V_{IH}(4)$	P87 small signal input side	Output disabled	2.5 to 3.6	$0.75V_{DD}$		V_{DD}	
	$V_{IH}(5)$	P70 watchdog timer side	Output disabled	2.5 to 3.6	$0.9V_{DD}$		V_{DD}	
	$V_{IH}(6)$	XT1, XT2, CF1, $\overline{RES}$		2.5 to 3.6	$0.75V_{DD}$		V_{DD}	
Low level input voltage	$V_{IL}(1)$	Ports 0, 3, 8 Ports A, B, C, D, E, F Port L	Output disabled	2.5 to 3.6	V_{SS}		$0.2V_{DD}$	
	$V_{IL}(2)$	Port 1 Ports 71 to 73 P70 port input/ interrupt side	• Output disabled • When INT1VTSL=0 (P71 only)	2.5 to 3.6	V_{SS}		$0.2V_{DD}$	
	$V_{IL}(3)$	P71 interrupt side	• Output disabled • When INT1VTSL=1	2.5 to 3.6	V_{SS}		$0.45V_{DD}$	
	$V_{IL}(4)$	P87 small signal input side	Output disabled	2.5 to 3.6	V_{SS}		$0.25V_{DD}$	
	$V_{IL}(5)$	P70 watchdog timer side	Output disabled	2.5 to 3.6	V_{SS}		$0.8V_{DD}$ -1.0	
	$V_{IL}(6)$	XT1, XT2, CF1, $\overline{RES}$		2.5 to 3.6	V_{SS}		$0.25V_{DD}$	
Instruction cycle time (Note 2-2)	tCYC			2.7 to 3.6	0.167		200	μs
				2.5 to 3.6	0.356		200	
External system clock frequency	FEXCF(1)	CF1	• CF2 pin open • System clock frequency division ratio=1/1 • External system clock duty=50±5%	2.5 to 3.6	0.1		18	MHz
			• CF2 pin open • System clock frequency division ratio=1/2	2.5 to 3.6	0.2		36	

Note 2-1: V_{DD} must be held greater than or equal to 3.0V 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.

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Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
Oscillation frequency range (Note 2-3)	FmCF(1)	CF1, CF2	• 18MHz ceramic oscillation • See Fig. 1.	2.7 to 3.6		18		MHz
	FmCF(2)	CF1, CF2	• 8MHz ceramic oscillation • See Fig. 1.	2.5 to 3.6		8		
	FmRC		Internal RC oscillation	2.5 to 3.6	0.3	1.0	2.0	
	FmVMRC(1)		• Frequency variable RC source oscillation • When VMRAJ2 to 0=4, VMFAJ2 to 0=0, VMSL4M=0	2.5 to 3.6		10		
	FmVMRC(2)		• Frequency variable RC source oscillation • When VMRAJ2 to 0=4, VMFAJ2 to 0=0, VMSL4M=1	2.5 to 3.6		4		
	FsX'tal	XT1, XT2	• 32.768kHz crystal oscillation • See Fig. 2.	2.5 to 3.6		32.768		kHz
Frequency variable RC oscillation usable range	OpVMRC(1)		When VMSL4M=0	2.5 to 3.6	8	10	12	MHz
	OpVMRC(2)		When VMSL4M=1	2.5 to 3.6	3.5	4	4.5	
Frequency variable RC oscillation adjustment range	VmADJ(1)		Each step of VMRAJn (Wide range)	2.5 to 3.6	8	24	64	%
	VmADJ(2)		Each step of VMFAJn (Small range)	2.5 to 3.6	1	4	8	

Note 2-3: See Tables 1 and 2 for the oscillation constants.

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

Electrical Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
High level input current	$I_{IH}(1)$	Ports 0, 1, 3, 7, 8 Ports A, B, C, D, E, F Port L	• Output disabled • Pull-up resistor off • $V_{IN}=V_{DD}$ (Including output Tr's off leakage current)	2.5 to 3.6			1	μA
	$I_{IH}(2)$	$\overline{RES}$	$V_{IN}=V_{DD}$	2.5 to 3.6			1	
	$I_{IH}(3)$	XT1, XT2	• For input port specification • $V_{IN}=V_{DD}$	2.5 to 3.6			1	
	$I_{IH}(4)$	CF1	$V_{IN}=V_{DD}$	2.5 to 3.6			15	
	$I_{IH}(5)$	P87 small signal input side	V_{IN}=VBIS+0.5V (VBIS: Bias voltage)	2.5 to 3.6	1.5	5.5	10	
Low level input current	$I_{IL}(1)$	Ports 0, 1, 3, 7, 8 Ports A, B, C, D, E, F Port L	• Output disabled • Pull-up resistor off • $V_{IN}=V_{SS}$ (Including output Tr's off leakage current)	2.5 to 3.6	–1			
	$I_{IL}(2)$	$\overline{RES}$	$V_{IN}=V_{SS}$	2.5 to 3.6	–1			
	$I_{IL}(3)$	XT1, XT2	• For input port specification • $V_{IN}=V_{SS}$	2.5 to 3.6	–1			
	$I_{IL}(4)$	CF1	$V_{IN}=V_{SS}$	2.5 to 3.6	–15			
	$I_{IL}(5)$	P87 small signal input side	V_{IN}=VBIS–0.5V (VBIS: Bias voltage)	2.5 to 3.6	–10	–5.5	–1.5	

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Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
High level output voltage	V_{OH}(1)	Ports 0, 1, 32 to 35	I_{OH}=−0.4mA	2.5 to 3.6	V_{DD}−0.4			V
	V_{OH}(2)	Ports 30, 31	I_{OH}=−1.6mA	2.5 to 3.6	V_{DD}−0.4			
	V_{OH}(3)	Ports 71 to 73	I_{OH}=−0.4mA	2.5 to 3.6	V_{DD}−0.4			
	V_{OH}(4)	Ports A, B, C Ports D, E, F	I_{OH}=−0.4mA	2.5 to 3.6	V_{DD}−0.4			
Low level output voltage	V_{OL}(1)	Ports 0, 1, 32 to 35 Ports 30, 31 (PWM function output mode)	I_{OL}=1.6mA	2.5 to 3.6			0.4	
	V_{OL}(2)	Ports 30, 31 (Port function output mode)	I_{OL}=5mA	2.5 to 3.6			0.4	
	V_{OL}(3)	Ports 7, 8 XT2	I_{OL}=1.6mA	2.5 to 3.6			0.4	
	V_{OL}(4)	Ports A, B, C Ports D, E, F	I_{OL}=1.6mA	2.5 to 3.6			0.4	
LCD output voltage regulation	VODLS	S0 to S53	• I_O=0mA • VLCD, 2/3VLCD, 1/3VLCD level output • See Fig. 8.	2.5 to 3.6	0		±0.2	
	VODLC	COM0 to COM3	• IO=0mA • VLCD, 2/3VLCD, 1/2VLCD, 1/3VLCD level output • See Fig. 8.	2.5 to 3.6	0		±0.2	
LCD bias resistor	RLCD(1)	Resistance per one bias resister	See Fig. 8.	2.5 to 3.6		60		kΩ
	RLCD(2)	Resistance per one bias resister 1/2R mode	See Fig. 8.	2.5 to 3.6		30		
Resistance of pull-up MOS Tr.	Rpu(1)	Ports 0, 1, 3, 7 Ports A, B, C, D, E, F	V_{OH}=0.9V_{DD}	2.5 to 3.6	18	50	50	
Hysterisis voltage	VHYS(1)	Ports 1, 7 $\overline{RES}$		2.5 to 3.6		0.1V_{DD}		V
	VHYS(2)	P87 small signal input side		2.5 to 3.6		0.1V_{DD}		
Pin capacitance	CP	All pins	• For pins other than that under test: V_{IN}=V_{SS} • f=1MHz • Ta=25°C	2.5 to 3.6		10		pF
Input sensitivity	Vsen	P87 small signal input side		2.5 to 3.6	0.12V_{DD}			Vpp

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.

Consumption Current Characteristics at Ta = –40°C to +85°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

Parameter	Symbol	Pin/ Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
Normal mode consumption current (Note 7-1)	IDDOP(1)	$V_{DD}1$ =$V_{DD}2$ =$V_{DD}3$	• FmCF=18MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 12MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.7 to 3.6		6.1	15.6	mA
	IDDOP(2)		• FmCF=8MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 12MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.5 to 3.6		3.9	8.8	
	IDDOP(3)		• FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • System clock set to internal RC oscillation • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	2.5 to 3.6		0.4	1.7	
	IDDOP(4)		• FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • Internal RC oscillation stopped. • System clock set to 10MHz with frequency variable RC oscillation • 1/1 frequency division ratio	2.5 to 3.6		4.3	12.0	
	IDDOP(5)		• FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • Internal RC oscillation stopped. • System clock set to 4MHz with frequency variable RC oscillation • 1/1 frequency division ratio	2.5 to 3.6		2.1	6.6	
	IDDOP(6)		• FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 32.768kHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	2.5 to 3.6		19.3	73	μA

Note 7-1: The consumption current value includes none of the currents that flow into the output Tr and internal pull-up resistors.

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Parameter	Symbol	Pin/ Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
HALT mode consumption current (Note 7-1)	IDDHALT(1)	$V_{DD}1$ =$V_{DD}2$ =$V_{DD}3$	• HALT mode • FmCF=18MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 12MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.7 to 3.6		2.7	6.8	mA
	IDDHALT(2)		• HALT mode • FmCF=8MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 12MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	2.5 to 3.6		1.4	3.1	
	IDDHALT(3)		• HALT mode • FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • System clock set to internal RC oscillation • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	2.5 to 3.6		0.2	0.75	
	IDDHALT(4)		• HALT mode • FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • Internal RC oscillation stopped. • System clock set to 10MHz with frequency variable RC oscillation • 1/1 frequency division ratio	2.5 to 3.6		1.6	4.6	
	IDDHALT(5)		• HALT mode • FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • Internal RC oscillation stopped. • System clock set to 4MHz with frequency variable RC oscillation • 1/1 frequency division ratio	2.5 to 3.6		0.7	1.75	
	IDDHALT(6)		• HALT mode • FmCF=0Hz (oscillation stopped) • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 32.768kHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	2.5 to 3.6		12.4	54.9	μA
HOLD mode consumption current	IDDHOLD(1)	$V_{DD}1$	• HOLD mode • CF1=V_{DD} or open (External clock mode)	2.5 to 3.6		0.08	18.4	
Timer HOLD mode consumption current	IDDHOLD(2)		• Timer HOLD mode • CF1=V_{DD} or open (External clock mode) • FmX'tal=32.768kHz crystal oscillation mode	2.5 to 3.6		10.14	34.4	

Note 7-1: The consumption current value includes none of the currents that flow into the output Tr and internal pull-up resistors.

F-ROM Write Characteristics at Ta = +10°C to +55°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

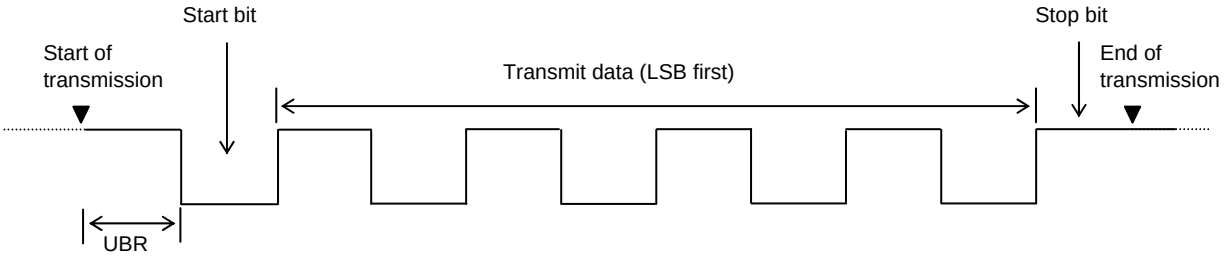
Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
Onboard programming current	IDDFW(1)	$V_{DD}1$	• Without CPU current	3.0 to 3.6		7	11	mA
Programming time	tFW(1)		• 2K-byte erase operation	3.0 to 3.6		12	15	ms
	tFW(2)		• 2K-byte writing operation	3.0 to 3.6		35	45	µs

UART (Full Duplex) Operating Conditions at Ta = +40 to +85°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

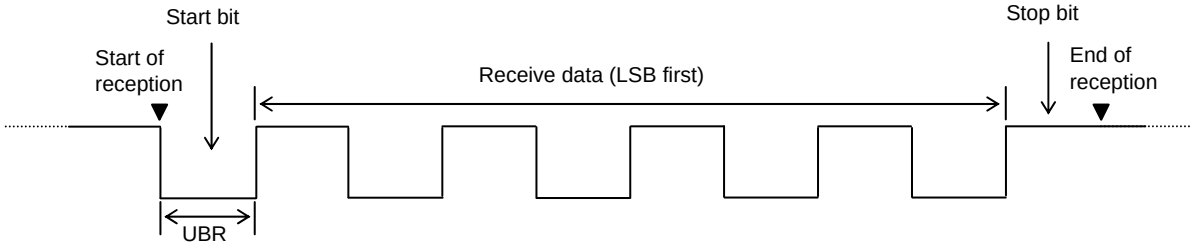
Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD} [V]	min	typ	max	unit
Transfer rate	UBR	UTX(S32), URX(S33)		2.5 to 3.6	16/3		8192/3	tCYC

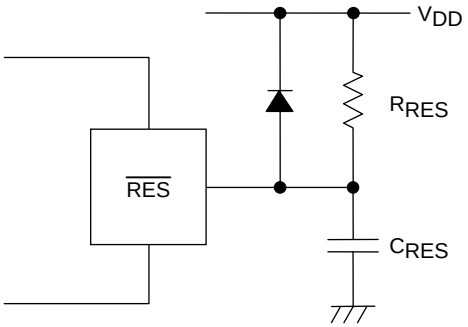
Data length : 7/8/9 bits (LSB first)
Stop bits : 1 bit (2-bit in continuous data transmission)
Parity bits : None

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



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





Note :
Determine the value of C_{RES} and R_{RES} so that the reset signal is present for a period of 200μs after the supply voltage goes beyond the lower limit of the IC's operating voltage.

Figure 5 Reset Circuit

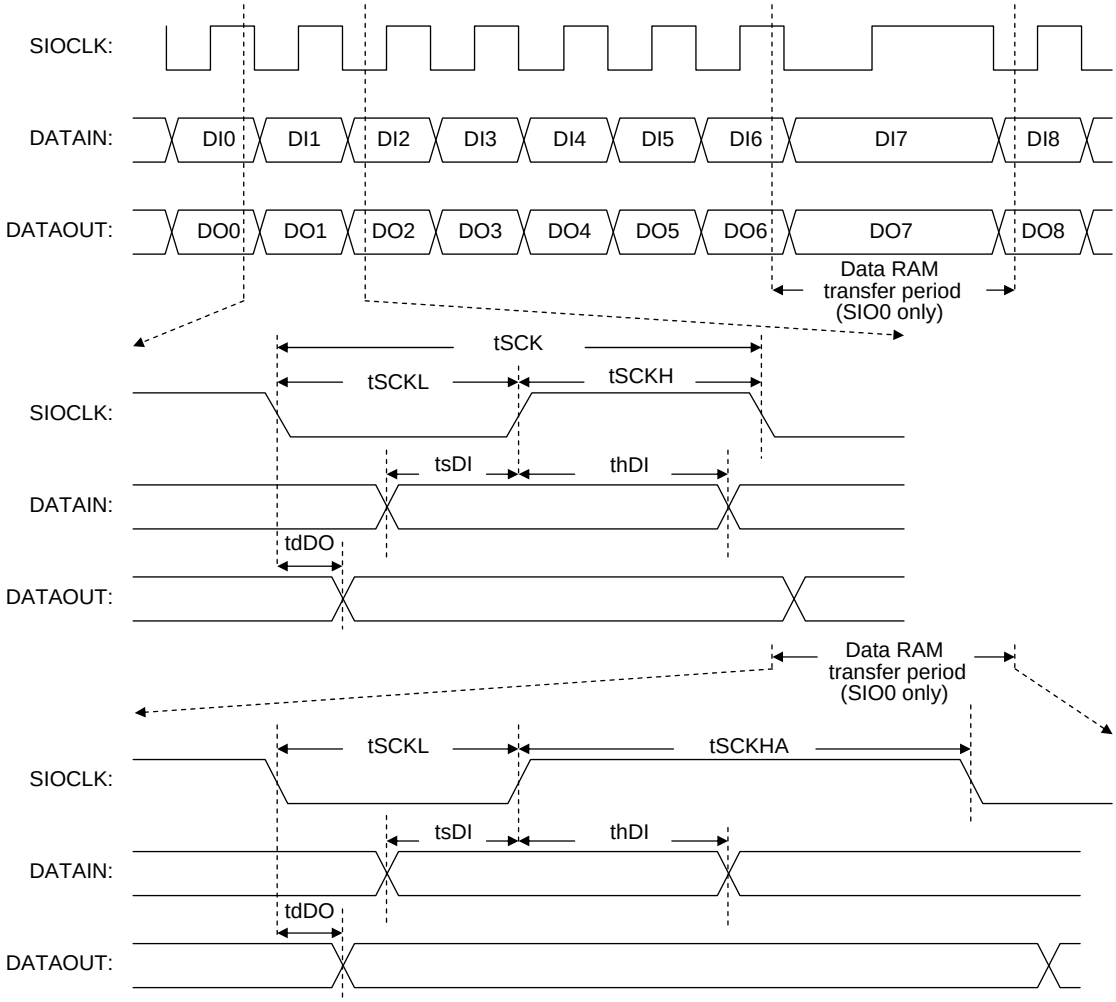


Figure 6 Serial I/O Waveforms

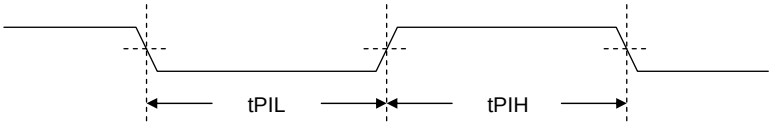


Figure 7 Pulse Input Timing Signal Waveform

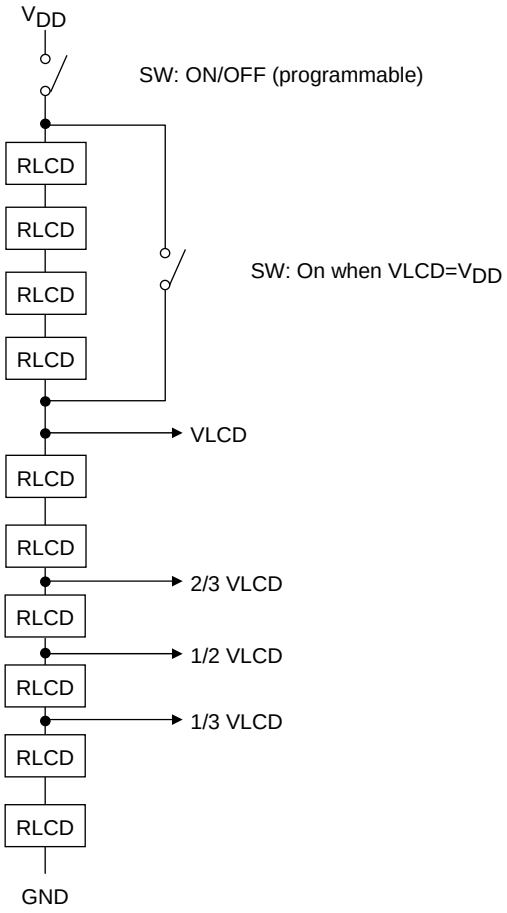


Figure 8 LCD bias resistor

ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LC87F7NC8AUEJ-2H	QIP100E(14×20) (Pb-Free / Halogen Free)	50 / Tray Foam
LC87F7NC8AVUEJ-2H	QIP100E(14×20) (Pb-Free / Halogen Free)	50 / Tray Foam