Ordering number : ENA1636

SANYO Semiconductors
DATA SHEET

LC87F7DJ2B — CMOS IC FROM 192K byte, RAM 8K byte on-chip 8-bit 1-chip Microcontroller

Overview

The SANYO LC87F7DJ2B is an 8-bit microcomputer that, centered around a CPU running at a minimum bus cycle time of 83.3ns, integrates on a single chip a number of hardware features such as 192K-byte flash ROM (onboard programmable), 8K-byte RAM, an on-chip debugger, an LCD controller/driver, sophisticated 16-bit timer/counter (may be divided into 8-bit timers), a 16-bit timer/counter (may be divided into 8-bit timers/counters or 8-bit PWMs), four 8-bit timers with a prescaler, 16-bit timer with a prescaler (may be divided into 8-bit timers), a base timer serving as a time-of-day clock, a day and time counter, a synchronous SIO interface (with automatic block transmission/reception capabilities), an asynchronous/synchronous SIO interface, two UART interface (full duplex), a 12-bit 15-channel AD converter, two 12-bit PWM channels, a high-speed clock counter, a system clock frequency divider, a small signal detector, two infrared remote controller receiver function, and a 31-source 10-vector interrupt feature.

Features

■Flash ROM
- Capable of on-board-programming with a wide range of souce voltages: 3.0 to 5.5V
- Block-erasable in 2-byte units
- 196608 × 8 bits

■RAM
- 8192 × 9 bits

■Minimum Bus Cycle Time
- 66.6ns (15MHz) V_{DD}=3.0 to 5.5V
- 125ns (8MHz) V_{DD}=2.5 to 5.5V
- 250ns (4MHz) V_{DD}=2.2 to 5.5V

Note: The bus cycle time here refers to the ROM read speed.

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■Minimum Instruction Cycle Time (tCYC)
- 200ns (15MHz) V_{DD}=3.0 to 5.5V
- 375ns (8MHz) V_{DD}=2.5 to 5.5V
- 750ns (4MHz) V_{DD}=2.2 to 5.5V

■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 terminals 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 pin 1 ($\overline{RES}$)
- 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 the 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)
- Timer 1: 16-bit timer/counter 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 timer/counter 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.)
- Timer 4: 8-bit timer with a 6-bit prescaler
- Timer 5: 8-bit timer with a 6-bit prescaler
- Timer 6: 8-bit timer with a 6-bit prescaler (with toggle output)
- Timer 7: 8-bit timer with a 6-bit prescaler (with toggle output)
- Timer 8: 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) Using with a base timer, it can be used as 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.

■SIO
- SIO0: 8-bit synchronous serial interface
  1) LSB first/MSB first mode selectable
  2) Built-in 8-bit baudrate generator (maximum transfer clock cycle = 4/3 tCYC)
  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-bit in continuous data transmission)
- Built-in baudrate generator

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

■AD Converter: 12 bits × 15 channels

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

■Remote Control Receiver Circuit1
1) Noise rejection function
   (Units of noise rejection filter: about 120µs, when selecting a 32.768kHz crystal oscillator as a 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).
4) X'tal HOLD mode release function

■Remote Control Receiver Circuit2
1) Noise rejection function
   (Units of noise rejection filter: about 120µs, when selecting a 32.768kHz crystal oscillator as a 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).
4) X'tal HOLD mode release function

■Watchdog Timer
- External RC watchdog timer
- 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, 1/64 as system clock.
2) Can output oscillation clock of sub clock.

■Interrupts

- 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 (shown in the diagram above).

■Subroutine Stack Levels: 4096 levels (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
- Frequency variable RC oscillation circuit (internal): For system clock
  1) Adjustable in ±4% (typ.) step from a 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).

■System Clock Multiplier Function

- Allows the 2 or 3 times the clock frequency to be selected when the crystal oscillation output is used as the system clock.

■Standby Function

- HALT mode: Halts instruction execution while allowing the peripheral circuits to continue operation.
  (Some parts of the serial transfer function stops operation.)
  1) Oscillation is not halted automatically.
  2) Canceled by a system reset or occurrence of an interrupt

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- HOLD mode: Suspends instruction execution and the operation of the peripheral circuits.
  1) The CF, RC, X'tal, and frequency variable RC oscillators automatically stop operation.
  2) There are three ways of resetting the HOLD mode.
     (1) Setting the reset pin to the low level
     (2) Setting at least one of the INT0, INT1, INT2, INT4, and INT5 pins to the specified level
     (3) Having an interrupt source established at port 0
- X'tal HOLD mode: Suspends instruction execution and the operation of the peripheral circuits except the base timer and the remote control receiver circuit.
  1) The CF, RC, and frequency variable RC oscillators automatically stop operation.
  2) The state of crystal oscillation established when the X'tal HOLD mode is entered is retained.
  3) There are five ways of resetting the X'tal HOLD mode.
     (1) Setting the reset pin to the low level
     (2) Setting at least one of the INT0, INT1, INT2, INT4, and INT5 pins to the specified level
     (3) Having an interrupt source established at port 0
     (4) Having an interrupt source established in the base timer circuit
     (5) Having an interrupt source established in the remote control receiver circuit

■On-chip Debugger

- Supports software debugging with the IC mounted on the target board.

■Package Form

- QIP100E(14×20): Lead-free type
- TQFP100(14×14): Lead-free type (Under Development)

■Development Tools

- On-chip debugger: TCB87-TypeB + LC87F7DJ2B or TCB87 TypeC(3Lines Cable) + LC87F7DJ2B

■Flash ROM Programming Boards

Package	Programming boards
QIP100E(14×20)	W87FQ100
TQFP100(14×14)	W87FSQ100

■Flash ROM Programmer

Maker		Model	Supported version	Device
Flash Support Group, Inc. (FSG)	Single	AF9708 AF9709/AF9709B/AF9709C (Including product of Ando Electric Co., Ltd)	(Note 2)	LC87F7DJ2B
	Gang	AF9723/AF9723B(Main body) (Including product of Ando Electric Co., Ltd)	(Note 2)	LC87F7DJ2B
		AF9833(Unit) (Including product of Ando Electric Co., Ltd)	(Note 2)	
Flash Support Group, Inc. (FSG) + SANYO (Note 1)	Onboard Single/Gang	AF9101/AF9103(Main body) (FSG)	(Note 2)	LC87F7DJ2B
		SIB87(interface driver) (SANYO)		
SANYO	Single/Gang	SKK/SKK Type B (SANYO FWS)	Application Version After 1.05 Chip Data Version After 2.23	LC87F7DJ2B
	Onboard Single/Gang	SKK-DBG Type B (SANYO FWS)		

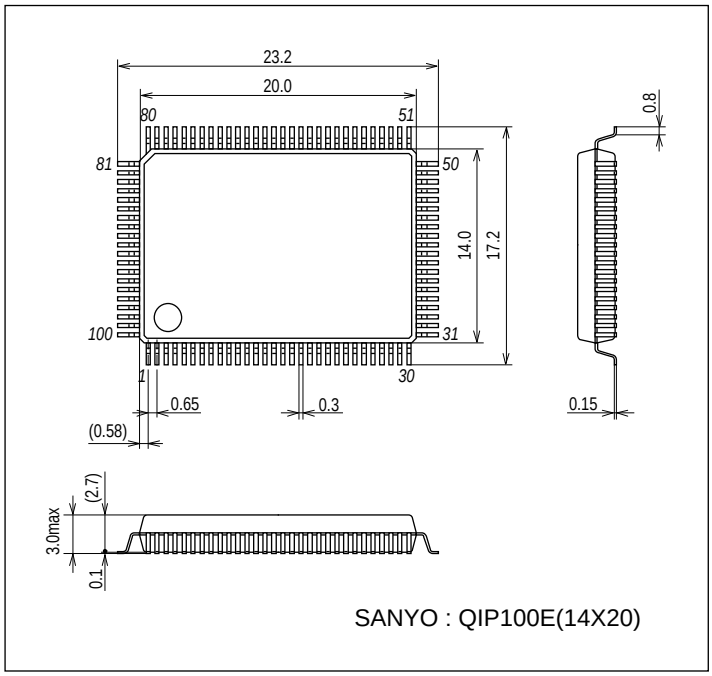
Note 1: With the FSG onboard programmer (AF9101/AF9103) and the serial interface driver provided by SANYO, PC-less standalone onboard programming is possible

Note 2: Depending on programming conditions, it is necessary to use a dedicated programming device and a program. Please contact SANYO or FSG if you have any questions or difficulties regarding this matter.

Package Dimensions

unit : mm (typ)

3151A

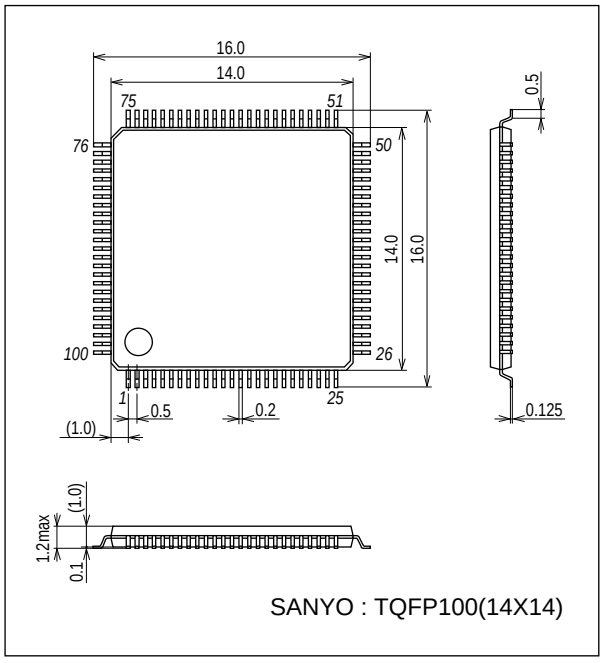


SANYO : QIP100E(14X20)

Package Dimensions

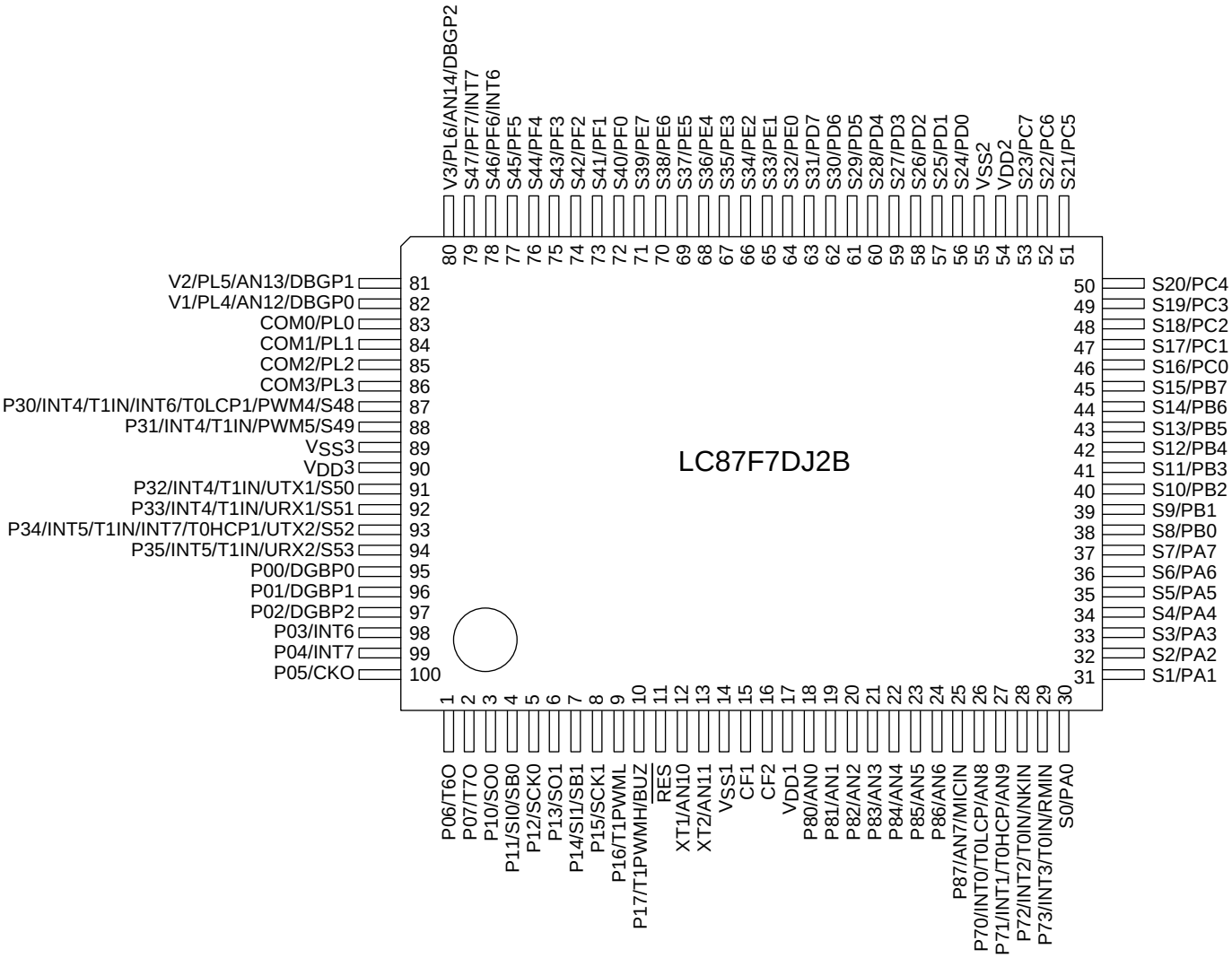
unit : mm (typ)

3274 [Under Development]



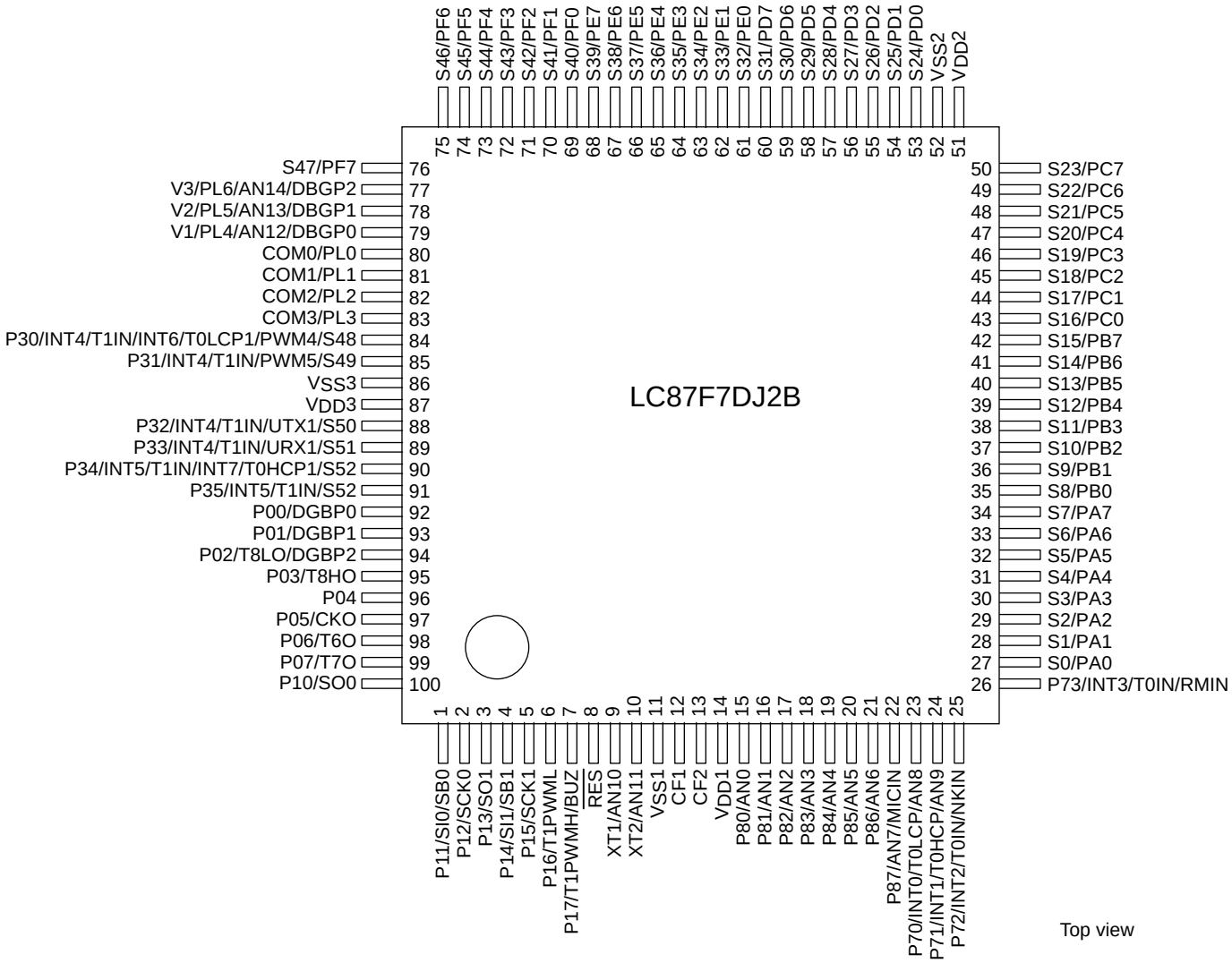
SANYO : TQFP100(14X14)

Pin Assignments



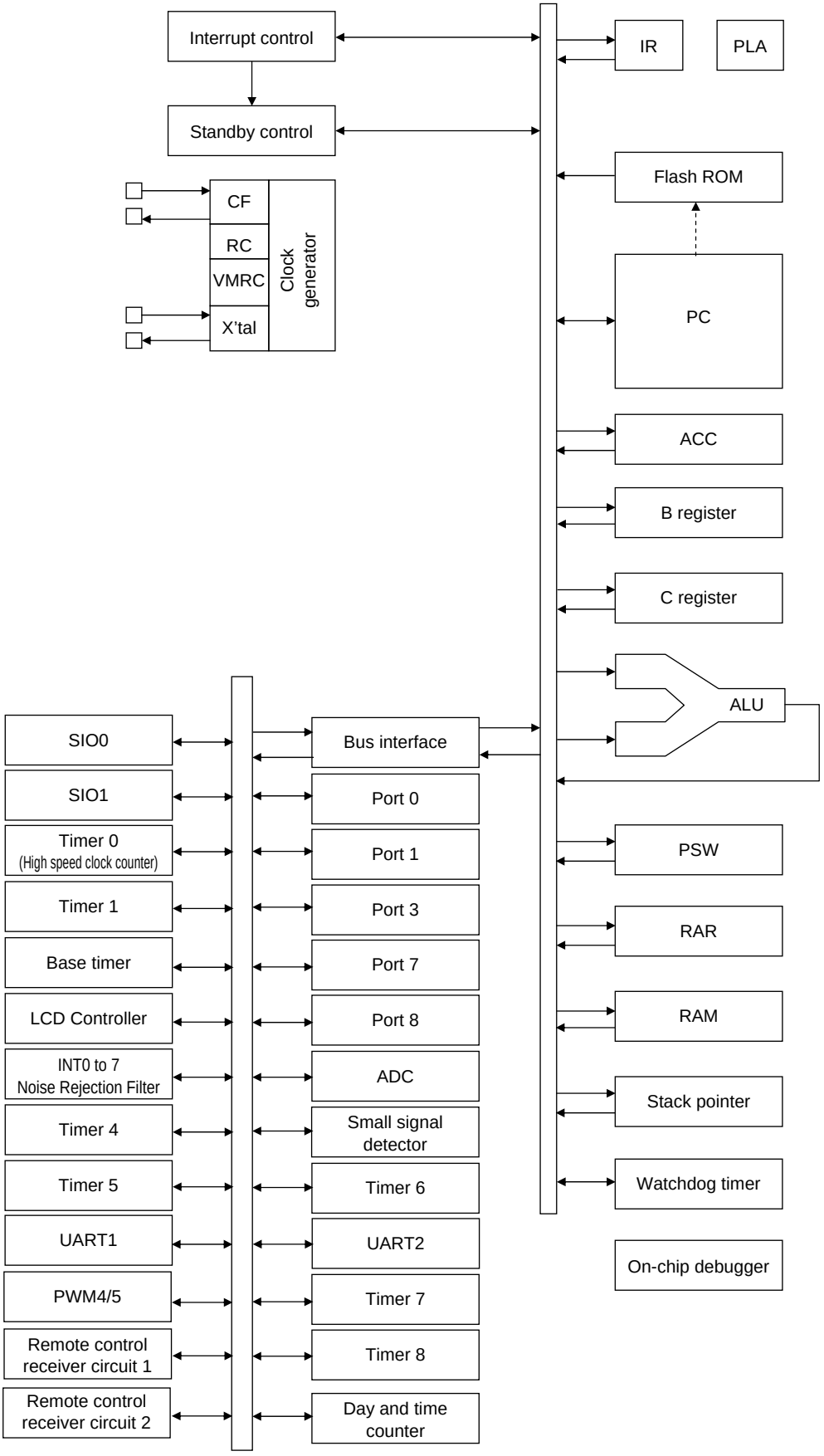
Top view

SANYO: QIP100E(14×20) “Lead-free Type”



SANYO: TQFP100(14×14) “Lead-free Type” (Under Development)

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>

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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
AD converter input port: AN10
Must be connected to $V_{DD}1$ if not to be used.</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
AD converter input port: AN11
Must be set for oscillation and kept open if not to be used.</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

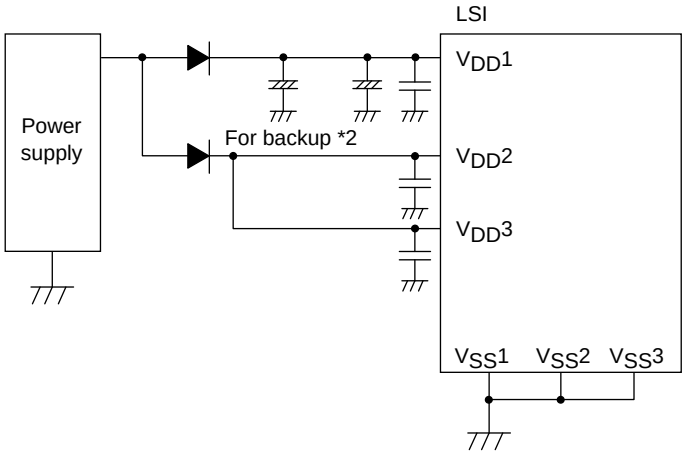
The table below lists the types of port outputs and the presence/absence of a pull-up resistor.
Data can be read into any input port even if it is in the output mode.

Port Name	Option Selected in Units of	Option Type	Output Type	Pull-up Resistor
P00 to P07	each bit	1	CMOS	Programmable
		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		+6.5	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 Ports 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 Ports 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 Ports 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 Ports 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 Ports 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 Ports D, E, F	Current at each pin				7.5	
	Total output current	ΣIOAL(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 Ports D, E, F	Total of all pins				80	
Maximum power dissipation		Pd max	QIP100E(14×20)	Ta=-40 to +85°C					mW
			TQFP100(14×14)	Ta=-40 to +85°C					

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

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Parameter	Symbol	Pin/Remarks	Conditions	Specification			
			V_{DD}[V]	min	typ	max	unit
Operating ambient temperature	Topr			-40		+85	°C
Storage ambient temperature	Tstg			-55		+125	

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	Specification			
			V_{DD}[V]	min	typ	max	unit
Operating supply voltage (Note 2-1)	$V_{DD}(1)$	$V_{DD}1=V_{DD}2=V_{DD}3$	0.190µs ≤ tCYC ≤ 200µs		3.0		5.5	V
	$V_{DD}(2)$		0.356µs ≤ tCYC ≤ 200µs		2.5		5.5	
	$V_{DD}(3)$		0.712µs ≤ tCYC ≤ 200µs		2.2		5.5	
Memory sustaining supply voltage	VHD	$V_{DD}1$	RAM and register contents sustained in HOLD mode.		2.0		5.5	
High level input voltage	$V_{IH}(1)$	Ports 0, 3, 8 Ports A, B, C, D, E, F Port L	Output disabled	2.2 to 5.5	$0.3V_{DD}$ +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)	2.2 to 5.5	$0.3V_{DD}$ +0.7		V_{DD}	
	$V_{IH}(3)$	P71 interrupt side	• Output disabled • When INT1VTSL=1	2.2 to 5.5	$0.85V_{DD}$		V_{DD}	
	$V_{IH}(4)$	P87 small signal input side	Output disabled	2.2 to 5.5	$0.75V_{DD}$		V_{DD}	
	$V_{IH}(5)$	P70 watchdog timer side	Output disabled	2.2 to 5.5	$0.9V_{DD}$		V_{DD}	
	$V_{IH}(6)$	XT1,XT2,CF1, $\overline{RES}$		2.2 to 5.5	$0.75V_{DD}$		V_{DD}	
Low level input voltage	$V_{IL}(1)$	Ports 0, 3, 8 Ports A, B, C, D, E, F Port L	Output disabled	4.0 to 5.5	V_{SS}		$0.15V_{DD}$ +0.4	
				2.2 to 4.0	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)	4.0 to 5.5	V_{SS}		$0.1V_{DD}$ +0.4	
				2.2 to 4.0	V_{SS}		$0.2V_{DD}$	
	$V_{IL}(3)$	P71 interrupt side	• Output disabled • When INT1VTSL=1	2.2 to 5.5	V_{SS}		$0.45V_{DD}$	
	$V_{IL}(4)$	P87 small signal input side	Output disabled	2.2 to 5.5	V_{SS}		$0.25V_{DD}$	
	$V_{IL}(5)$	P70 watchdog timer side	Output disabled	2.2 to 5.5	V_{SS}		$0.8V_{DD}$ -1.0	
	$V_{IL}(6)$	XT1, XT2, CF1, $\overline{RES}$		2.2 to 5.5	V_{SS}		$0.25V_{DD}$	
Instruction cycle time (Note 2-2)	tCYC			3.0 to 5.5	0.190		200	µs
				2.5 to 5.5	0.356		200	
				2.2 to 5.5	0.712		200	
External system clock frequency	FEXCF(1)	CF1	• CF2 pin open • System clock frequency division ratio=1/1 • External system clock duty=50±5%	3.0 to 5.5	0.1		15	MHz
				2.5 to 5.5	0.1		8	
				2.2 to 5.5	0.1		4	
			• CF2 pin open • System clock frequency division ratio=1/2	3.0 to 5.5	0.2		30	
				2.5 to 5.5	0.2		16	
				2.2 to 5.5	0.2		8	

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	• 15MHz ceramic oscillation • See Fig. 1.	3.0 to 5.5		15		MHz
	FmCF(2)	CF1, CF2	• 8MHz ceramic oscillation • See Fig. 1.	2.5 to 5.5		8		
	FmCF(3)	CF1, CF2	• 4MHz ceramic oscillation • See Fig. 1.	2.2 to 5.5		4		
	FmRC		Internal RC oscillation	2.2 to 5.5	0.3	1.0	2.0	
	FmVMRC(1)		• Frequency variable RC source oscillation • When VMRAJ2 to 0=4, VMFAJ2 to 0=0, VMSL4M=0	2.2 to 5.5		10		
	FmVMRC(2)		• Frequency variable RC source oscillation • When VMRAJ2 to 0=4, VMFAJ2 to 0=0, VMSL4M=1	2.2 to 5.5		4		
	FsX'tal	XT1, XT2	• 32.768kHz crystal oscillation • See Fig. 2.	2.2 to 5.5		32.768		kHz
Frequency variable RC oscillation usable range	OpVMRC(1)		When VMSL4M=0	2.2 to 5.5	8	10	12	MHz
	OpVMRC(2)		When VMSL4M=1	2.2 to 5.5	3.5	4	4.5	
Frequency variable RC oscillation adjustment range	VmADJ(1)		Each step of VMRAJn (Wide range)	2.2 to 5.5	8	24	64	%
	VmADJ(2)		Each step of VMFAJn (Small range)	2.2 to 5.5	1	4	8	

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

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 Ports D, E, F Port L	• Output disabled • Pull-up resistor off • $V_{IN}=V_{DD}$ (Including output Tr's off leakage current)	2.2 to 5.5			1	µA
	$I_{IH}(2)$	$\overline{RES}$	$V_{IN}=V_{DD}$	2.2 to 5.5			1	
	$I_{IH}(3)$	XT1, XT2	• For input port specification • $V_{IN}=V_{DD}$	2.2 to 5.5			1	
	$I_{IH}(4)$	CF1	$V_{IN}=V_{DD}$	2.2 to 5.5			15	
	$I_{IH}(5)$	P87 small signal input side	V_{IN}=VBIS+0.5V (VBIS: Bias voltage)	4.5 to 5.5	4.2	8.5	15	
				2.2 to 4.5	1.5	5.5	10	
Low level input current	$I_{IL}(1)$	Ports 0, 1, 3, 7, 8 Ports A, B, C Ports D, E, F Port L	• Output disabled • Pull-up resistor off • $V_{IN}=V_{SS}$ (Including output Tr's off leakage current)	2.2 to 5.5	-1			
	$I_{IL}(2)$	$\overline{RES}$	$V_{IN}=V_{SS}$	2.2 to 5.5	-1			
	$I_{IL}(3)$	XT1, XT2	• For input port specification • $V_{IN}=V_{SS}$	2.2 to 5.5	-1			
	$I_{IL}(4)$	CF1	$V_{IN}=V_{SS}$	2.2 to 5.5	-15			
	$I_{IL}(5)$	P87 small signal input side	V_{IN}=VBIS-0.5V (VBIS: Bias voltage)	4.5 to 5.5	-15	-8.5	-4.2	
				2.2 to 4.5	-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}=-1mA	4.5 to 5.5	V_{DD}-1			V
	V_{OH}(2)		I_{OH}=-0.4mA	3.0 to 5.5	V_{DD}-0.4			
	V_{OH}(3)		I_{OH}=-0.2mA	2.2 to 5.5	V_{DD}-0.4			
	V_{OH}(4)	Ports 30, 31	I_{OH}=-10mA	4.5 to 5.5	V_{DD}-1.5			
	V_{OH}(5)		I_{OH}=-1.6mA	3.0 to 5.5	V_{DD}-0.4			
	V_{OH}(6)		I_{OH}=-1mA	2.2 to 5.5	V_{DD}-0.4			
	V_{OH}(7)	Ports 71 to 73	I_{OH}=-0.4mA	3.0 to 5.5	V_{DD}-0.4			
	V_{OH}(8)		I_{OH}=-0.2mA	2.2 to 5.5	V_{DD}-0.4			
	V_{OH}(9)	Ports A, B, C Ports D, E, F	I_{OH}=-1mA	4.5 to 5.5	V_{DD}-1			
	V_{OH}(10)		I_{OH}=-0.4mA	3.0 to 5.5	V_{DD}-0.4			
	V_{OH}(11)		I_{OH}=-0.2mA	2.2 to 5.5	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}=10mA	4.5 to 5.5			1.5	
	V_{OL}(2)		I_{OL}=1.6mA	3.0 to 5.5			0.4	
	V_{OL}(3)		I_{OL}=1mA	2.2 to 5.5			0.4	
	V_{OL}(4)	Ports 30, 31 (Port function output mode)	I_{OL}=30mA	4.5 to 5.5			1.5	
	V_{OL}(5)		I_{OL}=5mA	3.0 to 5.5			0.4	
	V_{OL}(6)		I_{OL}=2.5mA	2.2 to 5.5			0.4	
	V_{OL}(7)	Ports 7, 8 XT2	I_{OL}=1.6mA	3.0 to 5.5			0.4	
	V_{OL}(8)		I_{OL}=1mA	2.2 to 5.5			0.4	
	V_{OL}(9)	Ports A, B, C Ports D, E, F	I_{OL}=1.6mA	3.0 to 5.5			0.4	
	V_{OL}(10)		I_{OL}=1mA	2.2 to 5.5			0.4	
LCD output voltage regulation	VODLS	S0 to S53	• I_O=0mA • VLCD, 2/3VLCD,1/3VLCD level output • See Fig. 8.	2.2 to 5.5	0		±0.2	
	VODLC	COM0 to COM3	• I_O=0mA • VLCD, 2/3VLCD,1/2VLCD, 1/3VLCD level output • See Fig. 8.	2.2 to 5.5	0		±0.2	
LCD bias resistor	RLCD(1)	Resistance per one bias resister	See Fig. 8.	2.2 to 5.5		60		kΩ
	RLCD(2)	Resistance per one bias resister 1/2 mode	See Fig. 8.	2.2 to 5.5		30		
Resistance of pull-up MOS Tr.	Rpu(1)	Ports 0, 1, 3, 7 Ports A, B, C Ports D, E, F	V_{OH}=0.9V_{DD}	4.5 to 5.5	15	35	80	
	Rpu(2)			2.2 to 5.5	18	50	150	
Hysterisis voltage	VHYS(1)	Ports 1, 7 $\overline{RES}$		2.2 to 5.5		0.1V_{DD}		V
	VHYS(2)	P87 small signal input side		2.2 to 5.5		0.1V_{DD}		
Pin capacitance	CP	All pins	• For pins other than that under test: V_{IN}=V_{SS} • f=1MHz • Ta=25°C	2.2 to 5.5		10		pF
Input sensitivity	Vsen	P87 small signal input side		2.2 to 5.5	0.12V_{DD}			Vp-p

Serial I/O Characteristics at Ta = -40°C to +85°C, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

1. SIO0 Serial I/O Characteristics (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. 6.	2.2 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. 6. • (Note 4-1-2)		4			
	Output clock	Frequency	tSCK(2)	SCK0(P12)	• CMOS output selected • See Fig. 6.	2.2 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. 6.		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. 6.	2.2 to 5.5	0.03			µs
	Data hold time		thDI(1)			2.2 to 5.5	0.03			
Serial output	Input clock	Output delay time	tdD0(1)	SO0(P10), SB0(P11)	• Continuous data transmission/reception mode • (Note 4-1-3)	2.2 to 5.5			(1/3)tCYC +0.05	
			tdD0(2)		• Synchronous 8-bit mode • (Note 4-1-3)	2.2 to 5.5			1tCYC +0.05	
	Output clock		tdD0(3)		(Note 4-1-3)	2.2 to 5.5			(1/3)tCYC +0.05	

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. 6.

2. SIO1 Serial I/O Characteristics (Note 4-2-1)

Parameter			Symbol	Pin/Remarks	Conditions		Specification			
						V_{DD}[V]	min	typ	max	unit
Serial clock	Input clock	Frequency	tSCK(3)	SCK1(P15)	See Fig. 6.	2.2 to 5.5	2			tCYC
		Low level pulse width	tSCKL(3)				1			
		High level pulse width	tSCKH(3)				1			
	Output clock	Frequency	tSCK(4)	SCK1(P15)	• CMOS output selected • See Fig. 6.	2.2 to 5.5	2			
		Low level pulse width	tSCKL(4)				1/2			tSCK
		High level pulse width	tSCKH(4)				1/2			
Serial input	Data setup time		tsDI(2)	SB1(P14), SI1(P14)	• Must be specified with respect to rising edge of SIOCLK. • See Fig. 6.	2.2 to 5.5	0.03			µs
	Data hold time		thDI(2)			2.2 to 5.5	0.03			
Serial output	Output delay time		tdD0(4)	SO1(P13), SB1(P14)	• 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. 6.	2.2 to 5.5			(1/3)tCYC +0.05	

Note 4-2-1: These specifications are theoretical values. Add margin depending on its use.

Pulse Input Conditions 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/low level pulse width	tPIH(1) tPIL(1)	INT0(P70), INT1(P71), INT2(P72), INT4(P30 to P33), INT5(P34 to P35), INT6(P30), INT7(P34)	• Interrupt source flag can be set. • Event inputs for timer 0 or 1 are enabled.	2.2 to 5.5	1			tCYC
	tPIH(2) tPIL(2)	INT3(P73) when noise filter time constant is 1/1	• Interrupt source flag can be set. • Event inputs for timer 0 are enabled.	2.2 to 5.5	2			
	tPIH(3) tPIL(3)	INT3(P73) when noise filter time constant is 1/32	• Interrupt source flag can be set. • Event inputs for timer 0 are enabled.	2.2 to 5.5	64			
	tPIH(4) tPIL(4)	INT3(P73) when noise filter time constant is 1/128	• Interrupt source flag can be set. • Event inputs for timer 0 are enabled.	2.2 to 5.5	256			
	tPIH(5) tPIL(5)	MICIN(P87)	Condition that signal is accepted to small signal detection counter.	2.2 to 5.5	1			
	tPIH(6) tPIL(6)	RMIN(P73)	Condition that signal is accepted to remote control receiver circuit.	2.2 to 5.5	4			RMCK (Note5-1)
	tPIL(7)	$\overline{RES}$	Resetting is enabled.	2.2 to 5.5	200			µs

Note 5-1: RMCK is an unit for the base clock (40tCYC/50tCYC/Sub-Clock) of remote control receiver circuit.

AD Converter Characteristics at $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

<12bits AD Converter Mode at Ta =-20 to +70°C>

Parameter	Symbol	Pin/Remarks	Conditions		Specification			
				V_{DD}[V]	min	typ	max	unit
Resolution	N	AN0(P80) to AN7(P87), AN8(P70), AN9(P71), AN10(XT1), AN11(XT2)		3.0 to 5.5		12		bit
Absolute accuracy	ET		(Note 6-1)	3.0 to 5.5				LSB
Conversion time	tCAD		• See Conversion time calculation formulas. (Note 6-2)	4.0 to 5.5	32		115	µs
				3.0 to 5.5	55.6		115	
Analog input voltage range	VAIN				V_{SS}		V_{DD}	V
Analog port input current	IAINH		VAIN=V_{DD}				1	µA
	IAINL		VAIN=V_{SS}		-1			

<8bits AD Converter Mode at Ta =-30 to +70°C>

Parameter	Symbol	Pin/Remarks	Conditions		Specification			
				V_{DD}[V]	min	typ	max	unit
Resolution	N	AN0(P80) to AN7(P87), AN8(P70), AN9(P71), AN10(XT1), AN11(XT2)		3.0 to 5.5		8		bit
Absolute accuracy	ET		(Note 6-1)	3.0 to 5.5			1.5	LSB
Conversion time	TCAD		• See Conversion time calculation formulas. (Note 6-2)	4.0 to 5.5	20		90	µs
				3.0 to 5.5	34.27		90	
Analog input voltage range	VAIN			3.0 to 5.5	V_{SS}		V_{DD}	V
Analog port input current	IAINH		VAIN=V_{DD}	3.0 to 5.5			1	µA
	IAINL		VAIN=V_{SS}	3.0 to 5.5	-1			

<Conversion time calculation formulas>

12bits AD Converter Mode: TCAD(Conversion time)=((52/(division ratio)) + 2) × (1/3) ×tCYC
8bits AD Converter Mode: TCAD(Conversion time)=((32/(division ratio)) + 2) × (1/3) ×tCYC

<Recommended Operating Conditions>

External oscillation FmCF [MHz]	Operating supply voltage range V_{DD} [V]	System division ratio (SYSDIV)	Cycle time tCYC [ns]	AD division ratio (ADDIV)	AD conversion time (tCAD) [µs]	
					12bit AD	8bit AD
12	4.0 to 5.5	1/1	250	1/8	34.8	21.5
	3.0 to 5.5	1/1	250	1/16	69.5	42.8
15	3.0 to 5.5	1/1	200	1/16	55.6	34.27

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.

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=15MHz 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	4.5 to 5.5		8.7	23.7	mA
	IDDOP(2)			3.0 to 3.6		5.6	12.0	
	IDDOP(3)		• FmCF=8MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 8MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	4.5 to 5.5		6.1	15.0	
	IDDOP(4)			3.0 to 3.6		4.0	8.8	
	IDDOP(5)			2.5 to 3.0		3.0	6.8	
	IDDOP(6)		• FmCF=4MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 4MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	4.5 to 5.5		2.1	8.7	
	IDDOP(7)			3.0 to 3.6		2.0	5.3	
	IDDOP(8)			2.2 to 3.0		1.7	4.4	
	IDDOP(9)		• 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	4.5 to 5.5		0.7	3.1	
	IDDOP(10)			3.0 to 3.6		0.4	1.7	
	IDDOP(11)			2.2 to 3.0		0.3	1.35	
	IDDOP(12)		• 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	4.5 to 5.5		6.5	20.0	
	IDDOP(13)			3.0 to 3.6		4.3	12.0	
	IDDOP(14)		• 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	4.5 to 5.5		3.25	11.5	
	IDDOP(15)			3.0 to 3.6		2.1	6.6	
	IDDOP(16)			2.2 to 3.0		1.7	3.5	
	IDDOP(17)		• 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	4.5 to 5.5		32.8	128.7	µA
	IDDOP(18)			3.0 to 3.6		17.4	56.9	
	IDDOP(19)			2.2 to 3.0		13.0	43.3	

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=15MHz 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	4.5 to 5.5		3.6	21.8	mA
	IDDHALT(2)			3.0 to 3.6		2.2	11.9	
	IDDHALT(3)		• HALT mode • FmCF=8MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 8MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/1 frequency division ratio	4.5 to 5.5		2.2	6.2	
	IDDHALT(4)			3.0 to 3.6		1.3	3.1	
	IDDHALT(5)			2.5 to 3.0		1.0	2.5	
	IDDHALT(6)		• HALT mode • FmCF=4MHz ceramic oscillation mode • FmX'tal=32.768kHz crystal oscillation mode • System clock set to 4MHz side • Internal RC oscillation stopped. • Frequency variable RC oscillation stopped. • 1/2 frequency division ratio	4.5 to 5.5		1.3	3.9	
	IDDHALT(7)			3.0 to 3.6		0.7	1.8	
	IDDHALT(8)			2.2 to 3.0		0.5	1.3	
	IDDHALT(9)		• 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	4.5 to 5.5		0.3	1.3	
	IDDHALT(10)			3.0 to 3.6		0.18	0.75	
	IDDHALT(11)			2.2 to 3.0		0.14	0.54	
	IDDHALT(12)		• 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	4.5 to 5.5		2.6	7.7	
	IDDHALT(13)			3.0 to 3.6		1.6	4.6	
	IDDHALT(14)		• 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	4.5 to 5.5		1.3	3.5	
	IDDHALT(15)			3.0 to 3.6		0.7	1.75	
	IDDHALT(16)			2.2 to 3.0		0.6	1.2	
	IDDHALT(17)		• 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	4.5 to 5.5		18.6	207.8	µA
	IDDHALT(18)			3.0 to 3.6		7.7	48.1	
	IDDHALT(19)			2.2 to 3.0		4.8	27.3	
HOLD mode consumption current	IDDHOLD(1)	$V_{DD}1$	• HOLD mode • CF1=V_{DD} or open (External clock mode)	4.5 to 5.5		0.14	38.8	
	IDDHOLD(2)			3.0 to 3.6		0.030	18.4	
	IDDHOLD(3)			2.2 to 3.0		0.025	14.0	
Timer HOLD mode consumption current	IDDHOLD(4)		• Timer HOLD mode • CF1=V_{DD} or open (External clock mode) • FmX'tal=32.768kHz crystal oscillation mode	4.5 to 5.5		15.5	91.0	
	IDDHOLD(5)			3.0 to 3.6		6.3	34.4	
	IDDHOLD(6)			2.2 to 3.0		3.6	24.6	

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, $V_{SS}1 = V_{SS}2 = V_{SS}3 = 0V$

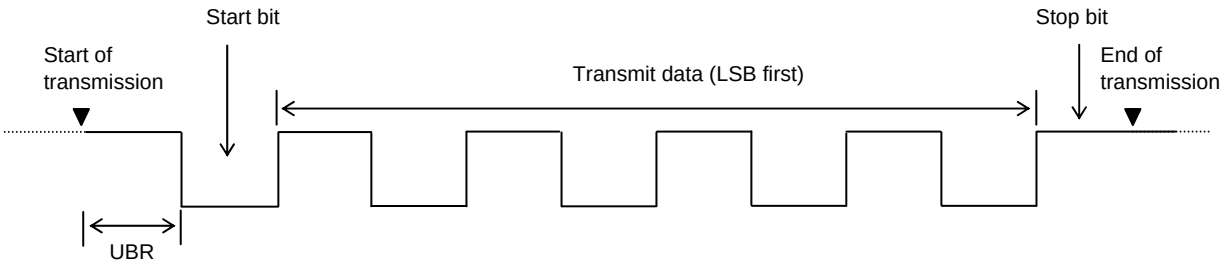
Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Onboard programming current	IDDFW(1)	$V_{DD}1$	• 128-byte programming • Erasing current included	3.0 to 5.5		25	40	mA
Programming time	tFW(1)		• 128-byte programming • Erasing current included • Time for setting up 128-byte data is excluded.	3.0 to 5.5		22.5	45	ms

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

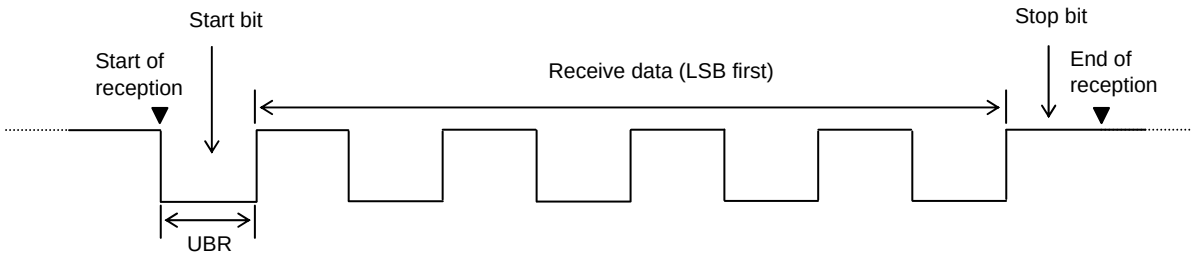
Parameter	Symbol	Pin/Remarks	Conditions	Specification				
				V_{DD}[V]	min	typ	max	unit
Transfer ate	UBR	UTX(P32), URX(P33)		2.2 to 5.5	16/3		8192/3	tCYC

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

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



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



Characteristics of a Sample Main System Clock Oscillation Circuit

Given below are the characteristics of a sample main system clock oscillation circuit that are measured using a SANYO-designated oscillation characteristics evaluation board and external components with circuit constant values with which the oscillator vendor confirmed normal and stable oscillation.

Table 1 Characteristics of a Sample Main System Clock Oscillator Circuit with a Ceramic Oscillator

Nominal Frequency	Vendor Name	Oscillator Name	Circuit Constant				Operating Voltage Range [V]	Oscillation Stabilization Time		Remarks
			C1 [pF]	C2 [pF]	Rf1 [Ω]	Rd1 [Ω]		typ [ms]	max [ms]	
15MHz	MURATA	CSTCE15M0V53-R0	(15)	(15)	Open	220	2.8 to 5.5	0.05	0.15	Values shown in parentheses are capacitance included in the oscillator
12MHz	MURATA	CSTCE12M0G52-R0	(10)	(10)	Open	470	2.8 to 5.5	0.05	0.15	Values shown in parentheses are capacitance included in the oscillator
8MHz	MURATA	CSTCE8M00G52-R0	(10)	(10)	Open	680	2.5 to 5.5	0.05	0.15	Values shown in parentheses are capacitance included in the oscillator
		CSTLS8M00G52-B0	(15)	(15)	Open	15k		0.05	0.15	
4MHz	MURATA	CSTCR4M00F53-R0	(15)	(15)	Open	2.2k	2.2 to 5.5	0.05	0.15	Values shown in parentheses are capacitance included in the oscillator
		CSTLS4M0053-B0	(15)	(15)	Open	2.2k		0.05	0.15	

The oscillation stabilization time refers to the time interval that is required for the oscillation to get stabilized after V_{DD} goes above the operating voltage lower limit (see Figure 4).

Characteristics of a Sample Subsystem Clock Oscillator Circuit

Given below are the characteristics of a sample subsystem clock oscillation circuit that are measured using a SANYO-designated oscillation characteristics evaluation board and external components with circuit constant values with which the oscillator vendor confirmed normal and stable oscillation.

Table 2 Characteristics of a Sample Subsystem Clock Oscillator Circuit with a Crystal Oscillator

Nominal Frequency	Vendor Name	Oscillator Name	Circuit Constant				Operating Voltage Range [V]	Oscillation Stabilization Time		Remarks
			C3 [pF]	C4 [pF]	Rf2 [Ω]	Rd2 [Ω]		typ [s]	max [s]	
32.768kHz	EPSON TOYOCOM	MC-306	18	18	Open	560k	2.0 to 5.5	1.4	3.0	Applicable CL value =12.5pF

The oscillation stabilization time refers to the time interval that is required for the oscillation to get stabilized after the instruction for starting the subclock oscillation circuit is executed and to the time interval that is required for the oscillation to get stabilized after the HOLD mode is reset (see Figure 4).

Note: The components that are involved in oscillation should be placed as close to the IC and to one another as possible because they are vulnerable to the influences of the circuit pattern.

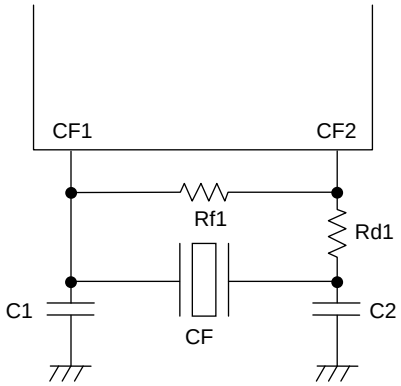


Figure 1 CF Oscillator Circuit

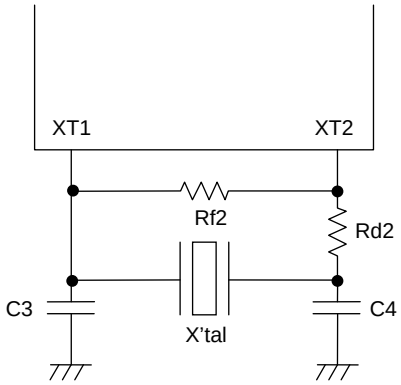


Figure 2 XT Oscillator Circuit

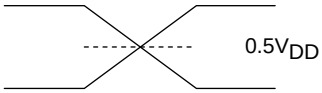
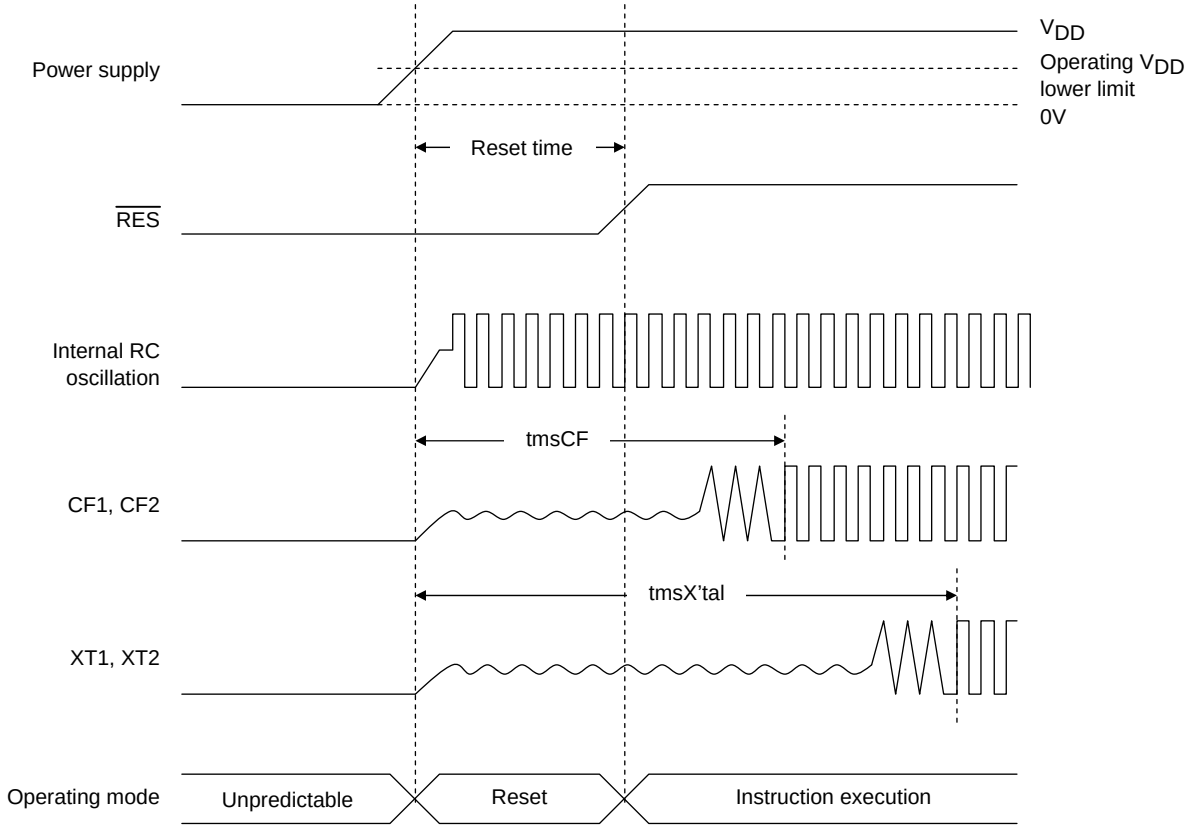
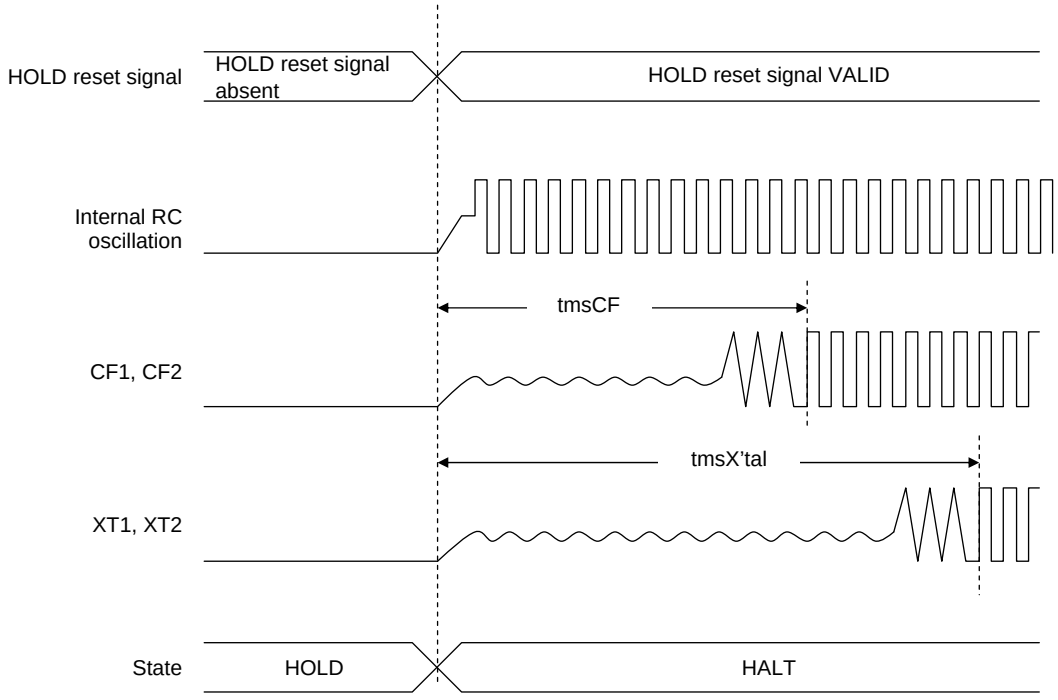


Figure 3 AC Timing Measurement Point

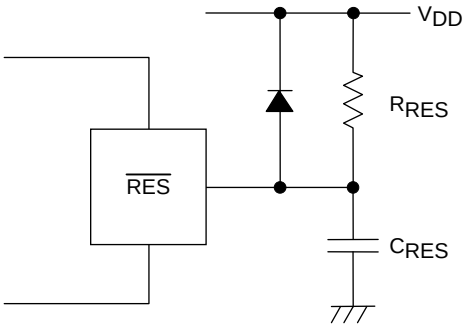


Reset Time and Oscillation Stabilization Time



HOLD Reset Signal and Oscillation Stabilization Time

Figure 4 Oscillation Stabilization Times



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

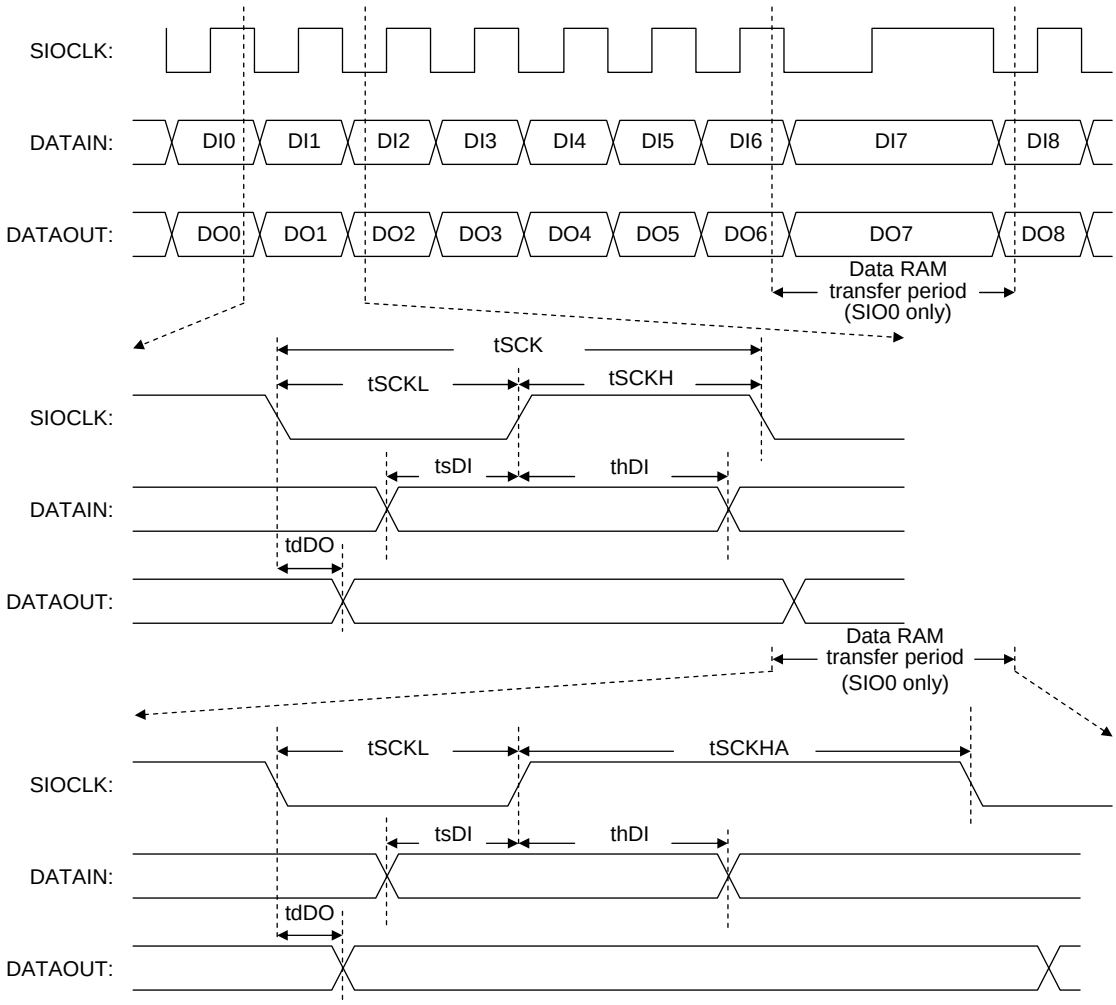


Figure 6 Serial I/O Waveforms

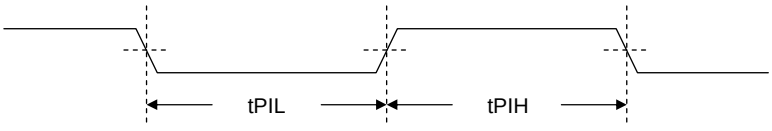


Figure 7 Pulse Input Timing Signal Waveform

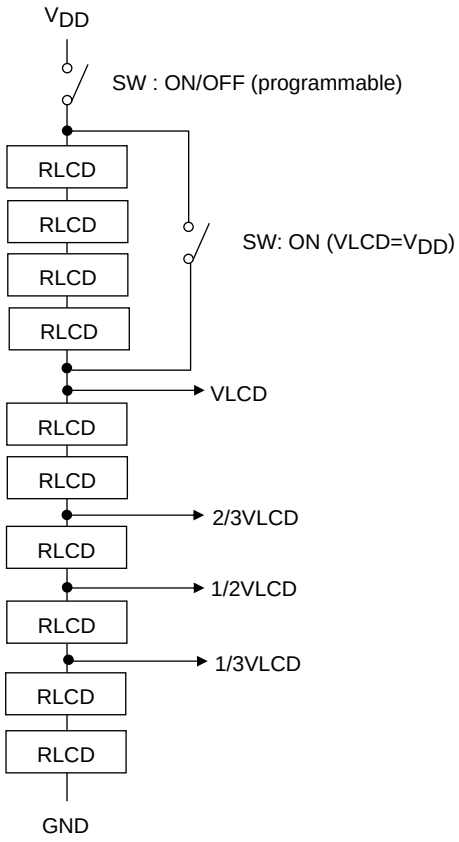


Figure 8 LCD Bias Resistor