Ordering number : ENA0460A

SANYO Semiconductors
DATA SHEET

LC723661, LC723662, LC723663

CMOS IC
Electronic tuning radio for car audio
ETR Controllers

Overview

The LC723661, 723662 and 723663 are ETR controllers that can support up to 64KB of ROM and up to 4KB of RAM. These are an 80-pin version of the 100-pin LC723780 series.
They have a built-in serial I/O port and 6-input 8-bit A/D converter to enhance communication with the internal and external devices.

Functions

- ROM : Up to 32K steps (32767×16-bits)
  The subroutine area holds 4K steps (4,096×16-bits)
- RAM : Up to 8K×4-bits (In banks 00 through 7F)
  LC723661-ROM 32KB, RAM 2KB
  LC723662-ROM 48KB, RAM 2KB
  LC723663-ROM 64KB, RAM 4KB
- Stack : 32 levels
- Serial I/O : Two channels. These circuits can support both 2-wire and 3-wire 8-bit communication techniques, and can be switched between MSB first and LSB first operation.
  One of six internally generated serial transfer clock rates can be selected: 12.5kHz, 37.5kHz, 187.5kHz, 281.25kHz, 375kHz, and 450kHz
- External interrupts : Five interrupt inputs (pins INT0, 1, 4, and 5, and the HOLD pin)
  These interrupts can be set to switch between rising and falling edges, although the HOLD pin only supports falling edge detection.
- Internal interrupts : Six interrupts ; four internal timer interrupts, and two serial I/O interrupts.

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SANYO Semiconductor Co., Ltd.
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

- Interrupt nesting levels : 11 levels
  Interrupts are prioritized in hardware as follows :
  HOLD pin>INT0 pin>INT1 pin> INT4 pin>INT5 pin>
  S-I/O0>S-I/O1>Internal TMR0>Internal TMR1>Internal TMR2>
  Internal TMR3
- A/D Converter : 8-bit resolution and 6 inputs
- General-purpose ports : Input ports : 10
  Output ports : 2
  I/O ports : 48 (These pins can be switched between input and output in 1-bit units.)
- PLL block : Includes a sub-charge pump for high-speed locking.
  Supports dead zone control.
  Built-in unlock detection circuit
  Twelve reference frequencies : 1kHz, 3kHz, 3.125kHz, 5kHz, 6.25kHz, 9kHz, 10kHz, 12.5kHz, 25kHz, 30kHz, 50kHz, and 100kHz
- Universal counter : This 20-bit counter can be used for either frequency or period measurement and supports four measurement (calculation) periods : 1ms, 4ms, 8ms, and 32ms
- Timers : Two fixed timers and two programmable timers (8-bit counters)
  TMR0 : Supports four periods : 10µs, 100µs, 1ms, and 5ms
  TMR1 : Supports four periods : 10µs, 100µs, 1ms, and 10ms
  TMR2 and TMR3 : Programmable 8-bit counters.
  Input clocks with 10µs, 100µs, and 1ms
  One 125-ms timer flip-flop provided
- Beep circuit : Provides 12 fixed beep tones :
  500Hz, 1kHz, 2kHz, 2.08kHz, 2.2kHz, 2.5kHz, 3.33kHz, 3.75kHz, 4.17kHz, and 7.03kHz
  Programmable 8-bit beep tone generator.
  Reference clocks with frequencies of 50kHz, 15kHz, and 5kHz.
- Reset : Built-in voltage detection reset circuit
  External reset pin
- Cycle time : 1.33µs/833ns (All instructions are one word), X'tal : 4.5MHz/7.2MHz
  (4.5MHz when initialization is to be performed. When 7.2MHz is used, select 4.5MHz by software.)
- Halt mode : Stops the operation clock of the controller.
  There are four conditions that can clear Halt mode : Interrupt requests, timer flip-flop overflows, port PA inputs, and HOLD pin inputs.
- Operating supply voltage : 4.5 to 5.5V (Microcontroller block only : 3.5 to 5.5V)
- Package : QIP80E
- OTP version : LC72F3661
- Development tools : Emulator : RE128V
  Evaluation chip : LC72EV3780
  Evaluation board : EB-72EV3780

Specifications

Absolute Maximum Ratings at Ta = 25°C V_{SS} = 0V

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{DD} max		-0.3 to +6.5	V
Input voltage	$V_{IN}1$	All input pins	-0.3 to V_{DD}+0.3	V
Output voltage	$V_{OUT}1$	PJ-PORT	-0.3 to +14	V
	$V_{OUT}2$	All input pins other than $V_{OUT}1$	-0.3 to V_{DD}+0.3	V
Output current	$I_{OUT}1$	PJ-PORT	0 to 5	mA
	$I_{OUT}2$	PB, PD, PE, PF, PG, PK, PL, PM, PN, PO, PQ, PR, PS-PORT, EO1, EO2	0 to 3	mA
Allowable power dissipation	Pd max	Ta = -40 to +85 °C	400	mW
Operating temperature	Topr		-40 to +85	°C
Storage temperature	Tstg		-45 to +125	°C

Allowable Operating Range at Ta = -40 to +85°C, V_{DD} = 3.5 to 5.5V

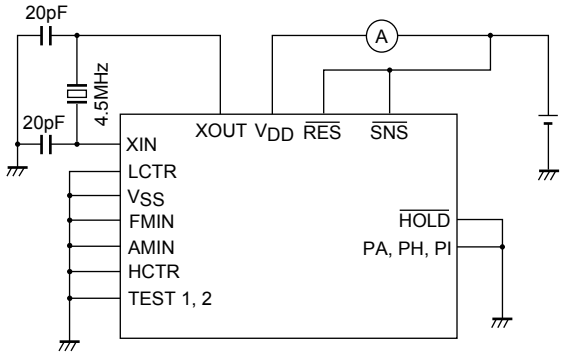
Parameter	Symbol	Pins	Ratings			uit
			min	typ	mx	
Supply voltage	$V_{DD}1$	PLL operation	4.5	5.0	5.5	V
	$V_{DD}2$	Memory retention	1.1		5.5	
	$V_{DD}3$	CPU operation	3.5		5.5	
Input high-level voltage	$V_{IH}1$	PB, PH, PI, PL, PM, PN, PO, PQ, PR, PS-PORT, HCTR, LCTR	0.7V_{DD}		V_{DD}	V
	$V_{IH}2$	PD, PE, PF, PG, PK-PORT, LCTR (in period measurement mode), $\overline{HOLD}$, $\overline{RESET}$	0.8V_{DD}		V_{DD}	V
	$V_{IH}3$	$\overline{SNS}$	2.5		V_{DD}	V
	$V_{IH}4$	PA-PORT	0.6V_{DD}		V_{DD}	V
Input low-level voltage	$V_{IL}1$	PB, PH, PI, PL, PM, PN, PO, PQ, PR, PS-PORT, HCTR, LCTR	0		0.3V_{DD}	V
	$V_{IL}2$	PA, PD, PE, PF, PG, PK-PORT, LCTR (in period measurement mode), $\overline{RESET}$	0		0.2V_{DD}	V
	$V_{IL}3$	$\overline{SNS}$	0		1.1	V
	$V_{IL}4$	$\overline{HOLD}$	0		0.4V_{DD}	V
Input amplitude	$V_{IN}1$	XIN	0.5		1.5	Vrms
	$V_{IN}2$	FMIN	0.07		1.5	Vrms
	$V_{IN}3$	FMIN, AMIN, HCTR, LCTR	0.04		1.5	Vrms
Input voltage range	$V_{IN}6$	ADI0 to ADI7	0		V_{DD}	V
Input frequency	$F_{IN}1$	XIN	4.0	4.5	8.0	MHz
	$F_{IN}2$	FMIN: $V_{IN}2$, $V_{DD}1$	10		150	MHz
	$F_{IN}3$	FMIN: $V_{IN}3$, $V_{DD}1$	10		130	MHz
	$F_{IN}4$	AMIN(H) : $V_{IN}3$, $V_{DD}1$	2.0		40	MHz
	$F_{IN}5$	AMIN(L) : $V_{IN}3$, $V_{DD}1$	0.5		10	MHz
	$F_{IN}6$	HCTR: $V_{IN}3$, $V_{DD}1$	0.4		12	MHz
	$F_{IN}7$	LCTR: $V_{IN}3$, $V_{DD}1$	100		500	kHz
	$F_{IN}8$	LCTR (in period measurement) : $V_{IH}2$, $V_{IL}2$, $V_{DD}1$	1		20×10^3	Hz

Electrical Characteristics in the allowable operating ranges

Parameter	Symbol	Pins	Ratings			unit
			min	typ	max	
Input high-level current	$I_{IH}1$	XIN : $V_I = V_{DD} = 5.0V$	2.0	5.0	15	µA
	$I_{IH}2$	FMIN, AMIN, HCTR, LCTR: $V_I = V_{DD} = 5.0V$	4.0	10	30	µA
	$I_{IH}3$	PA, PB, PD, PE, PF, PG, PH, PI, PK, PL, PM, PN, PO, PQ, PR, PS-PORT, $\overline{SNS}$, $\overline{HOLD}$, $\overline{RESET}$, HCTR, LCTR: $V_I = V_{DD} = 5.0V$ (with the ports PB, PD, PE, PF, PG, PK, PL, PM, PN, PO, PQ, PR, and PS-PORT set to input mode)			3	µA
Input low-level current	$I_{IL}1$	XIN : $V_I = V_{DD} = V_{SS}$	2.0	5.0	15	µA
	$I_{IL}2$	FMIN, AMIN, HCTR, LCTR: $V_I = V_{DD} = V_{SS}$	4.0	10	30	µA
	$I_{IL}3$	PA, PB, PD, PE, PF, PG, PH, PI, PK, PL, PM, PN, PO, PQ, PR, PS-PORT, $\overline{SNS}$, $\overline{HOLD}$, $\overline{RESET}$, HCTR, LCTR: $V_I = V_{SS}$ (with the ports PB, PD, PE, PF, PG, PK, PL, PM, PN, PO, PQ, PR, and PS-PORT set to input mode)			3	µA
Hysteresis	VH	PD, PE, PF, PG, PK-PORT, $\overline{RESET}$, LCTR (in period measurement)	$0.1V_{DD}$	$0.2V_{DD}$		V
Output high-level voltage	$V_{OH}1$	PB, PD, PE, PF, PG, PK, PL, PM, PN, PO, PQ, PR, PS-PORT: $I_O = -1mA$	$V_{DD}-1.0$			V
	$V_{OH}2$	EO1, EO2: $I_O = -500µA$	$V_{DD}-1.0$			V
	$V_{OH}3$	XOUT: $I_O = -200µA$	$V_{DD}-1.0$			V
Output low-level voltage	$V_{OL}1$	PB, PD, PE, PF, PG, PK, PL, PM, PN, PO, PQ, PR, PS-PORT: $I_O = -1mA$			1.0	V
	$V_{OL}2$	EO1, EO2: $I_O = -500µA$			1.0	V
	$V_{OL}3$	XOUT : $I_O = -200µA$			1.5	V
	$V_{OL}4$	PJ-PORT : $I_O = -5mA$			2.0	V
Output off leakage current	$I_{OFF}1$	PB, PD, PE, PF, PG, PK, PL, PM, PN, PO, PQ, PR, PS-PORT	-3		+3	µA
	$I_{OFF}2$	EO1, EO2	-100		+100	nA
	$I_{OFF}3$	PJ-PORT	-5		+5	µA
A/D conversion error		ADI0 to ADI7	-1.5		+1.5	LSB
Rejected pulse width	$P_{REJ}1$	$\overline{SNS}$			50	µs
Power down detection voltage	V_{DET}		2.7	3.0	3.3	V
Power supply current	$I_{DD}1$	$V_{DD}1$: $F_{IN}2$ = 130MHz Ta = 25°C		5	10	mA
	$I_{DD}2$	$V_{DD}1$: $F_{IN}2$ = 130MHz Ta = 25°C		5.5	11	mA
	$I_{DD}3$	$V_{DD}2$: Halt mode Ta = 25°C, X'tal : 4.5 MHz *1 (Fig. 1)		0.45		mA
	$I_{DD}4$	$V_{DD}2$: Halt mode Ta = 25°C, X'tal : 7.2MHz		0.55		mA
	$I_{DD}5$	Backup mode (OSC stopped) V_{DD} = 5.5V, Ta = 25°C *2 (Fig. 2)			5	µA
	$I_{DD}6$	Backup mode (OSC stopped) V_{DD} = 2.5V, Ta = 25°C *2 (Fig. 2)			1	µA

*1: Twenty instruction steps are executed every millisecond. The PLL, universal counter, and other functions are stopped.

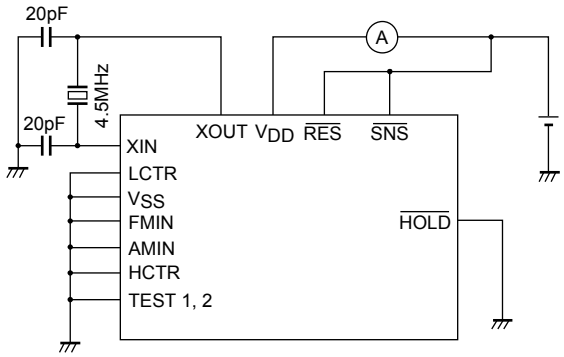
Test Circuits



Ports PB through PG, and PJ through PS are all left open. However, ports PB through PG, PK through PS are left open in output mode.

ILC05608

Figure 1. HALT current test condition



Ports PA through PS are all left open.

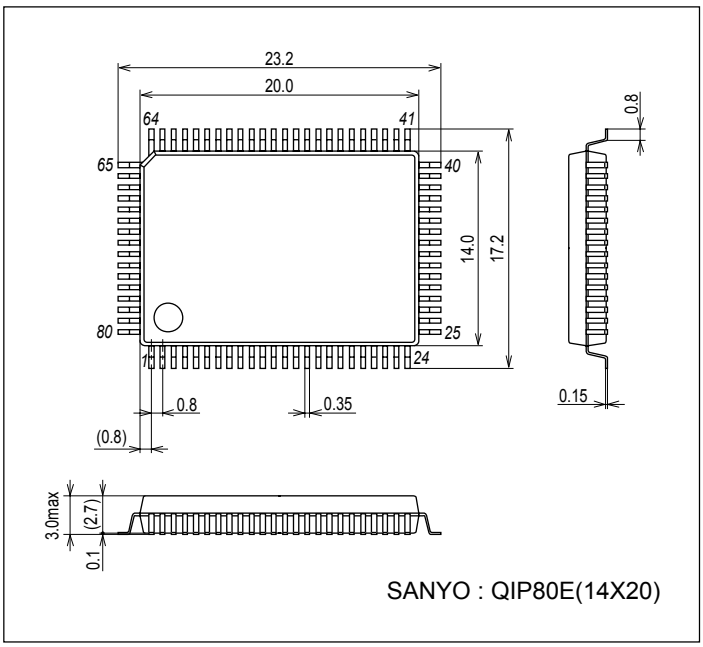
ILC05609

Figure 2. BACK UP current test condition

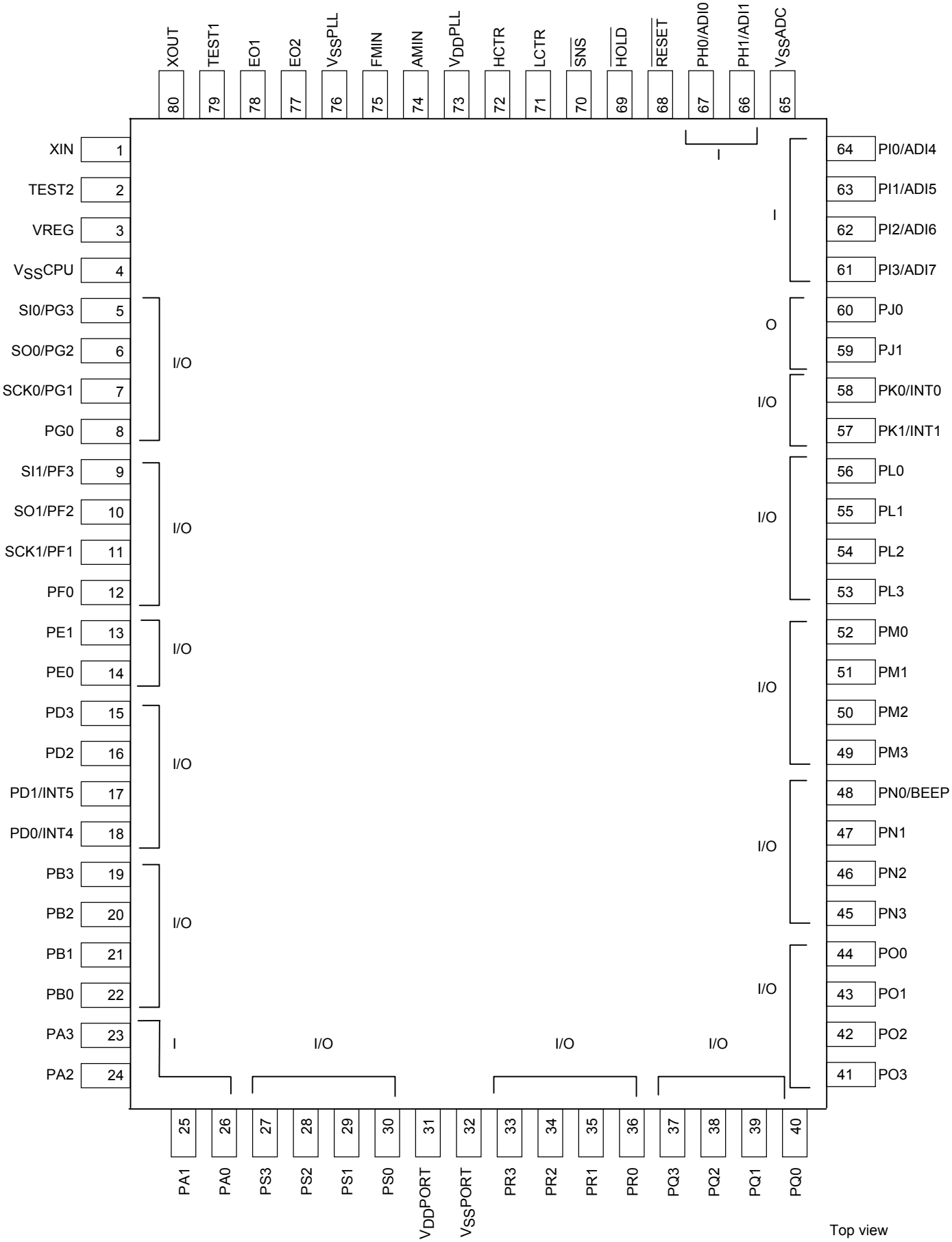
Package Dimensions

unit:mm (typ)

3174A

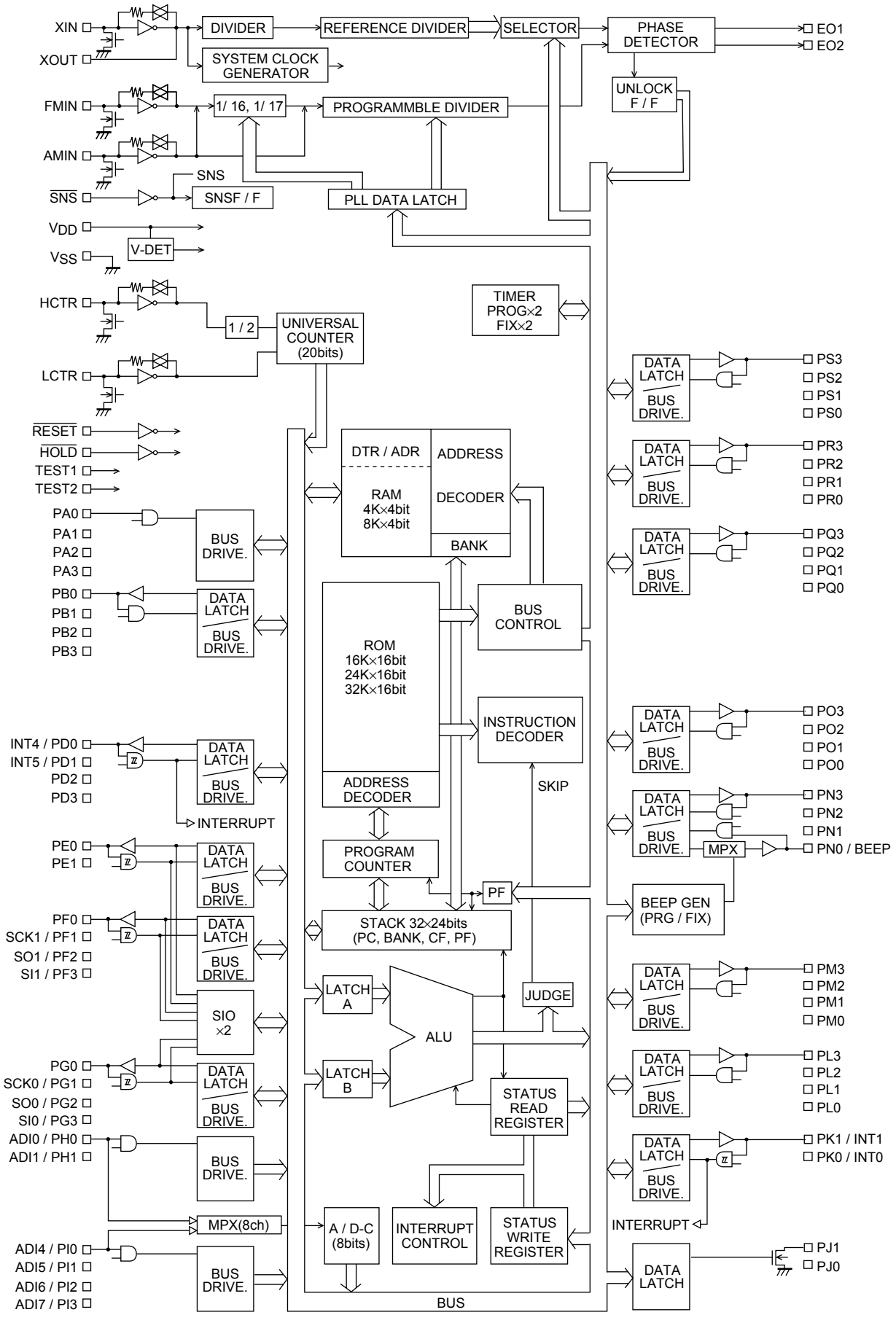


Pin Assignment



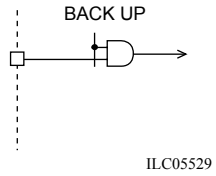
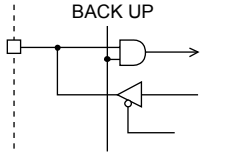
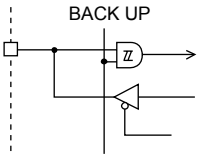
Top view

Block Diagram



ILC05610

Pin Description

Pin name	Pin No.	I/O	Pin explanation	Equivalent circuit
PA0 PA1 PA2 PA3	26 25 24 23	I	Dedicated input ports. These ports are designed with a low threshold voltage. Input is disabled in Backup mode.	 ILC05529
PB0 PB1 PB2 PB3	22 21 20 19	I/O	General-purpose I/O ports. The mode (input or output) is set using the IOS2 instruction. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	 ILC05530
PD0/INT4 PD1/INT5 PD2 PD3	18 17 16 15	I/O	General-purpose I/O and external interrupt shared function ports. The input formats are Schmitt inputs. The external interrupt function is enabled when the external interrupt enable flag is set. • When used as general-purpose I/O ports : The mode (input or output) is set in 1-bit units using the IOS2 instruction. • When used as external interrupt pins : The external interrupt functions are enabled by setting the corresponding external interrupt enable flag (INT4EN or INT5EN). In this case, the pins must be set to input mode in advance. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	
PE0 PE1	14 13	I/O	General-purpose I/O ports The input formats are Schmitt inputs. The mode (input or output) is set in 1-bit units using the IOS1 instruction Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	 ILC05532
PF0 PF1/SCK1 PF2/SO1 PF3/SI1 PG0 PG1/SCK0 PG2/SO0 PG3/SI0	12 11 10 9 8 7 6 5	I/O	General-purpose I/O ports with shared functions as serial I/O ports. The input formats are Schmitt inputs. The IOS1 instruction is used to switch between the general-purpose I/O port and serial I/O port functions. • When used as general-purpose I/O ports : The pins are set to the general-purpose I/O port function using the IOS1 instruction. The mode (input or output) is set in 1-bit units using the IOS1 instruction • When used serial I/O ports : The pins are set to the serial I/O port function using the IOS1 instruction. [Pin states when set to the serial I/O port function] PF0, PG0 … General-purpose I/O PF1, PG1 … SCK input or output PF2, PG2 … SO output PF3, PG3 … SI input Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	

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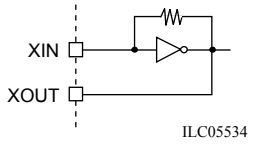
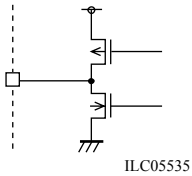
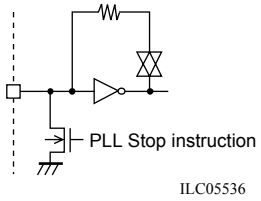
<table>
<tr><th>Pin name</th><th>Pin No.</th><th>I/O</th><th>Pin explanation</th><th>Equivalent circuit</th></tr>
<tr><td>XIN
XOUT</td><td>1
80</td><td>I
O</td><td>Connections for 4.5MHz/7.2MHz crystal oscillator element</td><td> 
</td></tr>
<tr><td>EO1
EO2</td><td>78
77</td><td>O</td><td>Main charge pump outputs.
These pins output a high level when the frequency of the local oscillator divided by n is higher than that of the reference frequency, and they output a low level when that frequency is lower.
They go to the high-impedance state when the frequencies match.
These pins go to the high-impedance state in Backup mode, after a power on reset, and in the PLL stopped state.</td><td> 
</td></tr>
<tr><td>V_{DD}PORT
V_{DD}PLL</td><td>31
73</td><td>-</td><td>+ pin of power supply (These pins must connected to VDD.)
The V_{DD}PORT pin is mainly supply power for the peripheral I/O blocks.
The V_{DD}PLL pin is mainly for the PLL circuits and the regulator.</td><td></td></tr>
<tr><td>V_{SS}CPU
V_{SS}PORT
V_{SS}ADC
V_{SS}PLL</td><td>4
32
65
76</td><td></td><td>Power supply ground pin (These pins must be connected to ground.)
The V_{SS}PORT pin is mainly supply power for the peripheral I/O blocks.
The V_{SS}PLL pin is mainly for the PLL circuits and the regulator.
The V_{SS}CPU pin is mainly used by the CPU block.
The V_{SS}ADC pin is mainly used by the ADC block.</td><td></td></tr>
<tr><td>VREG</td><td>3</td><td>O</td><td>Internal low voltage output.
Connect a bypass capacitor to this pin.</td><td></td></tr>
<tr><td>FMIN</td><td>75</td><td>I</td><td>FM VCO (local oscillator) input.
This pin is selected with CW1 in the PLL instruction.
The signal input to this pin must be capacitor coupled.
Input is disabled in Backup mode, after a power on reset, and in the PLL stopped state.</td><td rowspan="3"> 
</td></tr>
<tr><td>AMIN</td><td>74</td><td>I</td><td>AM VCO (local oscillator) input.
This pin is selected and the band set with CW1 (b1, b0) in the PLL instruction.
<table>
<tr><th>b1</th><th>b0</th><th>Band</th></tr>
<tr><td>1</td><td>0</td><td>2 to 40MHz (SW, AM upconversion)</td></tr>
<tr><td>1</td><td>1</td><td>0.5 to 10MHz (MW, LW)</td></tr>
</table>
The signal input to this pin must be capacitor coupled.
Input is disabled in Backup mode, after a power on reset, and in the PLL stopped state.</td></tr>
<tr><td>HCTR</td><td>72</td><td>I</td><td>Universal counter and general-purpose input shared function input port.
The IOS1 instruction is used for switching between the universal counter and general-purpose input functions.
• When used for frequency measurement :
The universal counter function is set up with the IOS1 instruction.
The counter is controlled using UCS and UCC instructions.
Since this pin functions as an AC amplifier in this mode, the input signal must be input with capacitor coupling.
• When used as a general-purpose input pin :
The general-purpose input function is set up with the IOS1 instruction.
Data is read from the port using the INR (b0) instruction.
Input is disabled in Backup mode. (The input pin will be pulled down.)
The universal counter function is selected after a power on reset.</td></tr>
</table>

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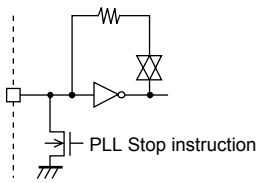
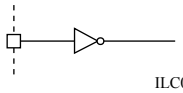
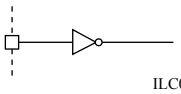
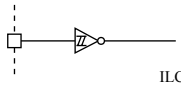
Pin name	Pin No.	I/O	Pin explanation	Equivalent circuit
LCTR	71	I	Universal counter (frequency or period measurement) and general-purpose input shared function input port. The IOS1 instruction is used for switching between the universal counter and general-purpose input functions. • When used for frequency measurement : The universal counter function is set up with the IOS1 instruction. Set up LCTR frequency measurement mode with the UCS instruction, and control operation with the UCC instruction. Since this pin functions as an AC amplifier in this mode, the input signal must be input with capacitor coupling. • When used for period measurement : The universal counter function is set up with the IOS1 instruction. Set up LCTR frequency measurement mode with the UCS instruction, and control operation with the UCC instruction. Since the bias feedback resistor is disconnected in this mode, the input signal must be input with DC coupling. • When used as a general-purpose input pin : The general-purpose input port function is set up with the IOS1 instruction. Data is read from the port using the INR (b1) instruction. Input is disabled in Backup mode. (The input pin will be pulled down.) The universal counter function (HCTR frequency measurement mode) is selected after a power on reset.	 ILC05536
$\overline{\text{SNS}}$	70	I	Voltage sense and general-purpose input shared function port. This input circuit is designed with a low input threshold voltage. • When used as a voltage sense input : The pin is used to test for power failures on the return from Backup mode. Application can test this condition using the internal SNS flip-flop. The SNS flip-flop can be tested with the TST instruction. (This usage requires external components, capacitors and resistors. For the sample application circuit, see the user's manual.) • When used as a general-purpose input port : When used as a general-purpose input port the pin state can be tested with the TST instruction. Unlike the other input ports, input to this pin is not disabled in Backup mode and after a power on reset. As a result, through currents must be taken into account when designing applications that use this pin as a general-purpose input.	 ILC05539
$\overline{\text{HOLD}}$	69	I	Power supply monitor (with interrupt function) This is designed with a high input threshold voltage. This pin is normally connected to the ACC line and used for power off detection. When a power off state is detected, the HOLDON flag and the hold interrupt request flag will be set. To enter Backup mode, execute a CKSTP instruction when the HOLD pin is low. Set this pin high to clear Backup mode.	 ILC05539
$\overline{\text{RESET}}$	68	I	System reset pin. When the CPU is operating or in Halt mode, the system is reset when this pin is held low for at least one machine cycle. Execution starts with the PC pointing to location 0. At this time the SNS flip-flop is set. A low level must be applied for at least 50ms when power is first applied.	 ILC05540

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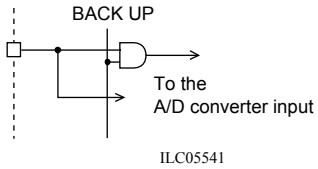
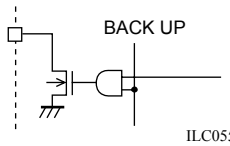
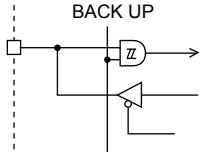
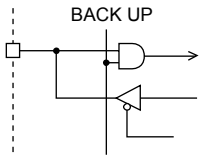
Pin name	Pin No.	I/O	Pin explanation	Equivalent circuit
PH0/ADI0 PH1/ADI1 PI0/ADI4 PI1/ADI5 PI2/ADI6 PI3/ADI7	67 66 64 63 62 61	I	General-purpose input and A/D converter input shared function ports. The IOS1 instruction is used to switch between the general-purpose input and the A/D converter input functions. • When used as general-purpose input ports : The general-purpose input port function is set up with the IOS1 instruction. (In bit units) • When used as A/D converter input pins : The A/D converter input port function is set up with the IOS1 instruction. (In bit units) The pin whose voltage is to be converted is specified with the IOS1 instruction, and the conversion is started with UCC instruction. Note : Since input is disabled for ports specified for the ADI function, executing an input instruction for such a port will always return a low level. Input is disabled in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	 ILC05541
PJ0 PJ1	60 59	O	General-purpose output ports (high-voltage output) Since these are open-drain output circuits, external pull-up resistors are required. The internal transistors are turned off (resulting in a high-level output) in Backup mode and after a power on reset.	 ILC05542
PK0/INT0 PK1/INT1	58 57	I/O	General-purpose I/O and external interrupt shared function ports. The input formats are Schmitt inputs. The external interrupt function is enabled when the external interrupt enable flag is set. • When used as general-purpose I/O ports : The mode (input or output) is set in 1-bit units using the IOS1 instruction. • When used as external interrupt pins : The external interrupt functions are enabled by setting the corresponding external interrupt enable flag (INT0EN through INT3EN). Here, the pins must be set to input mode in advance. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	 ILC05543
PL0 to 3 PM0 to 3	56 to 53 52 to 49	I/O	General-purpose I/O ports The mode is switched between input and output with the IOS instruction. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	
PN0/BEEP PN1 PN2 PN3	48 47 46 45	I/O	General-purpose I/O port and beep tone output shared function ports. The IOS2 instruction is used to switch between the general-purpose I/O port and the beep tone output functions. • When used as general-purpose I/O ports: The general-purpose I/O port function is set up with the IOS2 instruction. (Pins PN1 through PN3 are dedicated general-purpose output pins.) • When used as the beep tone output pin: The beep tone output function is set up with the IOS2 instruction. The frequency is set up with the BEEP instruction. When this pin is used as the beep tone output pin, executing an output instruction for this pin only sets the internal latch and has no influence on the output. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	 ILC05544

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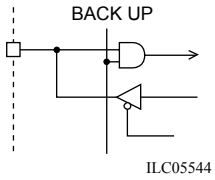
Pin name	Pin No.	I/O	Pin explanation	Equivalent circuit
P00 P01 P02 P03	44 43 42 41	I/O	General-purpose I/O ports The mode is switched between input and output with the IOS instruction. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	 ILC05544
PQ0 to 3 PR0 to 3 PS0 to 3	40 to 37 36 to 33 30 to 27	I/O	General-purpose I/O ports. The mode is switched between input and output with the IOS instruction, and data is input with the INR instruction and output with the OUTR instruction. The SPB, RPB, TPT, and TPF instruction cannot be used with these ports. Input is disabled and the pins go to the high-impedance state in Backup mode. These ports are set up as general-purpose input ports after a power on reset.	
TEST1 TEST2	79 2		LSI test pins. These pins must be connected to GND.	

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