



LC72336, 72338

Single-Chip Microcontrollers with Built-In LCD Driver and PLL Circuits

Overview

The LC72336 and LC72338 are single-chip microcontrollers for use in electronic tuners. These products include on chip a PLL circuit that can operate at up to 150 MHz and 1/3 duty LCD drivers. They feature a highly efficient instruction set and powerful hardware.

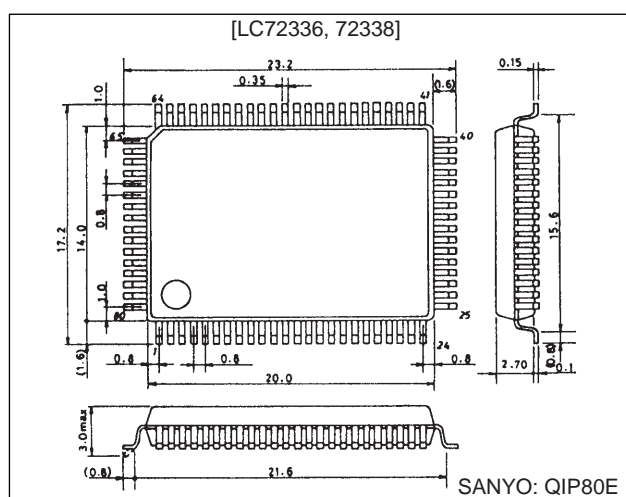
Functions

- High-speed programmable divider
- Program memory (ROM)
 - LC72336: 6143×16 bits (12 kB)
 - LC72338: 8191×16 bits (16 kB)
- Data memory (RAM): 512×4 bits
- All instructions are one-word instructions
- Cycle time: 1.33 μ s
- Stack: 8 levels
- LCD drivers: Up to 96 segments (1/3 duty, 1/3 bias)
- Serial I/O: Up to 3 channels (8-bit 3-wire type)
- External interrupts: 2 interrupts (INT0, INT1)
Interrupt on rising or falling edge (selectable)
- Internal interrupts: 3 interrupt
Two built-in timer interrupts and 1 serial I/O interrupt
- Nested interrupt levels: 4 levels
- D/A converter: 4 channels (8-bit PWM output)
- A/D converter: 4 channels
(6-bit successive approximation)
- General-purpose ports:
 - Input ports: 8
 - Output ports: 12 (16 maximum)
 - I/O ports: 8 (20 maximum, can be switched between input and output in bit units.)
- PLL block: Supports 4 types of dead zone control, and includes a built-in unlock detection circuit.
Supports 12 different reference frequencies.
- Universal counter: 20 bits (Can be used for either frequency or period measurement.)
- Timers: Eight types of time measurement
- Beep function: Six beep tones
- Reset: Built-in voltage detection type reset circuit
- Halt mode: Stops the controller operating clock.
- Operating supply voltage: 4.5 to 5.5 V (3.5 to 5.5 V if only the controller block operates.)

Package Dimensions

unit: mm

3174-QFP80E



This LSI can easily use CCB that is SANYO's original bus format.



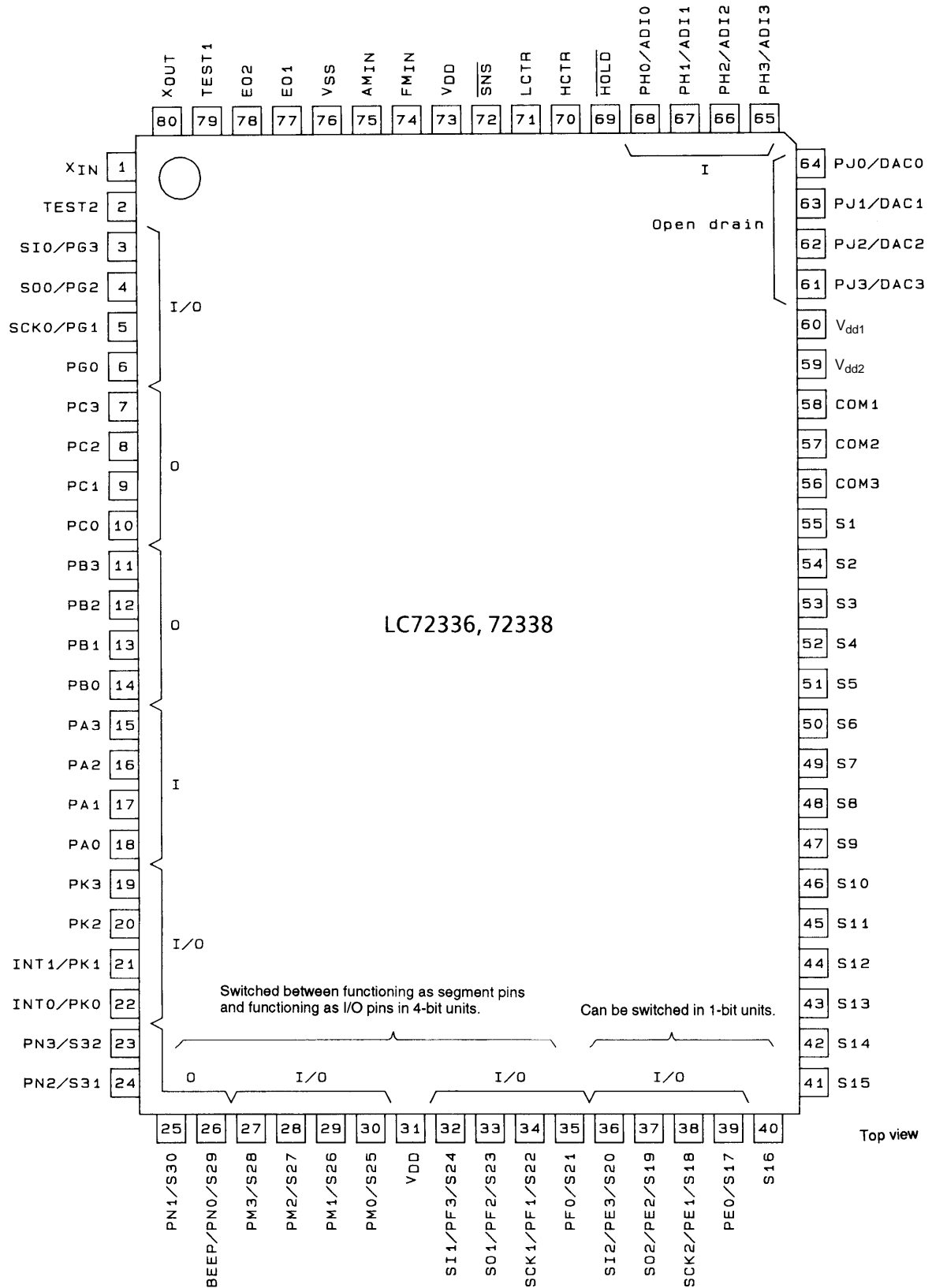
- CCB is a trademark of SANYO ELECTRIC CO., LTD.
- CCB is SANYO's original bus format and all the bus addresses are controlled by SANYO.

SANYO Electric Co.,Ltd. Semiconductor Bussiness Headquarters

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O3097HA (OT)/13095HA (OT) No. 5157-1/16

Pin Assignment



A04111

Specifications

Absolute Maximum Ratings at $T_a = 25^{\circ}\text{C}$, $V_{SS} = 0\text{ V}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{DD\text{ max}}$		-0.3 to +6.5	V
Input voltage	V_{IN}	All input pins	-0.3 to $V_{DD} + 0.3$	V
Output voltage	$V_{OUT(1)}$	Port PJ	-0.3 to +15	V
	$V_{OUT(2)}$	All output ports other than $V_{OUT(1)}$	-0.3 to $V_{DD} + 0.3$	V
Output current	$I_{OUT(1)}$	Port PJ	0 to +5	mA
	$I_{OUT(2)}$	PE, PF, PG, PK, PM, PN, EO1, EO2	0 to +3	mA
	$I_{OUT(3)}$	Ports PB and PC	0 to +1	mA
	$I_{OUT(4)}$	S1 to S32	300	μA
	$I_{OUT(5)}$	COM1 to COM3	3	mA
Allowable power dissipation	$P_{d\text{ max}}$	$T_a = -45\text{ to }85^{\circ}\text{C}$	300	mW*
Operating temperature	T_{opr}		-40 to +85	$^{\circ}\text{C}$
Storage temperature	T_{stg}		-45 to +125	$^{\circ}\text{C}$

Note: * Reference value

Allowable Operating Ranges at $T_a = -40\text{ to }+85^{\circ}\text{C}$, $V_{DD} = 3.5\text{ to }5.5\text{ V}$

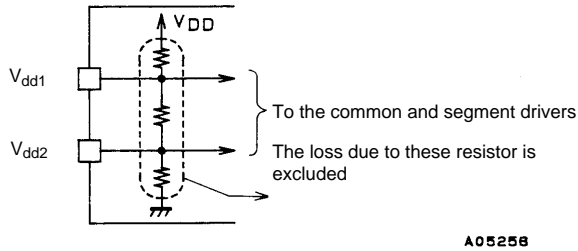
Parameter	Symbol	Conditions	min	typ	max	Unit
Supply voltage	$V_{DD(1)}$	CPU and PLL operating	4.5	5.0	5.5	V
	$V_{DD(2)}$	CPU operating	3.5		5.5	V
	$V_{DD(3)}$	Memory retention	1.3		5.5	V
Input high-level voltage	$V_{IH(1)}$	Ports PE, PH, and PM, HCTR and LCTR (when selected for input)	$0.7 V_{DD}$		V_{DD}	V
	$V_{IH(2)}$	Ports PF, PG, and PK, LCTR (frequency measurement mode), and $\overline{\text{HOLD}}$	$0.8 V_{DD}$		V_{DD}	V
	$V_{IH(3)}$	$\overline{\text{SNS}}$	2.5		V_{DD}	V
	$V_{IH(4)}$	Port PA	$0.6 V_{DD}$		V_{DD}	V
Input low-level voltage	$V_{IL(1)}$	Port PE, PH, and PM, HCTR and LCTR (when selected for input)	0		$0.3 V_{DD}$	V
	$V_{IL(2)}$	Port PA, PF, PG, and PK, LCTR (frequency measurement mode)	0		$0.2 V_{DD}$	V
	$V_{IL(3)}$	$\overline{\text{SNS}}$	0		+1.3	V
	$V_{IL(4)}$	$\overline{\text{HOLD}}$	0		$0.4 V_{DD}$	V
Input frequency	$f_{IN(1)}$	XIN	4.0	4.5	5.0	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 (frequency measurement mode): $V_{IH(2)}$, $V_{IL(2)}$, $V_{DD(1)}$	1		20×10^3	Hz
Input amplitude	$V_{IN(1)}$	XIN	0.5		1.5	Vrms
	$V_{IN(2)}$	FMIN	0.10		1.5	Vrms
	$V_{IN(3)}$	FMIN, AMIN, HCTR, LCTR	0.07		1.5	Vrms
Input voltage range	$V_{IN(4)}$	ADI0 to ADI3	0		V_{DD}	V

Electrical Characteristics for the Allowable Operating Ranges

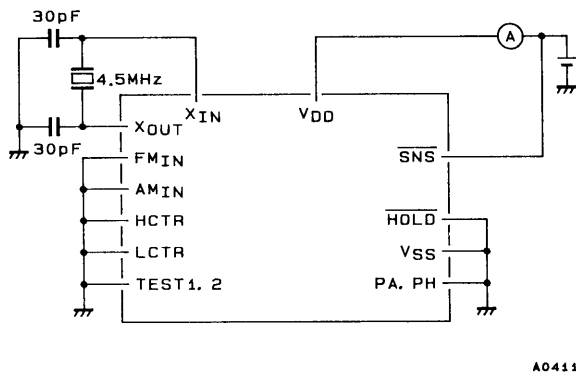
Parameter	Symbol	Conditions	min	typ	max	Unit
Input high-level current	$I_{IH}(1)$	XIN: $V_I = V_{DD} = 5.0\text{ V}$	2.0	5.0	15	μA
	$I_{IH}(2)$	FMIN, AMIN, HCTR, LCTR: $V_I = V_{DD} = 5.0\text{ V}$	4.0	10	30	μA
	$I_{IH}(3)$	Ports PA, PE, PF, PG, PH, PK, and PM, $\overline{\text{SNS}}$, $\overline{\text{HOLD}}$, HCTR, LCTR: No pull-down resistors on port PA, $V_I = V_{DD} = 5.0\text{ V}$, with input mode selected for ports PE, PF, PG, PK, and PM			3.0	μA
	$I_{IH}(4)$	With pull-down resistors on port PA, $V_I = V_{DD} = 5.0\text{ V}$		50		μA
Input low-level current	$I_{IL}(1)$	XIN: $V_I = V_{SS}$	2.0	5.0	15	μA
	$I_{IL}(2)$	FMIN, AMIN, HCTR, LCTR: $V_I = V_{SS}$	4.0	10	30	μA
	$I_{IL}(3)$	Ports PA, PE, PF, PG, PH, PK, and PM, $\overline{\text{SNS}}$, $\overline{\text{HOLD}}$, HCTR, LCTR: No pull-down resistors on port PA, $V_I = V_{SS}$, with input mode selected for ports PE, PF, PG, PK, and PM			3.0	μA
Input floating voltage	V_{IF}	With pull-down resistors on port PA			$0.05 V_{DD}$	V
Pull-down resistance	$R_{PD}(1)$	With pull-down resistors on port PA, $V_{DD} = 5\text{ V}$	75	100	200	$\text{k}\Omega$
Hysteresis	V_H	Ports PF, PG, and PK, LCTR (in frequency measurement mode)	$0.1 V_{DD}$	$0.2 V_{DD}$		V
Output high-level voltage	$V_{OH}(1)$	Ports PB and PC: $I_O = -1\text{ mA}$	$V_{DD} - 2.0$			V
	$V_{OH}(2)$	Ports PE, PF, PG, PK, PM, and PN: $I_O = -1\text{ mA}$	$V_{DD} - 1.0$			V
	$V_{OH}(3)$	EO1, EO2: $I_O = -500\text{ }\mu\text{A}$	$V_{DD} - 1.0$			V
	$V_{OH}(4)$	XOUT: $I_O = -200\text{ }\mu\text{A}$	$V_{DD} - 1.0$			V
	$V_{OH}(5)$	S1 to S32: $I_O = -20\text{ }\mu\text{A}$	$V_{DD} - 1.0$			V
	$V_{OH}(6)$	COM1, COM2, COM3: $I_O = -100\text{ }\mu\text{A}$	$V_{DD} - 1.0$			V
Output low-level voltage	$V_{OL}(1)$	Ports PB and PC: $I_O = 50\text{ }\mu\text{A}$			2.0	V
	$V_{OL}(2)$	Ports PE, PF, PG, PK, PM, and PN: $I_O = 1\text{ mA}$			1.0	V
	$V_{OL}(3)$	EO1, EO2: $I_O = 500\text{ }\mu\text{A}$			1.0	V
	$V_{OL}(4)$	XOUT: $I_O = 200\text{ }\mu\text{A}$			1.0	V
	$V_{OL}(5)$	S1 to S32: $I_O = 20\text{ }\mu\text{A}$			1.0	V
	$V_{OL}(6)$	COM1, COM2, COM3: $I_O = 100\text{ }\mu\text{A}$			1.0	V
	$V_{OL}(7)$	Port PJ: $I_O = 5\text{ mA}$	0.75		2.0	V
Output mid-level voltage	$V_{MID}(1)$	S1 to S32: $I_O = \pm 20\text{ }\mu\text{A}$	$\frac{2}{3} V_{DD} \pm 1.0$			V
	$V_{MID}(2)$	S1 to S32: $I_O = \pm 20\text{ }\mu\text{A}$	$\frac{1}{3} V_{DD} \pm 1.0$			V
	$V_{MID}(3)$	COM1, COM2, COM3: $I_O = \pm 100\text{ }\mu\text{A}$	$\frac{2}{3} V_{DD} \pm 1.0$			V
	$V_{MID}(4)$	COM1, COM2, COM3: $I_O = \pm 100\text{ }\mu\text{A}$	$\frac{1}{3} V_{DD} \pm 1.0$			V
Output off leakage current	$I_{OFF}(1)$	Ports PE, PF, PG, PK, PM, and PN	-3.0		+3.0	μA
	$I_{OFF}(2)$	EO1, EO2	-100		+100	nA
	$I_{OFF}(3)$	Port PJ	-5.0		+5.0	μA
AD conversion error	—	AD10 to AD13: $V_{DD}(1)$	-1/2		+1/2	LSB
Reject pulse width	P_{REJ}	$\overline{\text{SNS}}$			50	μs
Power-down detection voltage	V_{DET}		2.7	3.0	3.3	V
Pull-down resistance	$R_{PD}(2)$	TEST1, TEST2		10		$\text{k}\Omega$
Current drain	$I_{DD}(1)$	$V_{DD}(1)$: $f_{IN}(2) = 130\text{ MHz}$, $T_a = 25^\circ\text{C}$		12		mA
	$I_{DD}(2)$	$V_{DD}(2)$: halt mode*, $T_a = 25^\circ\text{C}$ (Fig. 1)		0.45		mA
	$I_{DD}(3)$	$V_{DD} = 5.5\text{ V}$, oscillator stopped, $T_a = 25^\circ\text{C}$ (Fig. 2)			5	μA
	$I_{DD}(4)$	$V_{DD} = 2.5\text{ V}$, oscillator stopped, $T_a = 25^\circ\text{C}$ (Fig. 2)			1	μA

Note: * In case of instruction execution for 20 steps at intervals of 1 ms, with the PLL, counter functions and other functions all stopped.

Note: 1. Except for the divider resistors used for the bias voltage generation circuit incorporated in the V_{dd1} and V_{dd2} systems.

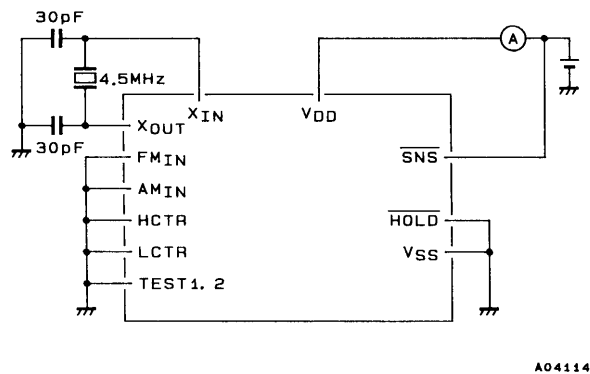


Test Circuits



Note: With all ports other than those indicated in the figure open.
With the segment port function selected for ports PE, PF, PM, and PN.
With the output function selected for ports PG and PK.

Figure 1 I_{DD2} , I_{DD3} , and I_{DD4} in Hold Mode



Note: With all ports other than those indicated in the figure open.
With the segment port function selected for ports PE, PF, PM, and PN.
With the output function selected for ports PG and PK.

Figure 2 I_{DD5} in Backup Mode

Pin Functions

Pin No.	Symbol	I/O	I/O type	Function
18 17 16 15	PA0 PA1 PA2 PA3	I	Inputs with pull-down resistors	These are special-purpose ports for key return signal inputs. Their threshold voltage is set lower than that of other inputs. When a key matrix is formed in conjunction with ports PB and PC, up to three simultaneous key presses can be detected. The pull-down resistors are set up for all four pins by the IOS instruction (Pn = 2, b1). This cannot be specified on an individual pin basis. Input is disabled in clock stop mode.
14 13 12 11 10 9 8 7	PB0 PB1 PB2 PB3 PC0 PC1 PC2 PC3	O	Unbalanced CMOS push-pull circuits	These are special-purpose ports for key return signal outputs. No diodes for preventing short-circuits due to multiple simultaneous key presses are required since the output transistor circuits are unbalanced CMOS circuits. These pins become high-impedance outputs in clock stop mode. These pins function as high-impedance outputs after a power-on reset and retain that state until an output instruction is executed.

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Pin No.	Symbol	I/O	I/O type	Function																		
6 5 4 3	PG0 PG1/SCK0 PG2/SO0 PG3/SI0	I/O	CMOS push-pull	<p>Shared-function general-purpose output and serial I/O port</p> <p>Inputs are a Schmitt input.</p> <p>The IOS instruction is used to switch between the general-purpose I/O port function and the serial I/O function, as well as between input and output for the general-purpose I/O port function.</p> <ul style="list-style-type: none">When used as a general-purpose I/O port: Input or output can be specified in bit units (bit I/O). These ports are set up to be general-purpose I/O ports with the IOS instruction with Pn = 0. <table><tr><td>b0 = SI/O0</td><td>0 ... General-purpose ports</td></tr><tr><td></td><td>1 ... SI/O ports</td></tr></table> <p>The IOS instruction is used to specify input or output in bit units.</p> <table><tr><td>PG ... Pn = 6</td><td>0 ... Input</td></tr><tr><td></td><td>1 ... Output</td></tr></table> <ul style="list-style-type: none">When used as a serial I/O port: These ports are set up to be serial I/O ports with the IOS instruction with Pn = 0. The contents of the serial I/O data buffers can be saved and loaded with the INR and OUTF instructions. <p>Note: Pin setup states when used as serial I/O ports:</p> <table><tr><td>PG0 ...</td><td>General-purpose I/O</td></tr><tr><td>PG1 ...</td><td>SCK0 output in internal clock mode</td></tr><tr><td></td><td>SCK0 input in external clock mode</td></tr><tr><td>PG2 ...</td><td>SO0 output</td></tr><tr><td>PG3 ...</td><td>SI0 input</td></tr></table> <p>These ports go to the input disabled high-impedance state in clock stop mode.</p> <p>These ports function as general-purpose input ports after a power-on reset.</p>	b0 = SI/O0	0 ... General-purpose ports		1 ... SI/O ports	PG ... Pn = 6	0 ... Input		1 ... Output	PG0 ...	General-purpose I/O	PG1 ...	SCK0 output in internal clock mode		SCK0 input in external clock mode	PG2 ...	SO0 output	PG3 ...	SI0 input
b0 = SI/O0	0 ... General-purpose ports																					
	1 ... SI/O ports																					
PG ... Pn = 6	0 ... Input																					
	1 ... Output																					
PG0 ...	General-purpose I/O																					
PG1 ...	SCK0 output in internal clock mode																					
	SCK0 input in external clock mode																					
PG2 ...	SO0 output																					
PG3 ...	SI0 input																					
1 80	XIN XOUT	I O	—	4.5 MHz crystal oscillator connections																		
77 78	EO1 EO2	O	CMOS tristate	<p>Charge pump outputs</p> <p>These pins go to the high-impedance state when the $\overline{\text{HOLD}}$ pin is set low in the hold enable state.</p> <p>These pins go to the high-impedance state in clock stop mode, after a power-on reset, and in the PLL stopped state.</p>																		
76 31, 73	V _{SS} V _{DD}	—	—	Power supply connections																		
75	AMIN	I	CMOS amplifier input	<p>AM VCO (local oscillator) input</p> <p>This pin is selected and the band set using the PLL instruction CW1 (b1 and b0) field.</p> <table><tr><td>b1</td><td>b0</td><td>Band</td></tr><tr><td>1</td><td>0</td><td>2 to 40 MHz (SW)</td></tr><tr><td>1</td><td>1</td><td>0.5 to 10 MHz (MW, LW)</td></tr></table> <p>The input signal must be capacitor coupled.</p> <p>Input is disabled if the $\overline{\text{HOLD}}$ pin is set low in the HOLD enabled state.</p> <p>Input is disabled in clock stop mode, after a power-on reset, and in the PLL stopped state.</p>	b1	b0	Band	1	0	2 to 40 MHz (SW)	1	1	0.5 to 10 MHz (MW, LW)									
b1	b0	Band																				
1	0	2 to 40 MHz (SW)																				
1	1	0.5 to 10 MHz (MW, LW)																				
74	FMIN	I	CMOS amplifier input	<p>FM VCO (local oscillator) input</p> <p>This pin is selected using the PLL instruction CW1 field (b1 = 0, b0 = don't care).</p> <p>The input signal must be capacitor coupled.</p> <p>Input is disabled if the $\overline{\text{HOLD}}$ pin is set low in the HOLD enabled state.</p> <p>Input is disabled in clock stop mode, after a power-on reset, and in the PLL stopped state.</p>																		

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Pin No.	Symbol	I/O	I/O type	Function
72	$\overline{\text{SNS}}$	I	CMOS input	<p>Shared-function voltage sensing input and general-purpose input port</p> <p>The input threshold voltage is set lower than that of other inputs.</p> <ul style="list-style-type: none"> When used as a voltage sensing pin: This pin is used to recognize power failures on recovery from backup (clock stop) mode. An internal sensing flip-flop is used for this determination. The TUL instruction (b2) can be used to test the sense flip-flop. When used as a general-purpose input port: Use the TUL instruction (b3) to test this pin when it is used as a general-purpose input port. <p>Unlike other input ports, input is not disabled during clock stop mode or a power-on reset. Thus applications must take through currents into consideration if this pin is used as a general-purpose input port.</p>
71	LCTR	I	CMOS amplifier input	<p>Shared-function universal counter (frequency or period measurement) and general-purpose input port</p> <p>The IOS instruction (Pn = 3, b3) is used to switch this pin between its universal counter and general-purpose input port functions.</p> <ul style="list-style-type: none"> When used for frequency measurement: Select the universal counter function with an IOS instruction (Pn = 3, b3 = 0). Set LCTR frequency measurement mode with a UCS instruction (b3 = 0, b2 = 1). After selecting the measurement time, start the counter with a UCC instruction. The CNTEND flag will be set when the count completes. Since this circuit operates as an AC amplifier in this mode, the input must be capacitor coupled. When used for period measurement: With the universal counter function selected, set period measurement mode with a UCS instruction (b3 = 1, b2 = 0). After selecting the measurement time, start the counter with a UCC instruction. The CNTEND flag will be set when the count completes. Since the bias feedback resistor is switched off in this mode, the input must be DC coupled. When used as a general-purpose input port: Specify the general-purpose input port function with an IOS instruction (Pn = 3, b3 = 1). Use the INR (b1) internal register (address 0EH) input instruction to read in the input data. <p>Input is disabled in clock stop mode. (The input pin is pulled down.)</p> <p>The universal counter function is selected after a power-on reset. (HCTR frequency measurement mode.)</p>

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Pin No.	Symbol	I/O	I/O type	Function
70	HCTR	I	CMOS amplifier input	<p>Shared-function universal counter input and general-purpose input port</p> <p>The IOS instruction (Pn = 3, b3) is used to switch this pin between its universal counter and general-purpose input port functions.</p> <ul style="list-style-type: none"> When used for frequency measurement: <ul style="list-style-type: none"> Select the universal counter function with an IOS instruction (Pn = 3, b2 = 0). Set HCTR frequency measurement mode with a UCS instruction (b3 = 0, b2 = 0). After selecting the measurement time, start the counter with a UCC instruction. The CNTEND flag will be set when the count completes. Since this circuit operates as an AC amplifier in this mode, the input must be capacitor coupled. When used as a general-purpose input port: <ul style="list-style-type: none"> Set the general-purpose input port function with an IOS instruction (Pn = 3, b2 = 1). Use the INR (b1) internal register (address 0EH) input instruction to read in the input data. <p>Input is disabled in clock stop mode. (The input pin is pulled down.)</p> <p>The universal counter function is selected after a power-on reset.</p>
69	$\overline{\text{HOLD}}$	I	CMOS input	<p>Controls the PLL circuit and clock stop mode.</p> <p>When this pin is set low in the hold enabled state, FMIN and AMIN pin input is disabled and the EO pin goes to the high-impedance state.</p> <p>To switch to clock stop mode, set the HOLDEN flag, set this pin low, and execute a CKSTP instruction.</p> <p>Set this pin high to clear clock stop mode.</p>
68 67 66 65	PH0/ADI0 PH1/ADI1 PH2/ADI2 PH3/ADI3	I	CMOS input Analog input	<p>Shared-function general-purpose input and A/D converter input port</p> <p>The IOS instruction (Pn = 7) is used to switch these pins between the general-purpose and A/D converter input port functions.</p> <ul style="list-style-type: none"> When used as a general-purpose input port: <ul style="list-style-type: none"> Set the general-purpose input port function (in bit units) with the IOS instruction (Pn = 7). When used for A/D converter input: <ul style="list-style-type: none"> Set the A/D converter input port function with an IOS instruction (Pn = 7). Specify the pin to convert with an IOS instruction (Pn = 1). Start the conversion with a UCC instruction (b2). The ADCE flag is set when the conversion has completed. <p>Note: Since input is disabled, low will always be returned if an input instruction (the IN instruction) is executed for a port specified for A/D converter input. (In other words, the port must be set to the general-purpose input function before the input instruction is executed.)</p> <p>Input is disabled in clock stop mode.</p> <p>The general-purpose input function is selected after a power-on reset.</p>

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Pin No.	Symbol	I/O	I/O type	Function
64 63 62 61	PJ0/DAC0 PJ1/DAC1 PJ2/DAC2 PJ3/DAC3	O	N-channel open drain	<p>Shared-function general-purpose and D/A converter output port</p> <p>The IOS instruction (Pn = 9) is used to switch these pins between the general-purpose and D/A converter output port functions.</p> <p>Since these pins are open drain circuits, pull-up resistors are required in external circuits accepting these outputs.</p> <ul style="list-style-type: none"> When used as a general-purpose port: Set the general-purpose input port function with the IOS instruction (Pn = 9). When used for D/A converter output: Use the IOS instruction (Pn = 9) to switch the port in bit units. D/A converter data is loaded into the DAC0 to DAC3 specified with the DAC instruction. Although a PWM waveform is output as soon as the port is switched, after data is loaded, the data prior to that load is output for up to 114 μs (1/8.79 kHz). <p>In clock stop mode, these outputs go to the transistor off (high output) state.</p> <p>The general-purpose output port function is selected after a power-on reset, and the outputs go to the transistor off (high output) state.</p>
22 21 20 19	PK0/INT0 PK1/INT1 PK2 PK3	I/O	CMOS push-pull	<p>Shared-function general-purpose I/O and external interrupt port</p> <p>There is no instruction that switches between the general-purpose port and the external interrupt pin functions. Rather, the corresponding pin becomes an input-only pin (output disabled) at the point where the external interrupt enable flag for that pin is set.</p> <ul style="list-style-type: none"> When used as a general-purpose I/O port: Input or output can be specified in bit units (bit I/O). The IOS instruction is used to specify input or output in bit units. When used as external interrupt pins: These pins are enabled by setting the external interrupt enable flags (INT0EN and INT1EN) in status register 2. At that point the pin is automatically set up to be an input port. The status register 1 interrupt enable flag (INTEN) must also be set to enable interrupt operation. Use the IOS instruction (Pn = 3, b1 = INT1, b0 = INT0) to select rising or falling edge detection. <p>Input is disabled with the pins in the high-impedance state in clock stop mode.</p> <p>The general-purpose input port function is selected after a power-on reset.</p>
60	Vdd1		—	Apply the LCD drive bias 2/3 voltage to this pin.
59	Vdd2		—	Apply the LCD drive bias 1/3 voltage to this pin.
79 2	TEST1 TEST2		—	<p>LSI test pin</p> <p>This pin must be left open or connected to ground.</p>
58 57 56	COM1 COM2 COM3	O	CMOS 3-value output	<p>LCD driver common output pins</p> <p>This drive circuit implements a 1/3-duty, 1/3-bias drive scheme.</p> <p>These pins are fixed at the low level in clock stop mode.</p> <p>These pins are fixed at the low level after a power-on reset.</p>
55 to 40	S1 to S16	O	CMOS 3-value output	<p>LCD driver segment output pins</p> <p>This drive circuit implements a 1/3-duty, 1/3-bias drive scheme.</p> <p>The frame frequency is 100 Hz.</p> <p>These pins are fixed at the low level in clock stop mode.</p> <p>These pins are fixed at the low level after a power-on reset.</p>

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Pin No.	Symbol	I/O	I/O type	Function
39 38 37 36	S17/PE0 S18/PE1/SCK2 S19/PE2/SO2 S20/PE3/SI2	I/O	CMOS 3-value output and push-pull	<p>Shared-function LCD driver segment output, general-purpose I/O, and serial I/O port</p> <p>The IOS instruction is used to switch between the LCD driver segment output, general-purpose I/O, and serial I/O functions, and to switch between input and output for the general-purpose input port function.</p> <ul style="list-style-type: none"> When used for segment output: The function can be specified in bit units. Segment output is specified with the IOS instruction (Pn = 0DH). b0 = S17/PE0 0 ... Segment output b1 = S18/PE1 1 ... PE0 to PE3 output b2 = S19/PE2 b3 = S20/PE3 When used as a general-purpose I/O port: Input or output can be specified in bit units (1-bit I/O). The general-purpose I/O port function is specified with the IOS instruction (Pn = 0). b2 = SI/O2 0 ... General-purpose port 1 ... SI/O port Input or output is specified with the IOS instruction in bit units. PE ... Pn = 4 0 ... Input 1 ... Output When used as a serial I/O port: The serial I/O port function is specified with the IOS instruction (Pn = 0). The contents of the serial I/O data buffer can be saved and loaded with the INR and OTR instructions. Note: Pin setup states when used as a serial I/O port: PE0 ... General-purpose I/O PE1 ... SCK2 output in internal clock mode SCK2 input in external clock mode PE2 ... SO2 output PE3 ... SI2 input <p>In clock stop mode, if this port is used as a general-purpose I/O port or as a serial I/O port, the pins go to the input disabled high-impedance state. If used for segment output, the pins are fixed at the low level.</p> <p>The segment output port function is selected after a power-on reset.</p>

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Pin No.	Symbol	I/O	I/O type	Function
35 34 33 32	S21/PF0 S22/PF1/SCK1 S23/PF2/SO1 S24/PF3/SI1	I/O	CMOS 3-value output and push-pull	<p>Shared-function LCD driver segment output, general-purpose I/O, and serial I/O port</p> <p>The PF0 to PF3 inputs are Schmitt inputs.</p> <p>The IOS instruction is used to switch between the LCD driver segment output, general-purpose I/O, and serial I/O functions, and to switch between input and output for the general-purpose input port function.</p> <ul style="list-style-type: none"> When used for segment output: The function is specified in 4-bit units. Segment output is specified with the IOS instruction ($P_n = 0EH$). $b_0 = S_{21}$ to S_{24}/PF_0 to PF_3 0 ... Segment output 1 ... PF0 to PF3 output When used as a general-purpose I/O port: Input or output can be specified in bit units (1-bit I/O). The general-purpose I/O port function is specified with the IOS instruction ($P_n = 0$). $b_1 = SI/O_1$ 0 ... General-purpose port 1 ... SI/O port <p>Input or output is specified with the IOS instruction in bit units. $PF \dots P_n = 5$ 0 ... Input 1 ... Output</p> <ul style="list-style-type: none"> When used as a serial I/O port: The serial I/O port function is specified with the IOS instruction ($P_n = 0$). The contents of the serial I/O data buffer can be saved and loaded with the INR and OTR instructions. Note: Pin setup states when used as a serial I/O port: $PF_0 \dots$ General-purpose I/O $PF_1 \dots$ SCK1 output in internal clock mode SCK1 input in external clock mode $PF_2 \dots$ SO1 output $PF_3 \dots$ SI1 input <p>In clock stop mode, if this port is used as a general-purpose I/O port or as a serial I/O port, the pins go to the input disabled high-impedance state. If used for segment output, the pins are fixed at the low level.</p> <p>The segment output port function is selected after a power-on reset.</p>
30 29 28 27	S25/PM0 S26/PM1 S27/PM2 S28/PM3	I/O	CMOS 3-value output and push-pull	<p>Shared-function LCD driver segment output and general-purpose I/O port</p> <p>The IOS instruction is used to switch between the LCD driver segment output and the general-purpose I/O functions, and to switch between input and output for the general-purpose input port function.</p> <ul style="list-style-type: none"> When used for segment output: The function is specified in 4-bit units. Segment output is specified with the IOS instruction ($P_n = 0EH$). $b_1 = S_{25}$ to S_{28}/PM_0 to PM_3 0 ... Segment output 1 ... PF0 to PF3 output When used as a general-purpose I/O port: Input or output can be specified in bit units (1-bit I/O). Input or output is specified with the IOS instruction in bit units. $PM \dots P_n = 0CH$ 0 ... Input 1 ... Output <p>In clock stop mode, if this port is used as a general-purpose I/O port, the pins go to the input disabled high-impedance state. If used for segment output, the pins are fixed at the low level.</p> <p>The segment output port function is selected after a power-on reset.</p>

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Pin No.	Symbol	I/O	I/O type	Function
26	S29/PN0/BEEP	O	CMOS 3-value output and push-pull	Shared-function segment output, general-purpose output, and beep tone output port
25	S30/PN1			The IOS instruction is used to switch between the segment output port and the PN0 to PN3 functions.
24	S31/PN2			The BEEP instruction is used to switch between the general-purpose output port and the beep tone output functions.
23	S32/PN3			<ul style="list-style-type: none">When used for segment output: The function can be specified in 3-bit units. Segment output is specified with the IOS instruction (Pn = 0EH). b2 = S29 to S32/PN0 to PN3 0 ... Segment output

LC723336 and LC72338 Instruction Table

Abbreviations:

ADDR: Program memory address

b: Borrow

C: Carry

D_H: Data memory address high (row address) [2 bits]D_L: Data memory address low (column address) [4 bits]

I: Immediate data [4 bits]

M: Data memory address

N: Bit position [4 bits]

Pn: Port number [4 bits]

r: General register (one of the locations 00 to 0FH in bank)

Rn: Register number [4 bits]

(): Contents of register or memory

()N: Contents of bit N of register or memory

Instruction group	Mnemonic	Operand		Function	Operation	Machine code															
		1st	2nd			D15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	D0
Addition instructions	AD	r	M	Add M to r	$r \leftarrow (r) + (M)$	0	1	0	0	0	0	D _H		D _L		r					
	ADS	r	M	Add M to r, then skip if carry	$r \leftarrow (r) + (M)$ skip if carry	0	1	0	0	0	1	D _H		D _L		r					
	AC	r	M	Add M to r with carry	$r \leftarrow (r) + (M) + C$	0	1	0	0	1	0	D _H		D _L		r					
	ACS	r	M	Add M to r with carry, then skip if carry	$r \leftarrow (r) + (M) + C$ skip if carry	0	1	0	0	1	1	D _H		D _L		r					
	AI	M	I	Add I to M	$M \leftarrow (M) + I$	0	1	0	1	0	0	D _H		D _L		I					
	AIS	M	I	Add I to M, then skip if carry	$M \leftarrow (M) + I$ skip if carry	0	1	0	1	0	1	D _H		D _L		I					
	AIC	M	I	Add I to M with carry	$M \leftarrow (M) + I + C$	0	1	0	1	1	0	D _H		D _L		I					
	AICS	M	I	Add I to M with carry, then skip if carry	$M \leftarrow (M) + I + C$ skip if carry	0	1	0	1	1	1	D _H		D _L		I					
Subtraction instructions	SU	r	M	Subtract M from r	$r \leftarrow (r) - (M)$	0	1	1	0	0	0	D _H		D _L		r					
	SUS	r	M	Subtract M from r, then skip if borrow	$r \leftarrow (r) - (M)$ skip if borrow	0	1	1	0	0	1	D _H		D _L		r					
	SB	r	M	Subtract M from r with borrow	$r \leftarrow (r) - (M) - b$	0	1	1	0	1	0	D _H		D _L		r					
	SBS	r	M	Subtract M from r with borrow, then skip if borrow	$r \leftarrow (r) - (M) - b$ skip if borrow	0	1	1	0	1	1	D _H		D _L		r					
	SI	M	I	Subtract I from M	$M \leftarrow (M) - I$	0	1	1	1	0	0	D _H		D _L		I					
	SIS	M	I	Subtract I from M, then skip if borrow	$M \leftarrow (M) - I$ skip if borrow	0	1	1	1	0	1	D _H		D _L		I					
	SIB	M	I	Subtract I from M with borrow	$M \leftarrow (M) - I - b$	0	1	1	1	1	0	D _H		D _L		I					
	SIBS	M	I	Subtract I from M with borrow, then skip if borrow	$M \leftarrow (M) - I - b$ skip if borrow	0	1	1	1	1	1	D _H		D _L		I					
Comparison instructions	SEQ	r	M	Skip if r equal to M	$(r) - (M)$ skip if zero	0	0	0	1	0	0	D _H		D _L		r					
	SEQI	M	I	Skip if M equal to I	$(M) - I$ skip if zero	0	0	0	1	0	1	D _H		D _L		I					
	SNEI	M	I	Skip if r not equal to M	$(M) - I$ skip if not zero	0	0	0	0	0	1	D _H		D _L		I					
	SGE	r	M	Skip if r is greater than or equal to M	$(r) - (M)$ skip if not borrow	0	0	0	1	1	0	D _H		D _L		r					
	SGEI	M	I	Skip if M is greater than or equal to I	$(M) - I$ skip if not borrow	0	0	0	1	1	1	D _H		D _L		I					
	SLEI	M	I	Skip if M is less than I	$(M) - I$ skip if borrow	0	0	0	0	1	1	D _H		D _L		I					

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Instruction group	Mnemonic	Operand		Function	Operation	Machine code												
		1st	2nd			D15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 D0									
Logical operation instructions	AND	r	M	AND M with r	$r \leftarrow (r) \text{ AND } (M)$	0 0 1 0	0 0	D _H	D _L	r								
	ANDI	M	I	AND I with M	$M \leftarrow (M) \text{ AND } I$	0 0 1 0	0 1	D _H	D _L	I								
	OR	r	M	OR M with r	$r \leftarrow (r) \text{ OR } (M)$	0 0 1 0	1 0	D _H	D _L	r								
	ORI	M	I	OR I with M	$M \leftarrow (M) \text{ OR } I$	0 0 1 0	1 1	D _H	D _L	I								
	EXL	r	M	Exclusive OR M with r	$r \leftarrow (r) \text{ XOR } (M)$	0 0 1 1	0 0	D _H	D _L	r								
	EXLI	M	I	Exclusive OR I with M	$M \leftarrow (M) \text{ XOR } I$	0 0 1 1	0 1	D _H	D _L	I								
Transfer instructions	LD	r	M	Load M to r	$r \leftarrow (M)$	1 1 0 1	0 0	D _H	D _L	r								
	ST	M	r	Store r to M	$M \leftarrow (r)$	1 1 0 1	0 1	D _H	D _L	r								
	MVRD	r	M	Move M to destination M referring to r in the same row	$[D_H, R_n] \leftarrow (M)$	1 1 0 1	1 0	D _H	D _L	r								
	MVRS	M	r	Move source M referring to r to M in the same row	$M \leftarrow [D_H, R_n]$	1 1 0 1	1 1	D _H	D _L	r								
	MVSR	M1	M2	Move M to M in the same row	$[D_H, D_L1] \leftarrow [D_H, D_L2]$	1 1 1 0	0 0	D _H	D _{L1}	D _{L2}								
	MVI	M	I	Move I to M	$M \leftarrow I$	1 1 1 0	0 1	D _H	D _L	I								
Bit test instructions	TMT	M	N	Test M bits, then skip if all bits specified are true	if M (N) = all "1", then skip	1 1 1 1	0 0	D _H	D _L	N								
	TMF	M	N	Test M bits, then skip if all bits specified are false	if M (N) = all "0", then skip	1 1 1 1	0 1	D _H	D _L	N								
Jump and subroutine call instructions	JMP	ADDR		Jump to the address	$PC \leftarrow ADDR$	1 0 0	ADDR (13 bits)											
	CAL	ADDR		Call subroutine	$Stack \leftarrow (PC) + 1$	1 0 1	ADDR (13 bits)											
	RT			Return from subroutine	$PC \leftarrow Stack$	0 0 0 0	0 0 0 0	1 0 0 0										
	RTS			Return from subroutine and skip	$PC \leftarrow Stack + 1$	0 0 0 0	0 0 0 0	1 0 1 0										
	RTB			Return from subroutine with bank data	$PC \leftarrow Stack$ $BANK \leftarrow Stack$	1 1 1 1	1 1 1 1	1 1 0 0										
	RTBS			Return from subroutine with bank data and skip	$PC \leftarrow Stack + 1$ $BANK \leftarrow Stack$	1 1 1 1	1 1 1 1	1 1 0 1										
	RTI			Return from interrupt	$PC \leftarrow Stack$ $BANK \leftarrow Stack$ $CARRY \leftarrow Stack$	0 0 0 0	0 0 0 0	1 0 0 1										
Status register instructions	SS	I	N	Set status register	(Status reg I) $N \leftarrow 1$	1 1 1 1	1 1 1 1	0 0 0	I	N								
	RS	I	N	Reset status register	(Status reg I) $N \leftarrow 0$	1 1 1 1	1 1 1 1	0 0 1	I	N								
	TST	I	N	Test status register true	if (Status reg I) N = all "1", then skip	1 1 1 1	1 1 1 1	0 1	I	N								
	TSF	I	N	Test status register false	if (Status reg I) N = all "0", then skip	1 1 1 1	1 1 1 1	1 0	I	N								
F/F test instruction	TUL	N		Test unlock F/F then skip if it has not been set	if Unlock F/F (N) = all "0", then skip	0 0 0 0	0 0 0 0	1 1 0 1	N									
Internal register transfer instructions	PLL	M	r	Load M to PLL registers	PLL reg \leftarrow PLL data	1 1 1 1	1 0	D _H	D _L	r								
	DAC	I			DAC reg \leftarrow DAC data	0 0 0 0	0 0 0 0	0 0 1 1	I									
	INR	M	R _n	Input register/port data to M	$M \leftarrow (R_n \text{ reg})$	0 0 1 1	1 0	D _H	D _L	R _n								
	OUTR	M	R _n	Output contents of M to register/port	$R_n \text{ reg} \leftarrow (M)$	0 0 1 1	1 1	D _H	D _L	R _n								

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Instruction group	Mnemonic	Operand		Function	Operation	Machine code											
		1st	2nd			D15 14	13	12	11	10	9	8	7	6	5	4	3 2 1 D0
Hardware control instructions	SIO	I1	I2	Serial I/O control	SIO \leftarrow I1, I2	0	0	0	0	0	0	0	1	I1		I2	
	UCS	I		Set I to UCCW1	UCCW1 \leftarrow I	0	0	0	0	0	0	0	0	0	0	1	I
	UCC	I		Set I to UCCW2	UCCW2 \leftarrow I	0	0	0	0	0	0	0	0	0	1	0	I
	BEEP	I		Beep control	BEEP reg \leftarrow I	0	0	0	0	0	0	0	0	0	1	1	0
	DZC	I		Dead zone control	DZC reg \leftarrow I	0	0	0	0	0	0	0	0	1	0	1	1
	IOS	Pn	I	Set port control word	IOS reg Pn \leftarrow I	1	1	1	1	1	1	1	0	Pn		I	
	TMS	I			Timmer reg I	0	0	0	0	0	0	0	0	1	1	0	0
Bank switching instruction	BANK	I		Select bank	BANK \leftarrow I	0	0	0	0	0	0	0	0	0	1	1	1
LCD control instructions	LCDA	M	I	Output segment pattern to LCD digit direct	LCD (DIGIT) \leftarrow M	1	1	0	0	0	0	D _H	D _L		DIGIT		
	LCDB	M	I			1	1	0	0	0	1	D _H	D _L		DIGIT		
	LCPA	M	I	Output segment pattern to LCD digit through Logic Array	LCD (DIGIT) \leftarrow Logic Array \leftarrow M	1	1	0	0	1	0	D _H	D _L		DIGIT		
	LCPB	M	I			1	1	0	0	1	1	D _H	D _L		DIGIT		
I/O instructions	IN	M	Pn	Input port data to M	M \leftarrow (Pn)	1	1	1	0	1	0	D _H	D _L		Pn		
	OUT	M	Pn	Output contents of M to port	Pn \leftarrow M	1	1	1	0	1	1	D _H	D _L		Pn		
	SPB	Pn	N	Set port bits	(Pn) N \leftarrow 1	0	0	0	0	0	0	1	0	Pn		N	
	RPB	Pn	N	Reset port bits	(Pn) N \leftarrow 0	0	0	0	0	0	0	1	1	Pn		N	
	TPT	Pn	N	Test port bits, then skip if all bits specified are true	if (Pn) N = all "1", then skip	1	1	1	1	1	1	0	0	Pn		N	
	TPF	Pn	N	Test port bits, then skip if all bits specified are false	if (Pn) N = all "0", then skip	1	1	1	1	1	1	0	1	Pn		N	
Other instructions	HALT	I		Halt mode control	HALT reg \leftarrow I, then CPU clock stop	0	0	0	0	0	0	0	0	0	1	0	0
	CKSTP			Clock stop	Stop X'tal OSC if HOLD = 0	0	0	0	0	0	0	0	0	0	1	0	1
	SHR	r			Shift r right with carry	0	0	0	0	0	0	0	0	1	1	1	0
	NOP			No operation	No operation	0	0	0	0	0	0	0	0	0	0	0	0

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