



LC72140, 72140M

PLL Frequency Synthesizers

Overview

The LC72140 and LC72140M are high-performance, phase-locked loop (PLL) frequency synthesizers that operate over the VHF, MW and LW wave bands. They feature excellent frequency tracking, making them ideal as a reference frequency source for use in AM/FM radio receivers. The LC72140 and LC72140M operate from a 5V supply. The LC72140 is available in 24-pin DIPs, and the LC72140M, in 24-pin MFPs.

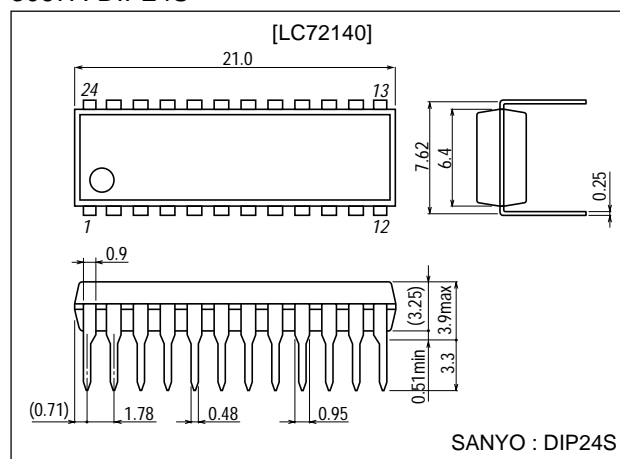
Features

- High-speed programmable dividers for
 - 10 to 160MHz on FMIN using pulse swallower.
 - 0.5 to 40.0MHz on AMIN using pulse swallower and direct division.
- General-purpose counters (used together with the SD in IF count mode).
 - HCTR for 0.4 to 25.0MHz frequency measurement.
 - LCTR for 10 to 500kHz frequency measurement and 1Hz to 20kHz period measurement.
- 4.5 or 7.2MHz crystal.
- Twelve selectable reference frequencies (1, 3, 5, 9, 10, 3.125, 6.25, 12.5, 25, 30, 50 and 100kHz).
- Phase comparator.
 - Insensitive band control.
 - Unlock detection.
 - Sub-charge pump for high-speed locking.
 - Deadlock clear circuit.
- C²B input/output data interface.
- Power-ON reset circuit.
- Built-in MOS transistor for a low-pass filter.
- Inputs/outputs (using five general-purpose input/output ports).
 - Maximum of seven inputs.
 - Maximum of seven outputs (three n-channel open-drain and four CMOS outputs).
- 5V supply.
- 24-pin DIP (LC72140) and 24-pin MFP (LC72140M).

Package Dimensions

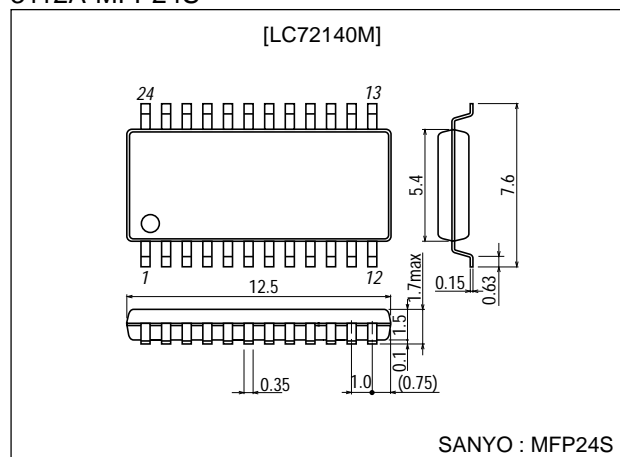
unit:mm

3067A-DIP24S



unit:mm

3112A-MFP24S

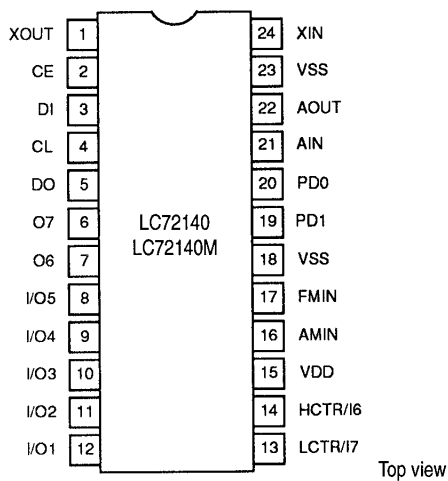


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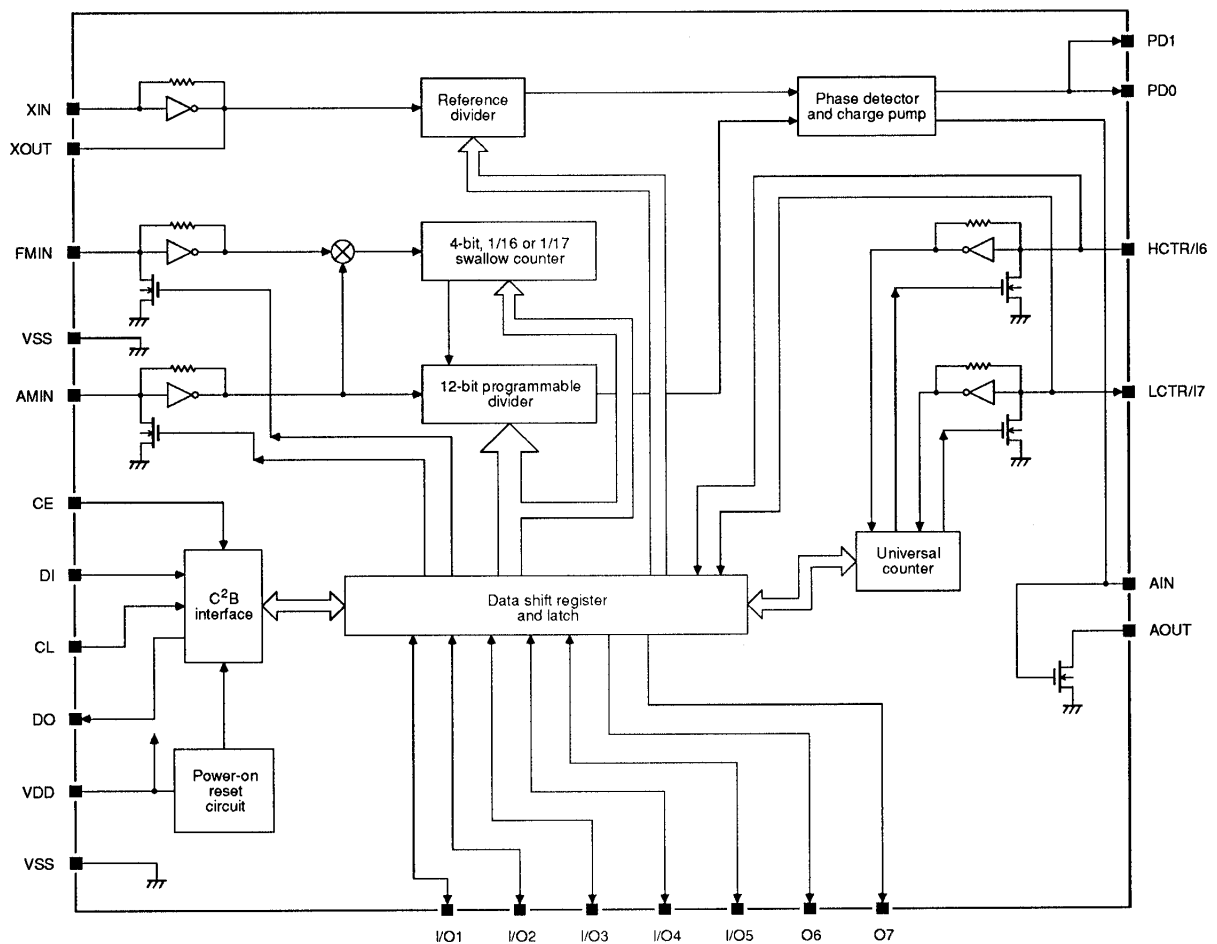
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Pin Assignment

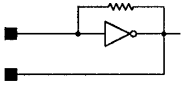



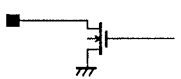
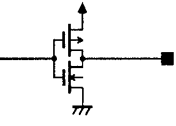
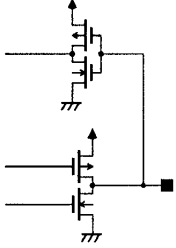
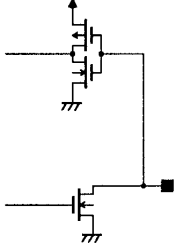
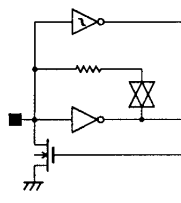


Block Diagram



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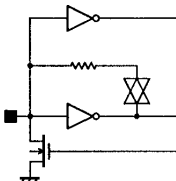
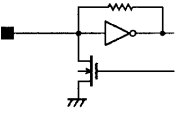
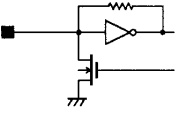
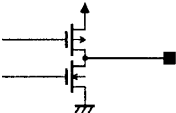
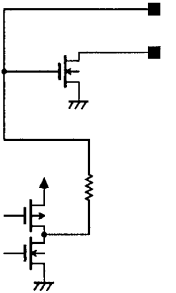
Pin Functions

Number	Name	Equivalent circuit	Function
1	XOUT		4.5 to 7.2MHz crystal oscillator output
24	XIN		4.5 or 7.2MHz crystal oscillator input
2	CE		Chip-enable input
3	DI		Data input from microcontroller
4	CL		Clock input
5	DO		Data output to microcontroller
6	O7		OUT7 flag output
7	O6		OUT6 flag output
8	I/O5		General-purpose input/output ports 4 and 5
9	I/O4		
10	I/O3		General-purpose input/output ports 1 to 3
11	I/O2		
12	I/O		
13	LCTR/I7		Period or frequency measurement general-purpose counter input and input port 7.

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Number	Name	Equivalent circuit	Function
14	HCTR/I6		Frequency measurement general-purpose counter input and input port 6.
15	V _{DD}		Supply voltage
16	AMIN		AM band local oscillator signal input
17	FMIN		FM band local oscillator signal input
19	PD1		Phase-detector charge pump outputs
20	PD0		
21	AIN		Analog low-pass filter transistor input
22	AOUT		Analog low-pass filter transistor output
18, 23	V _{SS}		Ground

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 +7.0	V
Maximum CE, CL and DI input voltage	V _{IN1} max		−0.3 to +7.0	V
Maximum I/O1 to I/O3 input voltage	V _{IN2} max		−0.3 to +15.0	V
Maximum input voltage for all other pins	V _{IN3} max		−0.3 to V _{DD} +0.3	V
Maximum DO output voltage	V _{OUT1} max		−0.3 to +7.0	V
Maximum I/O1 to I/O3 and AOUT output voltage	V _{OUT2} max		−0.3 to +15.0	V
Maximum output voltage for all other pins	V _{OUT3} max		−0.3 to V _{DD} +0.3	V
Maximum I/O4, I/O5, O6 and O7 output current	I _{OUT1} max		0 to 3.0	mA
Maximum I/O1 to I/O3, DO and AOUT output current	I _{OUT2} max		0 to 6.0	mA
Allowable power dissipation	Pd max	DIP24S, Ta≤85°C	350	mW
		MFP24S, Ta≤85°C	160	mW
Operating temperature	T _{opr}		−40 to +85	°C
Storage temperature	T _{stg}		−55 to +125	°C

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Allowable Operating Ranges at Ta = -40 to +85°C, V_{SS}=0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V _{DD1}	V _{DD}	4.5		5.5	V
	V _{DD2}	V _{DD} : serial data sustain voltage	2.0			V
CE, CL, DI and I/O1 to I/O3 high-level input voltage	V _{IH1}		2.2		6.5	V
I/O4, I/O5, HCTR/I6 and LCTR/I7 high-level input voltage	V _{IH2}		2.2		V _{DD}	V
CL, CE, DI, I/O1 to I/O5, HCTR/I6 and LCTR/I7 low-level input voltage	V _{IL1}		0		0.8	V
LCTR/I7 high-level input voltage	V _{IH3}	Pulse wave, period measurement	2.2		V _{DD}	V
LCTR/I7 low-level input voltage	V _{IL2}	Pulse wave, period measurement	0		0.8	V
DO output voltage	V _{OUT1}		0		6.5	V
I/O1 to I/O3 and AOUT output voltage	V _{OUT2}		0		13	V
XIN input frequency	f _{IN1}	Sine wave, capacitive coupling	1.0		8.0	MHz
FMIN input frequency	f _{IN2}	Sine wave, capacitive coupling	10		160	MHz
AMIN input frequency	f _{IN3}	Sine wave, capacitive coupling	0.5		40.0	MHz
HCTR/I6 input frequency	f _{IN4}	Sine wave, capacitive coupling	0.4		25	MHz
LCTR/I7 input frequency	f _{IN5}	Sine wave, capacitive coupling	10		500	kHz
		Period measurement, pulse wave, DC coupling	0.001		20.0	kHz
Crystal oscillator frequency	f _{XTAL}	Crystal impedance ≤120Ω	4.0		8.0	MHz
XIN rms input amplitude	V _{IN1}		0.2		1.5	V
FMIN rms input amplitude	V _{IN2}	50≤f<130MHz. See Programmable Divider section.	0.07		1.5	V
		10≤f<50 and 130≤f≤160MHz. See Programmable Divider section.	0.10		1.5	V
AMIN rms input amplitude	V _{IN3}	2≤f<25MHz. See Programmable Divider section.	0.04		1.5	V
		25≤f<40MHz. See Programmable Divider section.	0.07		1.5	V
		0.5≤f<2.5MHz. See Programmable Divider section.	0.04		1.5	V
		2.5≤f≤10MHz. See Programmable Divider section.	0.07		1.5	V
HCTR/I6 rms input amplitude	V _{IN4}		0.04		1.5	V
HCTR/I7 rms input amplitude	V _{IN5}		0.04		1.5	V
DI to CL data setup time	t _{SU}		0.45			μs
DI to CL data hold time	t _{HD}		0.45			μs
CL low-level clock pulsewidth	t _{CL}		0.45			μs
CL high-level clock pulsewidth	t _{CH}		0.45			μs
CL to CE chip enable wait time	t _{EL}		0.45			μs
CE to CL chip enable setup time	t _{ES}		0.45			μs
CL to CE chip enable hold time	t _{EH}		0.45			μs
Chip enable to data latch time	t _{LC}				0.45	μs
CL to DO data output time	t _{DC}	Depends on pull-up resistor				
CE to DO data output time	t _{DH}				0.2	μs

Electrical Characteristics at Ta = -40 to +85°C, V_{SS}=0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
XIN internal resistance	R _{f1}			1.0		MΩ
FMIN internal resistance	R _{f2}			500		kΩ
AMIN internal resistance	R _{f3}			500		kΩ
HCTR/I6 internal resistance	R _{f4}			500		kΩ
LCTR/I7 internal resistance	R _{f5}			500		kΩ
AIN sub-charge pump internal resistance	R _{1S}			500		Ω
CE, CL, DI and LCTR/I7 hysteresis width	V _H			0.1V _{DD}		V
PD0, PD1, I/O4, I/O5, O6 and O7 high-level output voltage	V _{OH1}	I _O =1mA	V _{DD} -1.0			V
AIN high-level output voltage	V _{OH2}	I _O =1mA	V _{DD} -1.5	V _{DD} -0.7		V
PD0, PD1, I/O4, I/O5, O6 and O7 low-level output voltage	V _{OL1}	I _O =1mA			1.0	V
I/O1 to I/O3 and DO low-level output voltage	V _{OL2}	I _O =5mA			1.0	V
AOUT low-level output voltage	V _{OL3}	I _O =1mA, V _{AIN} =1.3V			0.5	V
AIN low-level output voltage	V _{OL4}	I _O =1mA		0.7	1.5	V

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
CE, CL and DI high-level input current	I_{IH1}	$V_{IN}=6.5V$			5.0	μA
I/O1 to I/O3 high-level input current	I_{IH2}	$V_{IN}=13V$			5.0	μA
I/O4, I/O5, HCTR/I6 and LCTR/I7 high-level input current	I_{IH3}	$V_{IN}=V_{DD}$			5.0	μA
XIN high-level input current	I_{IH4}	$V_{IN}=V_{DD}$	3.5		11	μA
FMIN, AMIN, HCTR/I6 and LCTR/I7 high-level input current	I_{IH5}	$V_{IN}=V_{DD}$	6.0		18	μA
CE, CL and DI low-level input current	I_{IL1}	$V_{IN}=0V$			5.0	μA
I/O1 to I/O5 low-level input current	I_{IL2}	$V_{IN}=0V$			5.0	μA
HCTR/I6 and LCTR/I7 low-level input current	I_{IL3}	$V_{IN}=0V$			5.0	μA
XIN low-level input current	I_{IL4}	$V_{IN}=0V$	3.5		11	μA
FMIN, AMIN, HCTR/I6 and LCTR/I7 low-level input current	I_{IL5}	$V_{IN}=0V$	6.0		18	μA
I/O1 to I/O3 and AOUT output leakage current	I_{OFF1}	$V_O=13V$			5.0	μA
DO output leakage current	I_{OFF2}	$V_O=6.5V$			5.0	μA
PD0, PD1 and AIN tristate low-level leakage current	I_{OFFL}	$V_O=0V$		0.01	200	nA
PD0, PD1 and AIN tristate high-level leakage current	I_{OFFH}	$V_O=V_{DD}$		0.01	200	nA
Supply current	I_{DD}	$f_{IN2}=160MHz$, $V_{IN2}=100mV$, $f_{XTAL}=7.2MHz$, $f_{IN4}=25MHz$, $V_{IN4}=40mV$		10	15	mA
		PLL inhibited, crystal oscillator running, $f_{XTAL}=7.2MHz$		0.5		mA
		PLL inhibited, crystal oscillator stopped			10	μA
FMIN input capacitance	C_{IN}			6		pF

Functional Description

Serial Data Input

The LC72140 and LC72140M operating parameters are initialized by two 40-bit data words on the serial data input, DI, as shown in Figures 1 and 2 and Table 1.

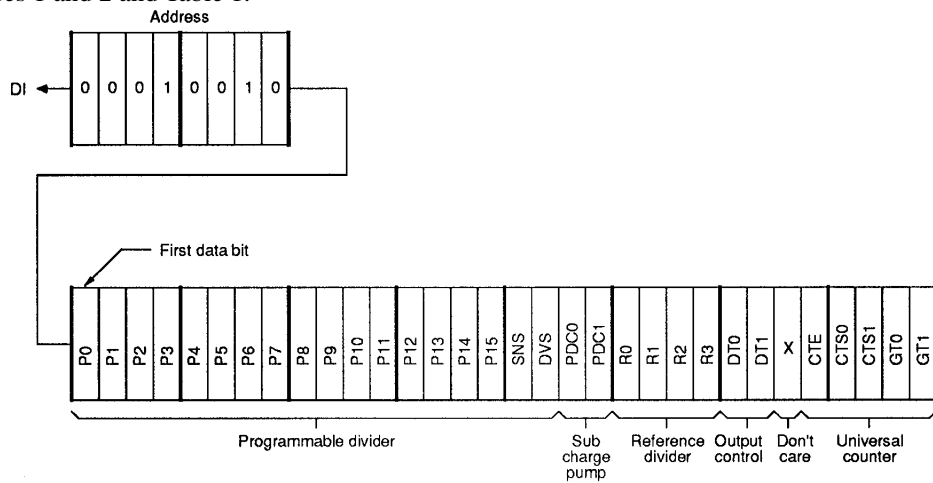


Figure 1. Input data word IN1

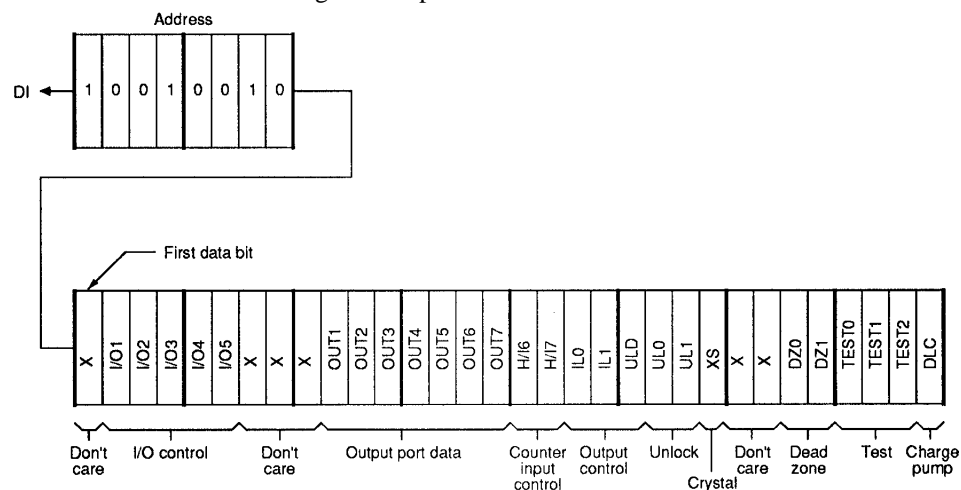


Figure 2. Input data word IN2

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Table 1. Input data functions

Name	Function	Related bits																																																																																					
P0 to P15, SNS, DVS	<p>Programmable divider ratio</p> <p>P15 is the msb. The divider ratio, frequency range and lsb are determined by the setting of the DVS and SNS flags as shown in Tables 2 and 3. P0 to P3 are ignored if P4 is the lsb.</p> <p>Table 2. Divider ratio settings</p> <table><tr><th>DVS</th><th>SNS</th><th>lsb</th><th>Divider ratio</th></tr><tr><td>1</td><td>×</td><td>P0</td><td>272 to 65535</td></tr><tr><td>0</td><td>1</td><td>P0</td><td>272 to 65535</td></tr><tr><td>0</td><td>0</td><td>P4</td><td>4 to 4095</td></tr></table> <p>Note ×=don't care</p> <p>Table 3. Frequency range settings</p> <table><tr><th>DVS</th><th>SNS</th><th>Input port</th><th>Input frequency range</th></tr><tr><td>1</td><td>×</td><td>FMIN</td><td>10 to 160MHz</td></tr><tr><td>0</td><td>1</td><td>AMIN</td><td>2 to 40MHz</td></tr><tr><td>0</td><td>0</td><td>AMIN</td><td>0.5 to 10MHz</td></tr></table> <p>Note ×=don't care</p>	DVS	SNS	lsb	Divider ratio	1	×	P0	272 to 65535	0	1	P0	272 to 65535	0	0	P4	4 to 4095	DVS	SNS	Input port	Input frequency range	1	×	FMIN	10 to 160MHz	0	1	AMIN	2 to 40MHz	0	0	AMIN	0.5 to 10MHz																																																						
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PDC0, PDC1	<p>Charge pump control</p> <p>Bits PDC0 and PDC1 control the charge pump state as shown in Table 4. The sub-charge pump is connected to the gate of the lowpass filter transistor. This can be used in conjunction with PD0 and PD1 (main charge pump) to build a fast locking PLL.</p> <p>Table 4. Charge pump state selection</p> <table><tr><th>PDC0</th><th>PDC1</th><th>Charge pump state</th></tr><tr><td>0</td><td>×</td><td>High-impedance</td></tr><tr><td>1</td><td>1</td><td>Operating (operates continuously)</td></tr><tr><td>1</td><td>0</td><td>Operating (when PLL is unlocked)</td></tr></table> <p>Note ×=don't care</p>	PDC0	PDC1	Charge pump state	0	×	High-impedance	1	1	Operating (operates continuously)	1	0	Operating (when PLL is unlocked)	UL0, UL1, DLC																																																																									
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R0 to R3	<p>Reference frequency select</p> <p>Bits R0 to R3 disable the PLL or select the reference frequency as shown in Table 5.</p> <p>Table 5. Reference frequency selection</p> <table><tr><th>R3</th><th>R2</th><th>R₁</th><th>R₀</th><th>Reference frequency (kHz)</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>50</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>25</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>25</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>12.5</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>6.25</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>3.125</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>3.125</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>10</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>9</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>5</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>3</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>30</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>PLL inhibited and crystal oscillator stopped</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>PLL inhibited</td></tr></table> <p>When the PLL is disabled, the programmable divider is stopped, AMIN and FMIN are pulled to ground, and the charge-pump outputs become high impedance.</p>	R3	R2	R ₁	R ₀	Reference frequency (kHz)	0	0	0	0	100	0	0	0	1	50	0	0	1	0	25	0	0	1	1	25	0	1	0	0	12.5	0	1	0	1	6.25	0	1	1	0	3.125	0	1	1	1	3.125	1	0	0	0	10	1	0	0	1	9	1	0	1	0	5	1	0	1	1	1	1	1	0	0	3	1	1	0	1	30	1	1	1	0	PLL inhibited and crystal oscillator stopped	1	1	1	1	PLL inhibited	
R3	R2	R ₁	R ₀	Reference frequency (kHz)																																																																																			
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Continued from preceding page.

Name	Function	Related bits																																																						
ULD, DT0, DT1, IL0, IL1	<p>DO and I/O5 output control data</p> <p>Bits ULD, DT0, DT1, IL0 and IL1 control the mode of outputs DO and I/O5 as shown in Tables 6 and 7.</p> <p>Table 6. DO and I/O5 output flag selection</p> <table><tr><th>ULD</th><th>DT1</th><th>DT0</th><th>DO</th><th>I/O5</th></tr><tr><td>0</td><td>0</td><td>0</td><td>Unlock flag</td><td rowspan="4">OUT5 flag. See Note 2.</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Open</td></tr><tr><td>0</td><td>1</td><td>0</td><td>End-UC flag. See note 1.</td></tr><tr><td>0</td><td>1</td><td>1</td><td>IN. See table 7.</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Open</td><td rowspan="4">Unlock flag. See Note 2.</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Open</td></tr><tr><td>1</td><td>1</td><td>0</td><td>End-UC flag</td></tr><tr><td>1</td><td>1</td><td>1</td><td>IN. See table 7.</td></tr></table> <p>Notes</p> <p>1. End-UC flags that general-purpose counter operation has finished.</p> <p>2. Applicable only if I/O5 is set to be an output port.</p>  <p>Figure 3. DO output state</p> <p>Table 7. IN state selection</p> <table><tr><th>IL1</th><th>IL0</th><th>IN state</th></tr><tr><td>0</td><td>0</td><td>Open</td></tr><tr><td>0</td><td>1</td><td>I1 input</td></tr><tr><td>1</td><td>0</td><td>I2 input</td></tr><tr><td>1</td><td>1</td><td>DO goes LOW when I1 changes.</td></tr></table> <p>Notes</p> <p>1. If I/O1 or I/O2 is set to be an output port, IN becomes open.</p> <p>2. DO does not go LOW when the crystal oscillator has stopped.</p>	ULD	DT1	DT0	DO	I/O5	0	0	0	Unlock flag	OUT5 flag. See Note 2.	0	0	1	Open	0	1	0	End-UC flag. See note 1.	0	1	1	IN. See table 7.	1	0	0	Open	Unlock flag. See Note 2.	1	0	1	Open	1	1	0	End-UC flag	1	1	1	IN. See table 7.	IL1	IL0	IN state	0	0	Open	0	1	I1 input	1	0	I2 input	1	1	DO goes LOW when I1 changes.	OUT5, I/O1, I/O2, I/O5
	ULD	DT1	DT0	DO	I/O5																																																			
	0	0	0	Unlock flag	OUT5 flag. See Note 2.																																																			
	0	0	1	Open																																																				
	0	1	0	End-UC flag. See note 1.																																																				
	0	1	1	IN. See table 7.																																																				
	1	0	0	Open	Unlock flag. See Note 2.																																																			
	1	0	1	Open																																																				
	1	1	0	End-UC flag																																																				
	1	1	1	IN. See table 7.																																																				
IL1	IL0	IN state																																																						
0	0	Open																																																						
0	1	I1 input																																																						
1	0	I2 input																																																						
1	1	DO goes LOW when I1 changes.																																																						
CTS0, CTS1, CTE, GT0, GT1	<p>Counter control</p> <p>Bits CTS0 and CTS1 select the counter input as shown in Table 8.</p> <p>Table 8. Counter input and measurement mode selection</p> <table><tr><th>Switch</th><th>CTS1</th><th>CTS0</th><th>Input</th><th>Measurement mode</th><th>Frequency range</th><th>Input rms sensitivity</th></tr><tr><td>S1</td><td>1</td><td>×</td><td>HCTR</td><td>Frequency</td><td>0.4 to 25.0MHz</td><td>40mV</td></tr><tr><td>S2</td><td>0</td><td>1</td><td>LCTR</td><td>Frequency</td><td>10 to 500kHz</td><td>40mV</td></tr><tr><td>S3</td><td>0</td><td>0</td><td>LCTR</td><td>Period</td><td>1Hz to 20kHz</td><td>(Pulse)</td></tr></table> <p>Note</p> <p>×=don't care</p> <p>Bit CTE starts the counter when 1, and resets the counter, when 0.</p> <p>Bits GT0 and GT1 select the measurement time in frequency measurement mode or the number of periods to count in period measurement mode as shown in Tabel 9.</p> <p>Table 9. Measurement duration selection</p> <table><tr><th rowspan="2">GT1</th><th rowspan="2">GT0</th><th colspan="2">Frequency measurement</th><th>Period measurement</th></tr><tr><th>Measurement duration (ms)</th><th>Wait time (ms)</th><th>Cycles</th></tr><tr><td>0</td><td>0</td><td>4</td><td rowspan="2">3 to 4</td><td rowspan="2">1</td></tr><tr><td>0</td><td>1</td><td>8</td></tr><tr><td>1</td><td>0</td><td>32</td><td rowspan="2">7 to 8</td><td rowspan="2">2</td></tr><tr><td>1</td><td>1</td><td>64</td></tr></table>	Switch	CTS1	CTS0	Input	Measurement mode	Frequency range	Input rms sensitivity	S1	1	×	HCTR	Frequency	0.4 to 25.0MHz	40mV	S2	0	1	LCTR	Frequency	10 to 500kHz	40mV	S3	0	0	LCTR	Period	1Hz to 20kHz	(Pulse)	GT1	GT0	Frequency measurement		Period measurement	Measurement duration (ms)	Wait time (ms)	Cycles	0	0	4	3 to 4	1	0	1	8	1	0	32	7 to 8	2	1	1	64	H/I6, L/I7		
	Switch	CTS1	CTS0	Input	Measurement mode	Frequency range	Input rms sensitivity																																																	
	S1	1	×	HCTR	Frequency	0.4 to 25.0MHz	40mV																																																	
	S2	0	1	LCTR	Frequency	10 to 500kHz	40mV																																																	
	S3	0	0	LCTR	Period	1Hz to 20kHz	(Pulse)																																																	
	GT1	GT0	Frequency measurement		Period measurement																																																			
			Measurement duration (ms)	Wait time (ms)	Cycles																																																			
	0	0	4	3 to 4	1																																																			
	0	1	8																																																					
	1	0	32	7 to 8	2																																																			
1	1	64																																																						
I/O1 to I/O5	Input/output port control	OUT1 to OUT5, ULD																																																						
OUT1 to OUT7	Output port data	I/O1 to I/O5, ULD																																																						
H/I6, L/I7	Counter input control	CTS0, CTS1																																																						

Continued on next page.

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Continued from preceding page.

Name	Function	Related bits																				
UL0, UL1	<p>PLL unlock detect control</p> <p>Bits UL0 UL1 select the phase error threshold and extension (ϕ_E) used to detect the PLL unlocked state as shown in Table 10 and Figure 4. When the phase error is greater than the selected error, the PLL unlock detector output goes LOW.</p> <p>Table 10. Unlock detection and extension selection</p> <table><tr><th>UL1</th><th>UL0</th><th>Phase error</th><th>Detector output</th></tr><tr><td>0</td><td>0</td><td>Stopped</td><td>Open</td></tr><tr><td>0</td><td>1</td><td>0</td><td>ϕ_E output</td></tr><tr><td>1</td><td>0</td><td>$\pm 0.56\mu s$</td><td>ϕ_E with 1 to 2ms extension</td></tr><tr><td>1</td><td>1</td><td>$\pm 1.11\mu s$</td><td>ϕ_E with 1 to 2ms extension</td></tr></table> <p>Figure 4. Phase-error extension</p>	UL1	UL0	Phase error	Detector output	0	0	Stopped	Open	0	1	0	ϕ_E output	1	0	$\pm 0.56\mu s$	ϕ_E with 1 to 2ms extension	1	1	$\pm 1.11\mu s$	ϕ_E with 1 to 2ms extension	ULD, DT0, DT1
UL1	UL0	Phase error	Detector output																			
0	0	Stopped	Open																			
0	1	0	ϕ_E output																			
1	0	$\pm 0.56\mu s$	ϕ_E with 1 to 2ms extension																			
1	1	$\pm 1.11\mu s$	ϕ_E with 1 to 2ms extension																			
XS	<p>Crystal oscillator control</p> <p>Bit XS selects the oscillator frequency. When XS is 1, the frequency is 7.2MHz, and when XS is 0, 4.5MHz.</p> <p>4.5MHz is selected after power-ON reset.</p>																					
DZ0, DZ1	<p>Phase comparator control</p> <p>Bits DZ0 and DZ1 select the phase comparator insensitive band, or dead zone.</p> <p>Table 11. Insensitive band mode selection</p> <table><tr><th>DZ1</th><th>DZ0</th><th>Insensitive band (dead zone) mode</th></tr><tr><td>0</td><td>0</td><td>DZA</td></tr><tr><td>0</td><td>1</td><td>DZB</td></tr><tr><td>1</td><td>0</td><td>DZC</td></tr><tr><td>1</td><td>1</td><td>DZD</td></tr></table> <p>DZA is selected after power-ON reset.</p>	DZ1	DZ0	Insensitive band (dead zone) mode	0	0	DZA	0	1	DZB	1	0	DZC	1	1	DZD						
DZ1	DZ0	Insensitive band (dead zone) mode																				
0	0	DZA																				
0	1	DZB																				
1	0	DZC																				
1	1	DZD																				
DLC	<p>Charge pump control</p> <p>Bit DLC controls the charge pump operation. When DLC is 1, the charge pump outputs are forced to LOW, and when DLC is 0, the charge pump operates normally.</p> <p>This feature can be useful to remove the PLL from a deadlock state. The PLL can deadlock if its VCO control voltage V_{tune} becomes 0V, halting the VCO. Setting DLC to 1 sets V_{tune} to V_{CC}, restarting the VCO.</p> <p>Normally operating mode is selected after power-ON reset.</p>																					
TEST0 to TEST2	<p>Test data</p> <p>Bits TEST0 to TEST2 are used for in-factory device testing. Set them all to 0. They are set to zero after a power-ON reset.</p>																					

Serial Data Input Timing

The timing for the serial data input words is shown in Figure 5. The first eight bits are the mode select bits.

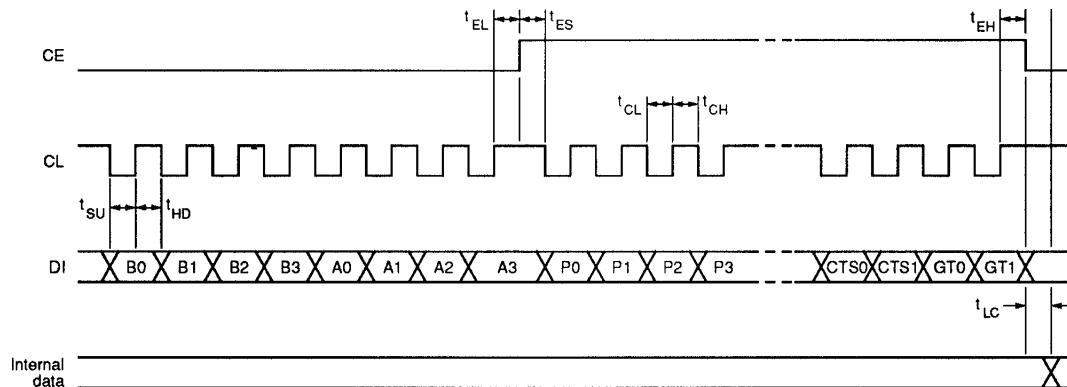


Figure 5. Input timing

Notes

1. t_{SU} , t_{HD} , t_{EL} , t_{ES} , t_{CL} , t_{CH} and $t_{EH} > 0.45\mu s$
2. $t_{LC} < 0.45\mu s$

Serial Data Output

The 40-bit data word output on DO has the format and functions as shown in Figure 6 and Table 12, respectively.

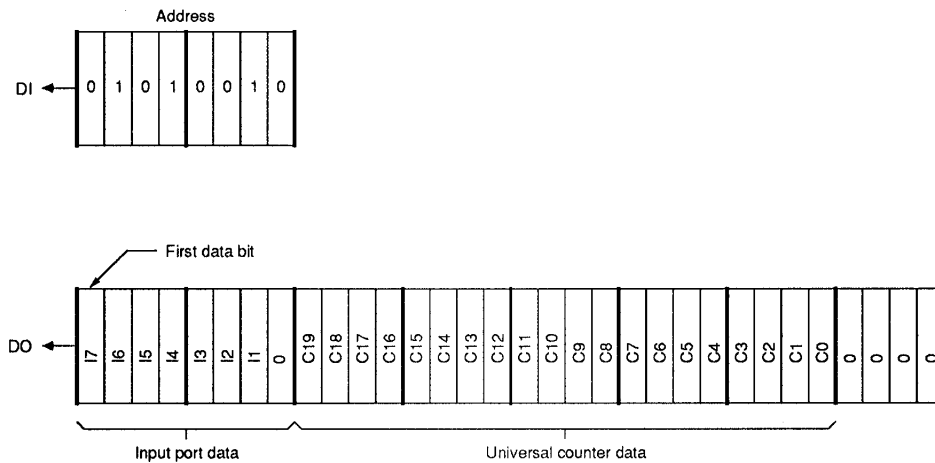


Figure 6. Output data word OUT

Table 12. Input data functions

Name	Function	Related bits
I1 to I7	Input port data Bits I1 to I7 reflect the data latched into each input port when the device changes to data output mode. I6 and I7 are zero when the corresponding port is a counter input. I1 to I5 correspond to the I/O1 to I/O5 ports, and I6 and I7, to the HCTR/I6 and LCTR/I7 inputs, respectively.	I/O1 to I/O5, H/I6, L/I7
C0 to C19	Counter contents Bits C0 to C19 are the latched contents of the 20-bit binary counter. C0 is the lsb.	CTS0, CTS1, CTE

Serial Data Output Timing

The timing for the serial data output is shown in figure 7. The first eight bits are the mode select bits.

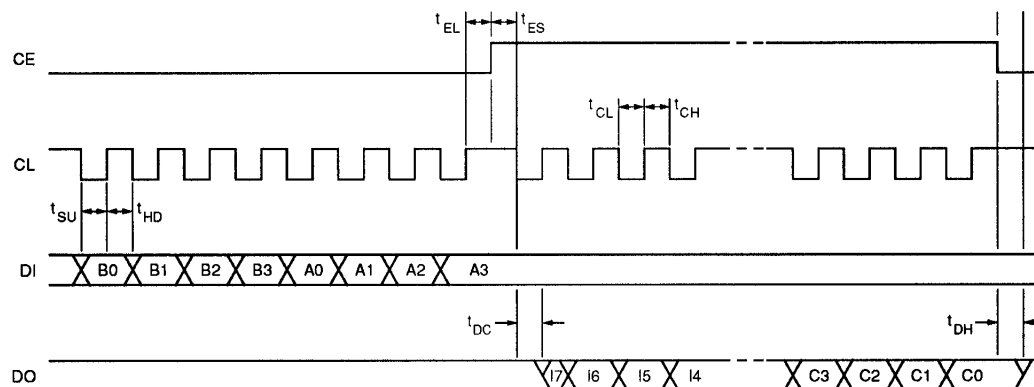


Figure 7. Output timing

Notes

1. t_{SU} , t_{HD} , t_{EL} , t_{ES} , t_{CL} and t_{CH} $> 0.45\mu s$
2. t_{DC} and t_{DH} $< 0.2\mu s$
3. Since DO is an open-drain output, the data transition time depends on the value of the pull-up resistor.
4. DO is normally open.

Serial Data Input/Output Mode Selection

The LC72140 and LC72140M use the C²B (computer control bus) serial data format. The first 8 bits form the address, shown in Figure 8, used to select the mode of operation as shown in Table 13.

Input/output mode	Address								Description
	B0	B1	B2	B3	A0	A1	A2	A3	
IN1	0	0	0	1	0	0	1	0	32-bit control data input
IN2	1	0	0	1	0	0	1	0	32-bit control data input
OUT	0	1	0	1	0	0	1	0	Output data. Data is output if the clock is active.

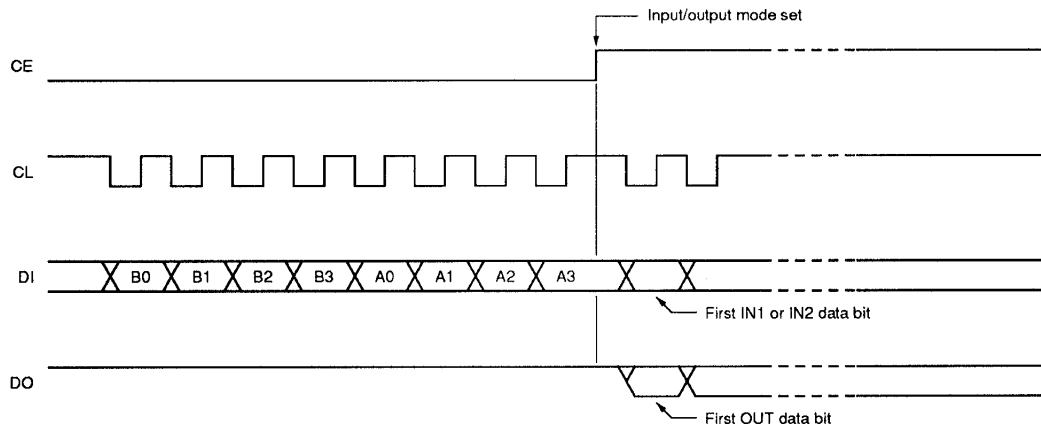


Figure 8. Mode selection address bits

Programmable Divider

The configuration of the programmable divider is shown in Figure 9. The input mode selection is shown in Table 14, and the input sensitivity, in Table 15.

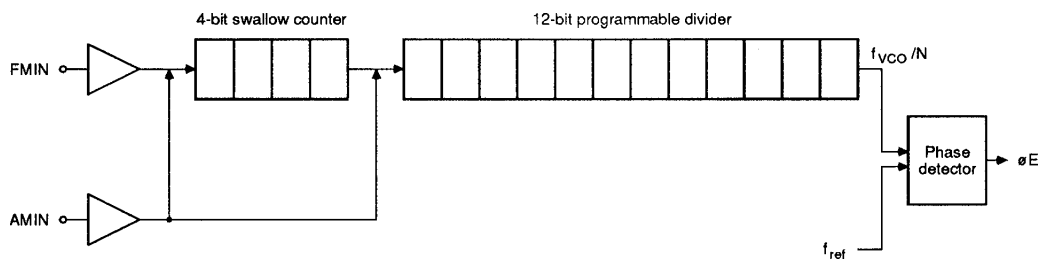


Figure 9. Programmable divider

Table 14. Programmable divider selection

DVS	SNS	1/16 and 1/17 pulse swallower	12-bit programmable divider	Input port
1	x	✓	✓	FMIN
0	1	✓	✓	AMIN
0	0	—	✓	AMIN

Note

x=don't care

Table 15. Input sensitivity

DVS	SNS	Input	Frequency (MHz)	Input rms sensitivity (mV)
1	×	FMIN	$10 \leq f < 50$	100
			$50 \leq f < 130$	70
			$130 \leq f < 160$	100
0	1	AMIN	$2 \leq f < 25$	40
			$25 \leq f < 40$	70
0	0	AMIN	$0.5 \leq f < 2.5$	40
			$2.5 \leq f < 10$	70

Note

×=don't care

General-purpose Counter

The 20-bit general-purpose counter is used for both frequency and period measurement as shown in Figure 10. The measurement mode is selected by bits CTS0 and CTS1. The counter contents, C, in frequency measurement mode are given by

$$C = \text{FIF} \times \text{GT}$$

and in period measurement mode by

$$C = \left(\frac{1}{T} \right) \div 900\text{kHz}$$

The counter contents are output on DO, msb first.

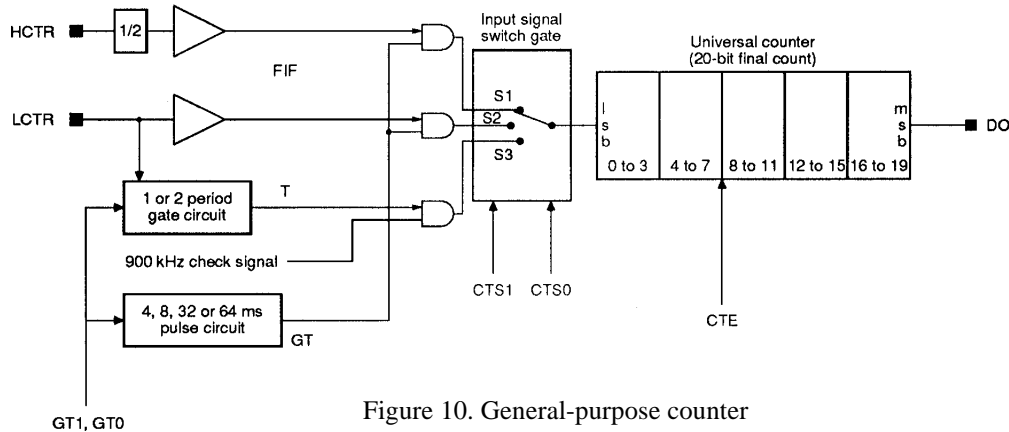


Figure 10. General-purpose counter

The LCTR signal is passed directly to the counter input. The HCTR signal is passed through a divide-by-two prescaler. The actual HCTR frequency is, therefore, two times the measured frequency. The timing for the general-purpose counter is shown in Figure 11.

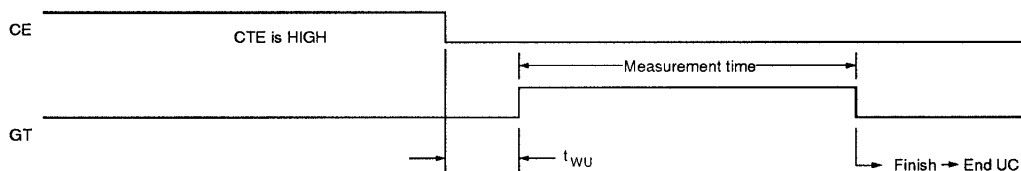


Figure 11. General-purpose counter timing

Note

t_{wu} =wait time

The counter starts when the CTE flag is set. The serial input data is latched in on the falling edge of CE. Note that the HCTR or LCTR input signal should be input within the wait time of this transition.

The period or frequency count should be read while CTE is set to 1, because the counter is reset when CTE is set to 0. Note that CTE should be set to 0 before each measurement.

In IF count mode, the IF IC's SD (station detector) signal presence is determined by the microcontroller and if an SD signal is present, the IF count buffer output turns ON and IF count becomes active. During auto-search in IF count only, there is a possibility of the count stopping even when there is no station present due to the IF count buffer output leakage.

Integrating count

When integrating the count, the count value is added to the general-purpose counter as shown in Figure 12. However, the counter can overflow. The maximum count is $2^{20}-1$, or FFFFF in hexadecimal. DO can also be used to monitor for frequency or period measurement completion as shown in Figure 12.

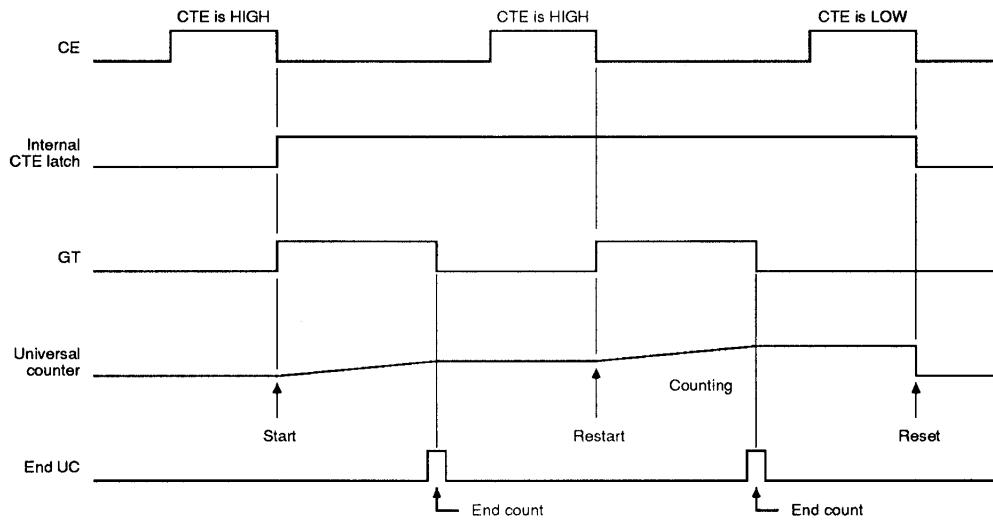


Figure 12. Integrating count timing

Charge Pump

The charge pump configuration is shown in Figure 13.

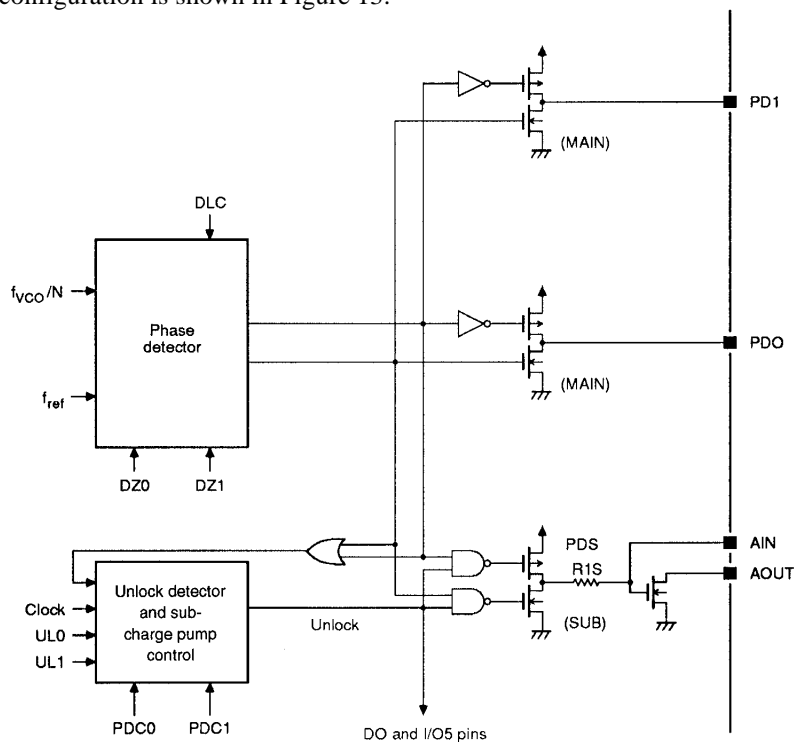


Figure 13. Charge pump

When unlock is detected following a channel change, PDS (the sub-charge pump) operates. The value of R1 changes to $R1M||R1S$ ($R1S \approx 500\Omega$), as shown in Figure 14, decreasing the low-pass filter time-constant and accelerating PLL locking.

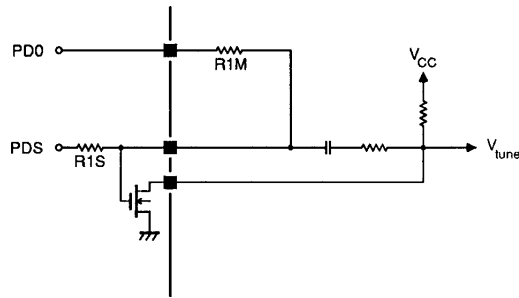


Figure 14. Charge pump connections

The local oscillator signal is divided by N. When the frequency of the divided signal is higher than the reference frequency, PD0 and PD1 are HIGH, and when lower, they are LOW. Both outputs are floating when the two signals are equal in frequency.

Pin States After Power-ON Reset

The state of the input/output ports after power-ON reset is shown in Table 16.

Table 16. Power-ON reset states

Pin	Reset state	Pin type
I/O1	I1	Open-drain
I/O2	I2	Open-drain
I/O3	I3	Open-drain
I/O4	I4	CMOS
I/O5	I5	CMOS
O6	O6	CMOS
O7	O7	CMOS
HCTR/I6	I6	
LCTR/I7	I7	

Notes

1. Phase comparator control

Modes DZA and DZB do not have insensitive bands (dead zones) and, therefore, the charge pump operates continuously. Consequently, measures should be taken to ensure reference frequency sidebands do not occur.

Modes DZC and DZD do have insensitive bands. Consequently, measures should be taken to ensure phase noise is not generated.

2. FMIN, AMIN, HCTR and LCTR

These inputs should each be capacitively coupled using a 50 to 100pF capacitor. Also, these capacitors should be mounted as close as possible to their respective inputs.

3. IF counting using HCTR or LCTR

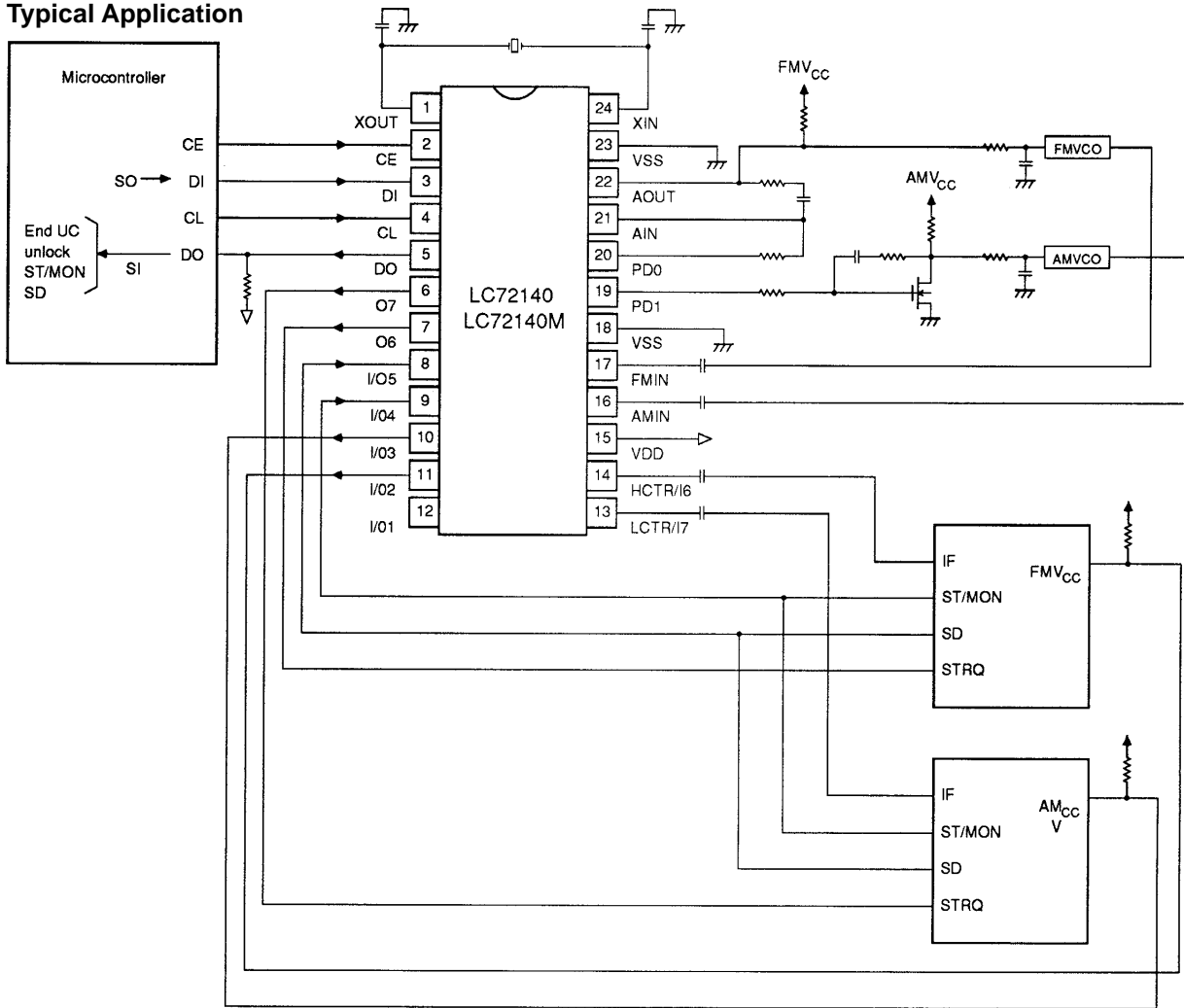
The LC72140 and LC72140M can perform IF count tuning when connected to an SD (station detector) signal from an IF IC. IF counting should start when the SD signal becomes active.

4. Using the general-purpose counter

In IF count mode, the IF IC's SD (station detector) signal presence is determined by the microcontroller and if an SD signal is present, the IF count buffer output turns ON and IF count becomes active. During auto-search in IF count only, there is a possibility of the count stopping even when there is no station present due to the IF count buffer output leakage.

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Typical Application



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