

**SANYO**

No. 3355A

**LC7216M**

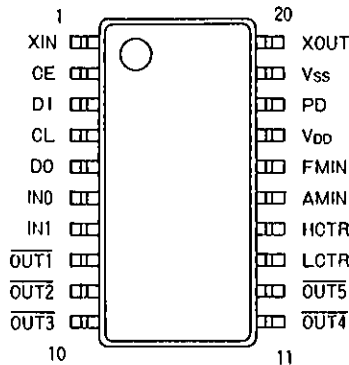
PLL Frequency Synthesizer for  
Electronic Tuning

**Features**

Various reference frequencies, input/output ports, and a universal counter, and unlock detector.

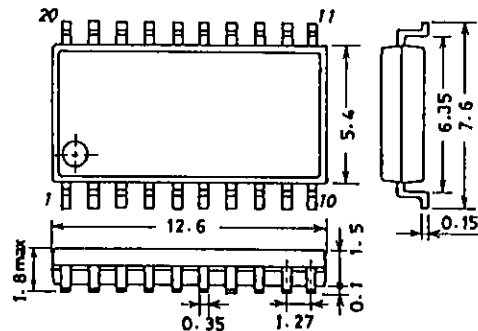
- (1) Programmable divider
  - FMIN pin: 130MHz: 70mVrms/160MHz: 110mVrms input (Prescaler built-in)
  - AMIN pin: Pulse swallow and direct frequency-divide method.
- (2) Reference frequency: 10 user selectable reference frequencies.  
100, 50, 25, 12.5, 6.25, 3.125, 10, 9, 5, and 1kHz
- (3) Output port: 5 ports  
2 complementary outputs  
3N-channel open drain outputs
- (4) Input port: 2 ports
- (5) Universal counter: Used to measure IF signals, etc. (The IF signals counting must be sure to use together with the SD (Station Detect) signals from IF-IC.)
  - HCTR pin: For frequency measurement (>70MHz input capable)
  - LCTR pin: For frequency or period measurement
- (6) Unlock detection for PLL: 0.55, 1.11, 2.22, 3.33 μsec phase difference
- (7) Package: MFP20 (Miniflat)

**Pin Assignment**



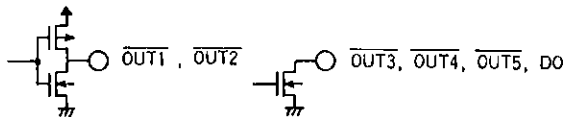
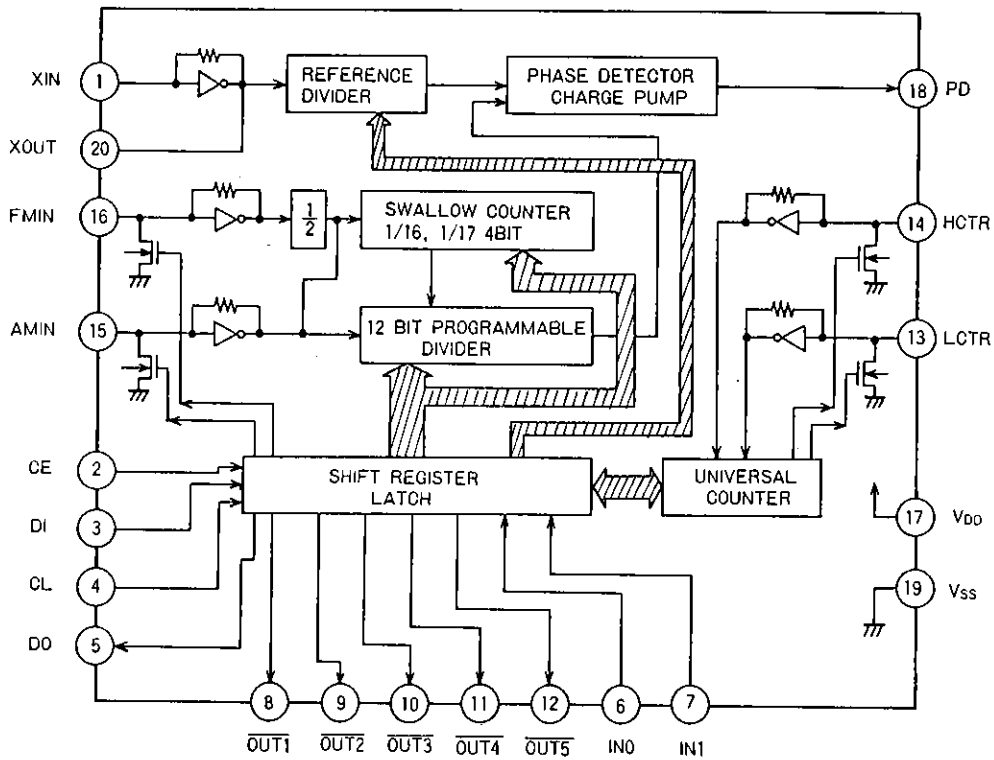
**Package Dimensions 3036B**

(unit: mm)

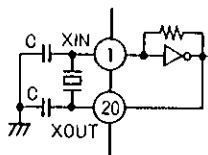


# LC7216M

## Block Diagram



※Sample Crystal Resonator:  
 7.200MHz CL16pF (C=27pF)  
 • LN-X-0702 (NR-18 type)  
 • LN-P-0001 (AT-51 type)



Nihon Dempa Kogyo Co., Ltd.

### Pin Description

XIN, XOUT :Crystal OSC (7.2MHz)  
 FMIN, AMIN :Local oscillating signal input  
 CE, CL, DI, DO :Serial data input/output  
 OUT1 to OUT5 :Output ports  
 IN0, IN1 :Input ports  
 HCTR, LCTR :Universal counter signal input  
 PD :Charge pump output

### Maximum Ratings at Ta=25°C, Vss=0V

				unit
Maximum Supply Voltage	V <sub>DDmax</sub>	V <sub>DD</sub>	-0.3 to +7.0	V
Input Voltage	V <sub>IN(1)</sub>	CE, CL, DI, IN0, IN1	-0.3 to +7.0	V
	V <sub>IN(2)</sub>	Input ports other than V <sub>IN(1)</sub>	-0.3 to V <sub>DD</sub> +0.3	V
Output Voltage	V <sub>OUT(1)</sub>	DO	-0.3 to +7.0	V
	V <sub>OUT(2)</sub>	OUT1, OUT2	-0.3 to V <sub>DD</sub> +0.3	V
	V <sub>OUT(3)</sub>	OUT3, OUT4, OUT5	-0.3 to +15	V
	V <sub>OUT(4)</sub>	Output ports other than V <sub>OUT(1), (2), (3)</sub>	-0.3 to V <sub>DD</sub> +0.3	V
Allowable Power Dissipation	P <sub>dmax</sub>	Ta ≤ 85°C	200	mW
Operating Temperature	T <sub>opr</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +125	°C

## LC7216M

Allowable Operating Conditions at Ta = -40 to +85°C, V<sub>ss</sub> = 0V

				min	typ	max	unit
Supply Voltage	V <sub>DD</sub> (1)	V <sub>DD</sub>		4.5		6.5	V
	V <sub>DD</sub> (2)	V <sub>DD</sub>	Crystal OSC	3.5		6.5	V
High Level Input Voltage	V <sub>IH</sub> (1)	CE, CL, DI IN0, IN1		2.2		6.5	V
	V <sub>IH</sub> (2)	LCTR	Pulse wave, DC coupling	0.7V <sub>DD</sub> (1)		V <sub>DD</sub> (1)	V
Low Level Input Voltage	V <sub>IL</sub> (1)	CE, CL, DI IN0, IN1		0		0.7	V
	V <sub>IL</sub> (2)	LCTR	Note 4)	0		0.3V <sub>DD</sub> (1)	V
Output Voltage	V <sub>OUT</sub> (1)	DO				6.5	V
	V <sub>OUT</sub> (2)	$\overline{\text{OUT3}}$ to $\overline{\text{OUT5}}$				13	V
Input Frequency	f <sub>IN</sub> (1)	XIN	Sine wave, capacitive coupling, V <sub>DD</sub> (2)	1.0	7.2	8.0	MHz
	f <sub>IN</sub> (2)	FMIN	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	Note 1) 10		130	MHz
	f <sub>IN</sub> (3)	AMIN	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	Note 1) 0.5	Note 5) (160)	40	MHz
	f <sub>IN</sub> (4)	HCTR	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	Note 2) 10		60	MHz
	f <sub>IN</sub> (5)	LCTR	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	Note 3) 15	Note 6) (70)	500	kHz
	f <sub>IN</sub> (6)	LCTR	Pulse wave, DC coupling	Note 4) 1.0		20 × 10 <sup>3</sup>	Hz
Crystal Oscillator Frequency	X'tal	X <sub>IN</sub> - X <sub>OUT</sub>	CI ≤ 50Ω	3.0	7.2	8.0	MHz
Input Amplitude	V <sub>IN</sub> (1)	X <sub>IN</sub>	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	0.5		1.5	Vrms
	V <sub>IN</sub> (2)	FMIN	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	0.07	Note 5) (0.11)	0.5	Vrms
	V <sub>IN</sub> (3)	AMIN	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	0.07		0.5	Vrms
	V <sub>IN</sub> (4)	HCTR	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	Note 2) 0.07	Note 6) (0.11)	0.5	Vrms
	V <sub>IN</sub> (5)	LCTR	Sine wave, capacitive coupling, V <sub>DD</sub> (1)	Note 3) 0.07		0.5	Vrms

Note 1) DV and SP represent 1 bit within serial data.

\* : Don't care

DV	SP	Input frequency	1/2 divider	1/16,17 swallow	12-bit main divider	Input pin
1	*	10 to 130(160)MHz	○	○	○	(FMIN)
0	1	2 to 40 MHz	—	○	○	(AMIN)
0	0	0.5 to 10 MHz	—	—	○	(AMIN)

Note 2) Frequency measurement

Note 3) Frequency measurement

Note 4) Period measurement

Note 5) f<sub>IN</sub>(2) 10 to 160MHz/V<sub>IN</sub>(2)  
0.11Vrms (min)

Note 6) f<sub>IN</sub>(4) 10 to 70MHz/V<sub>IN</sub>(4)  
0.11Vrms (min)

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Electrical Characteristics under allowable operating conditions

			min	typ	max	unit	
Built-in Feedback Resistance	R <sub>f</sub> (1)	XIN		1.0		MΩ	
	R <sub>f</sub> (2)	FMIN		500		kΩ	
	R <sub>f</sub> (3)	AMIN		500		kΩ	
	R <sub>f</sub> (4)	HCTR		500		kΩ	
	R <sub>f</sub> (5)	LCTR		500		kΩ	
Hysteresis Width	V <sub>H</sub>	LCTR	0.1V <sub>DD</sub>		0.6V <sub>DD</sub>	V	
High Level Input Current	I <sub>ih</sub> (1)	CE,CL,DI	V <sub>i</sub> =6.5		5.0	μA	
	I <sub>ih</sub> (2)	IN0,IN1	V <sub>i</sub> =V <sub>DD</sub>		5.0	μA	
	I <sub>ih</sub> (3)	XIN	V <sub>i</sub> =V <sub>DD</sub>		20	μA	
	I <sub>ih</sub> (4)	FMIN,AMIN	V <sub>i</sub> =V <sub>DD</sub>		40	μA	
	I <sub>ih</sub> (5)	HCTR,LCTR	V <sub>i</sub> =V <sub>DD</sub>		40	μA	
Low Level Input Current	I <sub>il</sub> (1)	CE,CL,DI	V <sub>i</sub> =V <sub>SS</sub>		5.0	μA	
	I <sub>il</sub> (2)	IN0,IN1	V <sub>i</sub> =V <sub>SS</sub>		5.0	μA	
	I <sub>il</sub> (3)	XIN	V <sub>i</sub> =V <sub>SS</sub>		20	μA	
	I <sub>il</sub> (4)	FMIN,AMIN	V <sub>i</sub> =V <sub>SS</sub>		40	μA	
	I <sub>il</sub> (5)	HCTR,LCTR	V <sub>i</sub> =V <sub>SS</sub>		40	μA	
High Level Output Voltage	V <sub>oh</sub> (1)	OUT1,OUT2	I <sub>o</sub> =1mA	V <sub>DD</sub> -1.0		V	
	V <sub>oh</sub> (2)	PD	I <sub>o</sub> =0.5mA	V <sub>DD</sub> -1.0		V	
Low Level Output Voltage	V <sub>ol</sub> (1)	OUT1,OUT2	I <sub>o</sub> =1mA		1.0	V	
	V <sub>ol</sub> (2)	PD	I <sub>o</sub> =0.5mA		1.0	V	
	V <sub>ol</sub> (3)	OUT3 to OUT5	I <sub>o</sub> =5mA		1.0	V	
	V <sub>ol</sub> (4)	DO	I <sub>o</sub> =5mA		1.0	V	
Output Off Leak Current	I <sub>off</sub> (1)	OUT3 to OUT5	V <sub>o</sub> =13V		5.0	μA	
	I <sub>off</sub> (2)	DO	V <sub>o</sub> =6.5V		5.0	μA	
High Level 3-State Off Leak Current	I <sub>offH</sub>	PD	V <sub>o</sub> =V <sub>DD</sub>	0.01	10.0	nA	
Low Level 3-Stage Off Leak Current	I <sub>offL</sub>	PD	V <sub>o</sub> =V <sub>SS</sub>	0.01	10.0	nA	
Input Capacitance	C <sub>IN</sub>	FMIN, HCTR		1	2	3	pF
Supply Current	I <sub>DD</sub> (1)	V <sub>DD</sub>	{ f <sub>IN</sub> (2)=130MHz V <sub>IN</sub> (2)=70mVrms Crystal 7.2MHz OSC is connected. Other input pins=V <sub>SS</sub> Output pins=Open		20	30	mA
	I <sub>DD</sub> (2)	V <sub>DD</sub>		{ PLL partially stops (PLL inhibit). Crystal OSC operates. Crystal 7.2MHz OSC is connected. Other input pins=V <sub>SS</sub> Output pins=Open		1.0	

Note) Use a capacitor of 2000pF or more between power supplies V<sub>DD</sub> and V<sub>SS</sub>.

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Pin Description

Symbol	Pin No.	Description	Function	Input/output
XIN XOUT	1 20	X'tal OSC	• Crystal oscillator (7.2MHz) is connected.	Input Output
FMIN	16	Local oscillation signal input	<ul style="list-style-type: none"> <li>• FMIN is selected by specifying serial data input: DV=1</li> <li>• Frequency between 10 and 130MHz is input (70mVrms min).</li> <li>• Signals are set to the swallow counter via built-in prescaler (1/2).</li> <li>• From 256 to 65536 frequency divisions are selected but this value can be doubled with built-in prescaler (1/2).</li> </ul>	Input
AMIN	15	Local oscillation signal input	<ul style="list-style-type: none"> <li>• AMIN is selected by specifying serial data input: DV=0.</li> <li>• When serial data input: SP=1 is specified. <ul style="list-style-type: none"> <li>– Input frequency is between 2 and 40 MHz (70mVrms min).</li> <li>– Signals are not sent to built-in prescaler (1/2), but are directly transferred to swallow counter.</li> <li>– From 256 to 65536 frequency divisions are selected and used as is.</li> </ul> </li> <li>• When serial data input: SP=0 is specified, <ul style="list-style-type: none"> <li>– Input frequency is between 0.5 and 10MHz (70mVrms min).</li> <li>– Signals are directly transferred to a 12-bit programmable divider.</li> <li>– From 4 to 4095 frequency divisions are selected and used as is.</li> </ul> </li> </ul>	Input
PD	18	Charge pump output	• This is an output terminal for PLL charge pump signals. If the local oscillation signal frequency divided by N is higher than the reference frequency, high level signals are output from PD; if it is lower than the reference frequency, low level signals are output. If it is the same as the reference frequency, the signals are floated.	3 state
VDD	17	Power supply	<ul style="list-style-type: none"> <li>• Power is supplied to LC7216M via this pin. During PLL operation, 4.5 to 6.5V is applied.</li> <li>If only a crystal oscillation circuit is used for the controller clock and time base for the clock, the power supply can be reduced to a minimum of 3.5V.</li> </ul>	—

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Symbol	Pin No.	Description	Function	Input/output
VSS	19	Ground	<ul style="list-style-type: none"> <li>This pin is tied to the ground of LC7216M.</li> </ul>	—
CE	2	Chip enable	<ul style="list-style-type: none"> <li>High level signals are input during serial data input (DI) or output (DO).</li> </ul>	Input *
CL	4	Clock	<ul style="list-style-type: none"> <li>Data is synchronized by this clock signal during serial data input (DI) or output (DO).</li> </ul>	Input *
DI	3	Input data	<ul style="list-style-type: none"> <li>Serial data transferred from controller to LC7216M is input to this pin.</li> <li>A total of 36 bits of data should be input for initialization.</li> </ul>	Input *
DO	5	Output data	<ul style="list-style-type: none"> <li>Serial data transferred from the controller to LC7216M output from this pin.</li> <li>By synchronizing it with CL, 28 bits of the contents of the internal shift register can be output.</li> </ul>	Output (N-channel open drain)
<u>OUT1</u> <u>OUT2</u> <u>OUT3</u> <u>OUT4</u> <u>OUT5</u>	8 9 10 11 12	Output port	<ul style="list-style-type: none"> <li>Bits 0<sub>1</sub> to 0<sub>5</sub> of serial data, transferred from the controller, are latched, and the data is inverted and output in parallel.</li> <li><u>OUT1</u> and <u>OUT2</u> are complementary outputs.</li> <li><u>OUT3</u>, <u>OUT4</u>, and <u>OUT5</u> are N-ch open drain outputs (voltage durability: 13V).</li> </ul>	Output
IN0 IN1	6 7	Input port	<ul style="list-style-type: none"> <li>Contents of input ports IN0 and IN1 are converted from parallel to serial form and are output from output pin DO.</li> </ul>	Input *
HCTR	14	Universal counter frequency measuring signal input pin	<ul style="list-style-type: none"> <li>HCTR is selected by specifying serial data input: SC=1.</li> <li>Input frequency is between 10 and 60 MHz (70mVrms min).</li> <li>Since signals are sent to a universal counter (20-bit binary counter) via a 1/8 of the actual frequency input to HCTR.</li> <li>When HCTR is selected, either 120msec or 60msec can be specified as the measuring time in the frequency measurement mode. (GT=1/0; 120/60msec)</li> <li>Result can be output from MSB of the universal counter via output pin DO.</li> </ul>	Input

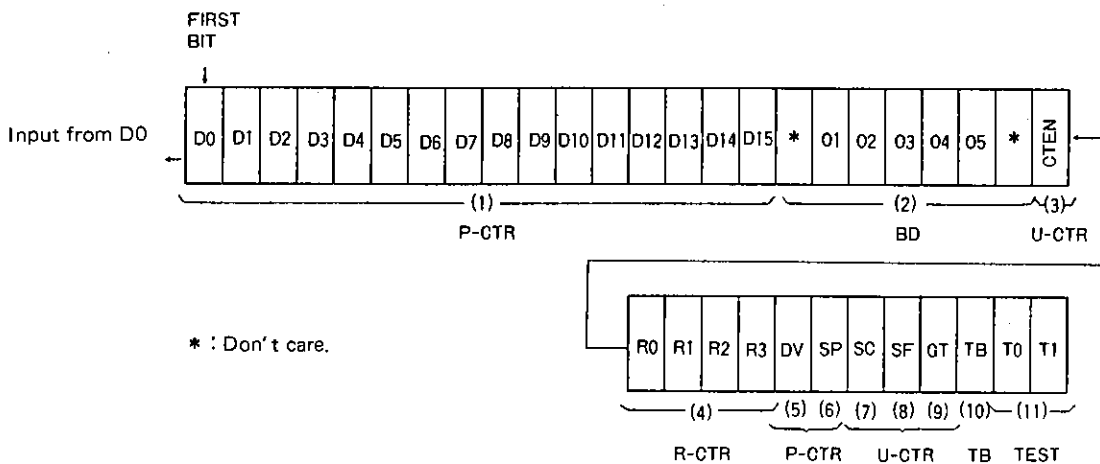
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Symbol	Pin No.	Description	Function	Input/output
LCTR	13	Universal counter frequency/period measuring signal input pin	<ul style="list-style-type: none"> <li>LCTR is selected by specifying serial data input: SC=0.</li> <li>If serial data input : SF=1 is set,                             <ul style="list-style-type: none"> <li>Frequency measurement mode is selected.</li> <li>Input frequency range is between 15 and 500kHz (870mVrms min).</li> <li>Signals are not sent to the internal 1/8 divider, but are directly transmitted to the universal counter.</li> <li>Same measuring time options as for HCTR are provided.</li> </ul> </li> <li>If serial data input: SF=0 is set,                             <ul style="list-style-type: none"> <li>Period measurement mode is selected.</li> <li>Input frequency range is between 1Hz and 20kHz. (<math>V_{IH} = 0.7V_{DD}</math> min, <math>V_{IL} = 0.3V_{DD}</math> max)</li> <li>Either a 1- or 2-cycle measuring period can be selected. When a 2-cycle period is selected, the input frequency range is between 2 Hz and 20kHz. (<math>GT = 1/0</math>; 2/1 cycle)</li> </ul> </li> <li>Result is output as in HCTR.</li> </ul>	Input

\* High and low level input voltage to CE, CL, DI, IN0 and IN1 are held to the following range, respectively, regardless of the supply voltage ( $V_{DD}$ ):  
 $V_{IH} = 2.2$  to  $6.5V$ ,  $V_{IL} = 0$  to  $0.7V$

Structure of Control Data (Serial Data Input)



## LC7216M

The control serial data of LC7216M consists of 36 bits. When power is turned on, data should be entered on every one of these bits for initialization. However, the last two bits are not related to the user, because data on these bits is used for switching the test mode.

After initialization, only the contents of D0 through CTEN (the first 24 bits) can be changed without affecting the rest of the bits (the last 12 bits) using the serial data input mode. Data is input at the DI pin.

Symbol	Control section/data	Description	Related data																				
(1)	Programmable divider data  D0 to D15	<ul style="list-style-type: none"> <li>Used to determine number of frequency divisions of the programmable divider. Data is in binary notation and D15 is the MSB. The LSB depends on the DV and SP settings (see table below)</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>DV</th> <th>SP</th> <th>LSB</th> <th>No. of divisions</th> <th>Actual No. of divisions</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">*</td> <td style="text-align: center;">D0</td> <td style="text-align: center;">256 to 65535</td> <td style="text-align: center;">Twice the set value</td> </tr> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">D0</td> <td style="text-align: center;">256 to 65535</td> <td style="text-align: center;">Set value</td> </tr> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">D4</td> <td style="text-align: center;">4 to 4095</td> <td style="text-align: center;">Set value</td> </tr> </tbody> </table> <p style="margin-left: 40px;">* : Don't care. If the LSB is D4, the data in D0 to D3 is of no value.</p>	DV	SP	LSB	No. of divisions	Actual No. of divisions	1	*	D0	256 to 65535	Twice the set value	0	1	D0	256 to 65535	Set value	0	0	D4	4 to 4095	Set value	DV  SP
DV	SP	LSB	No. of divisions	Actual No. of divisions																			
1	*	D0	256 to 65535	Twice the set value																			
0	1	D0	256 to 65535	Set value																			
0	0	D4	4 to 4095	Set value																			
(2)	Output port data  O1 to O5	<ul style="list-style-type: none"> <li>Used to determine output from output ports <u>OUT1</u> to <u>OUT5</u>. <u>O1</u> determines output from <u>OUT1</u>. When <u>O1</u>=1, <u>OUT1</u> is set low; and when <u>O1</u>=0, <u>OUT1</u> is set high. the same applies to O2 to O5.</li> <li>Can be used to switch bands and for various other operations.</li> </ul>																					
(3)	Universal counter starting data  CTEN	<ul style="list-style-type: none"> <li>Used to operate the universal counter. When CTEN=0, the universal counter, or 20-bit binary counter is reset, and both HCTR and LCTR are put into the pull-down (GND) state. When CTEN=1, the universal counter is released from reset, and counts signals input to HCTR or LCTR (which one is specified by the universal counter select data SC setting.).</li> <li>Universal counter is reset when CTEN=0, note that count data should be transferred to the controller while CTEN=1.</li> </ul>	SC SF GT																				

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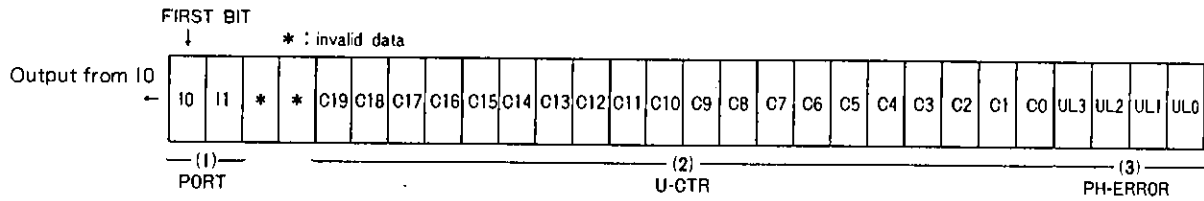
Symbol	Control section/data	Description	Related data																																																																																		
(4)	Reference frequency data R0 to R3	<ul style="list-style-type: none"> <li>Used to select a reference frequency from among 10 options, and inhibit PLL operation of LC7216M, i.e., put it into backup mode.</li> </ul> <p style="text-align: right;">(unit: kHz)</p> <table border="1"> <thead> <tr> <th>R0</th> <th>R1</th> <th>R2</th> <th>R3</th> <th>Reference frequency</th> </tr> </thead> <tbody> <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 rowspan="4" style="text-align: center;">* PLL INHIBIT</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td></tr> </tbody> </table> <p>* PLL INHIBIT (Backup mode) Programmable divider stops, and both FMIN and AMIN are set to pull-down state (GND), charge pump output is floated.</p>	R0	R1	R2	R3	Reference frequency	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	* PLL INHIBIT	1	1	0	1	1	1	1	0	1	1	1	1	
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(5)  (6)	Divider select data DV  Sensitivity select data SP	<ul style="list-style-type: none"> <li>DV is used to select the input pin (either FMIN or AMIN) of local oscillation signal.</li> <li>SP is used to switch the input frequency range for AMIN selection.</li> </ul> <table border="1"> <thead> <tr> <th>DV</th> <th>SP</th> <th>Input pin</th> <th>Input frequency range</th> </tr> </thead> <tbody> <tr><td>1</td><td>*</td><td>FMIN</td><td>10 to 130MHz</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> </tbody> </table> <p>* Don't care.</p>	DV	SP	Input pin	Input frequency range	1	*	FMIN	10 to 130MHz	0	1	AMIN	2 to 40MHz	0	0	AMIN	0.5 to 10MHz																																																																			
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Continued from preceding page.

Symbol	Control section/data	Description	Related data															
(7)	Universal counter input pin select data SC	<ul style="list-style-type: none"> <li>• SC is used to select the input pin (either HCTR or LCTR) of the universal counter.</li> <li>• SF is used to switch frequency/period measurement for LCTR selection. SF is invalid when HCTR is selected, in which case frequency measurement is automatically selected.</li> </ul>	CTEN GT															
(8)	Universal counter frequency/period switch data SF	<table border="1"> <thead> <tr> <th>DV</th> <th>SP</th> <th>Input pin</th> <th>Input frequency range</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>*</td> <td>HCTR</td> <td>Frequency (sine wave)</td> </tr> <tr> <td>0</td> <td>1</td> <td>LCTR</td> <td>Frequency (sine wave)</td> </tr> <tr> <td>0</td> <td>0</td> <td>LCTR</td> <td>Period (pulse)</td> </tr> </tbody> </table> <p>* Don't care.</p>		DV	SP	Input pin	Input frequency range	1	*	HCTR	Frequency (sine wave)	0	1	LCTR	Frequency (sine wave)	0	0	LCTR
DV	SP	Input pin	Input frequency range															
1	*	HCTR	Frequency (sine wave)															
0	1	LCTR	Frequency (sine wave)															
0	0	LCTR	Period (pulse)															
(9)	Universal counter count time select data GT	<ul style="list-style-type: none"> <li>• GT is used to select the measuring time for frequency measurement, or the number of cycles for period measurement.</li> </ul> <p>GT = 1; 120 ms/2 cycles GT = 0; 60 ms/1 cycle (Frequency measurement/period measurement)</p>	CTEN SC SF															
(10)	Time base output data TB	TB=0																
(11)	LSI test data T0, T1	<ul style="list-style-type: none"> <li>• T0 and T1 are used to switch LSI test modes, not user-related data.</li> </ul> <p>Set T0 and T1 to 0 normally. Do not forget to enter 0 for T0 and T1 at power-on.</p>																

Structure of DO Output (Serial Data Output)



LC7216M has 28-bit shift registers which can output to the DO pin the contents of input ports IN0 and IN1, and a universal counter (20-bit binary counter). The contents of each shift register are determined (latched) when the serial data output mode is selected.

No.	Data	Description
(1)	Input port data I <sub>0</sub> , I <sub>1</sub>	<ul style="list-style-type: none"> <li>Latched contents of input ports IN0 and IN1 are placed in I<sub>0</sub> and I<sub>1</sub>, respectively.</li> </ul>
(2)	Universal counter binary data C <sub>19</sub> to C <sub>0</sub>	<ul style="list-style-type: none"> <li>Latched contents of universal counter (20-bit binary counter) are placed in C<sub>19</sub> to C<sub>0</sub>.</li> <li>C<sub>19</sub> ←MSB or 20-bit binary counter.</li> <li>C<sub>0</sub> ←LSB of 20-bit binary counter.</li> </ul>
(3)	PLL unlock data UL3 to UL0	<ul style="list-style-type: none"> <li>Latched contents of unlocked detector are placed in UL3 to UL0.</li> <li>When phase difference more than shown below occurs, each of UL3 to UL0 is set to "1".</li> <li>UL0 : 1.11μsec.</li> <li>UL1 : 2.22μsec.</li> <li>UL2 : 3.33μsec.</li> <li>UL3 : 0.55μsec.</li> <li>(Crystal : 7.2MHz)</li> </ul>

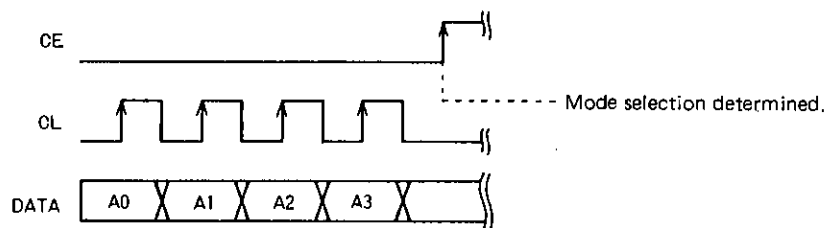
## LC7216M

### Input/Output of Serial Data

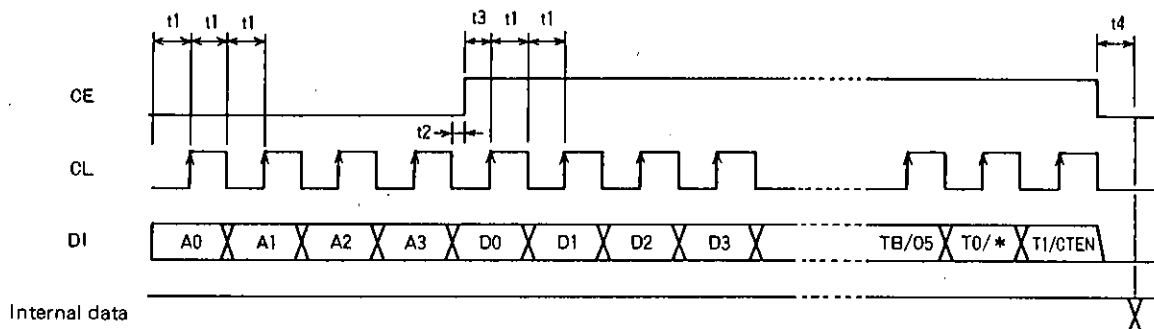
The LC7216M provides two input modes for control data (serial data input) and one output mode for DO output (serial data output). Data is input or output when one of these modes is selected.

The mode is set by the four bits  $A_3$  to  $A_0$  (from the DI pin) sent immediately before the CE pin is set high, then synchronized with the clock (CL), and selected when CE is set high.

Mode	$A_3$	$A_2$	$A_1$	$A_0$	Input/output	Description
1	0	0	0	1	Serial data (all bits) input	<ul style="list-style-type: none"> <li>All bits (36 bits) of control data (serial data) are input in this mode.</li> <li>It is used during initialization following power ON sequence, or when data that cannot be changed in mode 2 is to be changed.</li> <li>All 36 bits are input from the DI pin of LC7216M.</li> </ul>
2	0	0	1	0	Serial data (part of bits) input	<ul style="list-style-type: none"> <li>A part (24 bits) of control data (serial data) is input in this mode.</li> <li>It is used to change the 24 bits comprising (1) the programmable divider data (<math>D_0</math> to <math>D_{15}</math>), (2) the output port data (<math>O_1</math> to <math>O_5</math>), and (3) the universal counter starting data (CTEN). Data in the other 12 bits does not change at this time. (If this part of data is to be changed, select mode 1.)</li> </ul>
3	0	0	1	1	Serial data output	<ul style="list-style-type: none"> <li>This mode is used to output (1) input port data, and (2) universal counter binary data from DO.</li> </ul>
	0 to 0	1 to 0	0 to 0	0 to 0	Invalid setting	Serial data is neither input nor output.

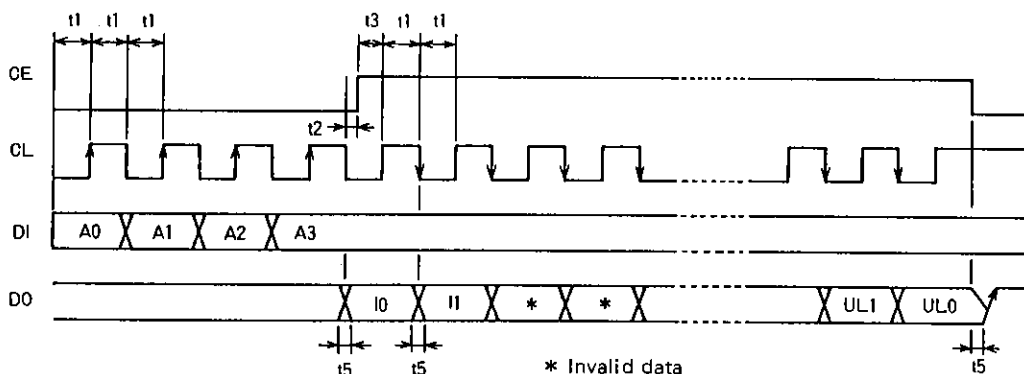


i) Input of serial data (mode 1, mode 2)  $t_1 \geq 1.5\mu s$  .  $t_2 \geq 0\mu s$  .  $t_3 \geq 1.5\mu s$  .  $t_4 < 1.5\mu s$  .



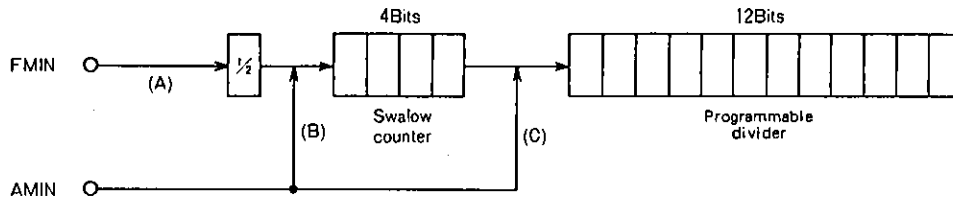
- 1) In mode 1: A total of 40 bits consisting of mode select data (4 bits) and control data (36 bits) are synchronized with the clock (CL) and input from the DI pin (data from D<sub>6</sub> to T<sub>1</sub>).
- 2) In mode 2: A total of 28 bits consisting of mode select data (4 bits) and control data (24 bits) are synchronized with the clock and input from the DI pin (data from D<sub>6</sub> to CTEN).

ii) Output of serial data (mode 3)  $t_1 \geq 1.5\mu s$  .  $t_2 \geq 0\mu s$  .  $t_3 \geq 1.5\mu s$  .  $t_5 < 1.5\mu s$  .  
 (DO is the N-ch open drain terminal and the change time depends on the pull-up resistance value.)



- 3) In mode 3: The serial data output mode (mode 3) is selected by specifying the mode select data (4 bits). Setting CE high allows I<sub>0</sub> to be output to DO. Once CE is put high data is output to the DO pin when the internal shift register contents shift as CL falls. (To output data up to UL<sub>0</sub>, 27 clocks are required after CE is set high.) When this mode is selected, DO is forcibly set high as CE goes low, and set low when the IN0 pin changes, or after the measurement using the universal counter is finished (the completion of measurement has priority over the change of IN0 level).

Structure of Programmable Divider



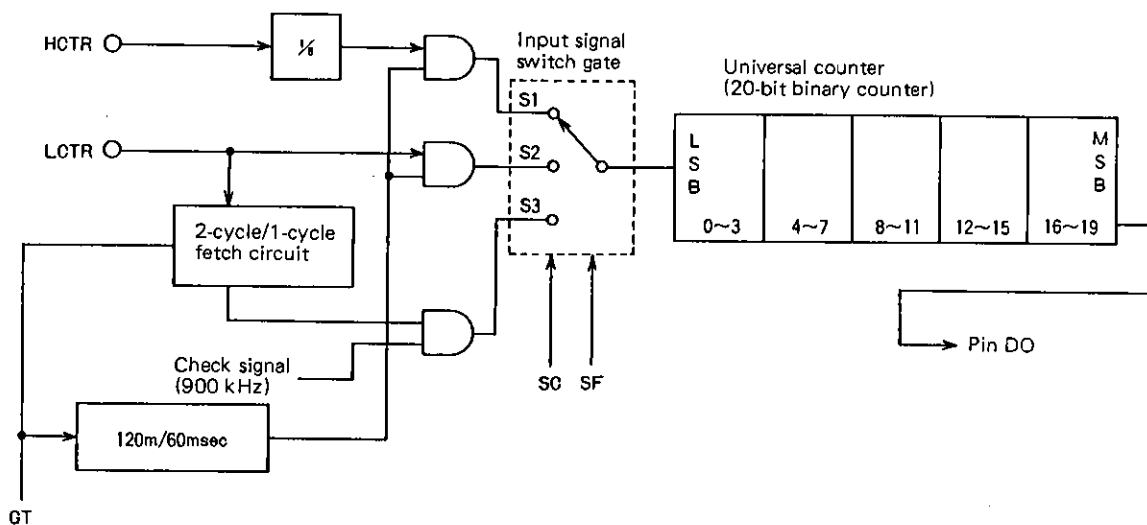
	DV	SP	Input pin	No. of divisions	Actual No. of divisions	Input frequency range
(A)	1	*	FMIN	256 to 65535	Twice the set value	10 to 130MHz
(B)	0	1	AMIN	256 to 65535	Set value	2 to 40MHz
(C)	0	0	AMIN	4 to 4095	Set value	0.5 to 10MHz

Notes:

- 1) When FMIN (A) is selected, the actual number of frequency divisions is twice the set number of divisions. For example, if the set number of divisions=1000, the actual number of divisions=2000. If set number of divisions=1001, the actual number of divisions=2002. In other words, the reference frequency multiplied by 2 is used for the channel step.
- 2) To set the channel step to 9, 5, or 1kHz during FMIN (A), the crystal OSC should be changed to 3.6MHz. Remember that the times listed in the following table also refer to the crystal OSC, and therefore, change as the crystal OSC changes. When 3.6MHz is used for the crystal OSC, care should be taken for overtone oscillation.

Parameter	X'tal	
	7.2MHz	3.6MHz
Frequency measuring time	120/60ms	240/120ms
Frequency measuring check signal	900kHz	450kHz
Reference frequency	100, 50, 25, ... 10, 9, 5, 1kHz	50, 25, 12.5, ... 5, 4.5, 2.5, 0.5kHz
Serial data input/output (CL)	t1 ≥ 1.5µs t3 ≥ 1.5µs	t1 ≥ 3.0µs t3 ≥ 3.0µs

Structure of Universal Counter



	SC	SF	Input pin	Measurement	Frequency range	GT (1/0)
S1	1	*	HCTR	Frequency	10 to 60MHz (sine wave)	120ms / 60ms
S2	0	1	LCTR	Frequency	15 to 500kHz (sine wave)	120ms / 60ms
S3	0	0	LCTR	Period	1Hz to 20kHz (pulse)	2-cycle/1-cycle

The universal counter of LC7216M consists of a 20-bit binary counter. The count value can be read from the MSB via pin DO.

When the universal counter is used to measure the frequency, the measuring time can be selected from between 120ms and 60ms by setting the GT value. The frequency of the signals input to the HCTR or LCTR pin is determined by the pulse count on the universal counter within the selected measuring time.

When the universal counter is used to measure the period, the period of signals input to the LCTR pin is determined by the check signal (900kHz) count on the universal counter within the selected cycle (2- or 1-cycle) of signals input to LCTR.

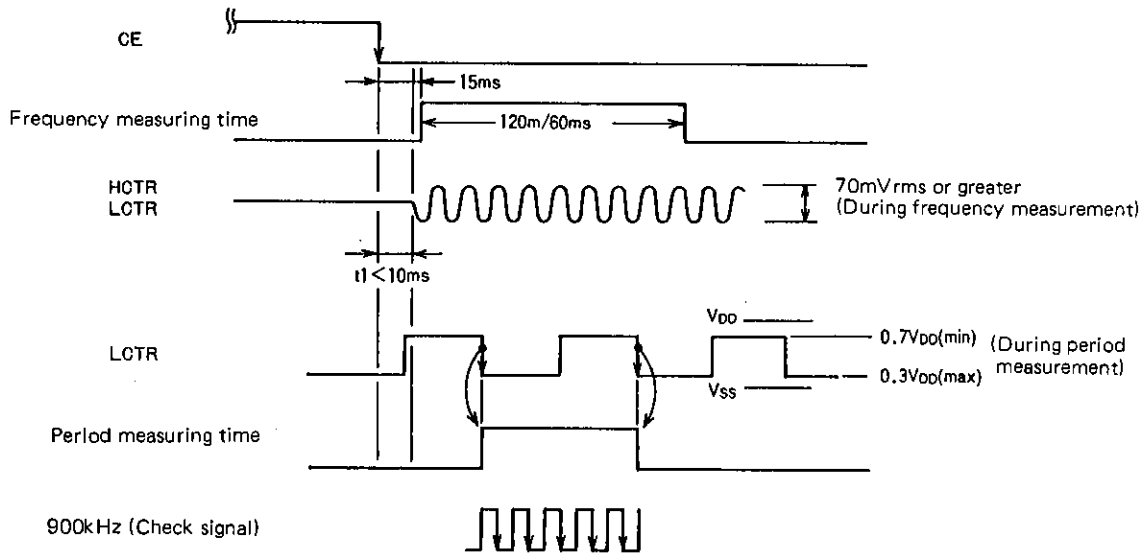
The universal counter starts counting when serial data CTEN is set to 1. Serial data is determined inside the LC7216M by dropping CE from high to low. However, signal must be input to the HCTR or LCTR pin within 10ms after CE goes low.

Upon completion of measurement, the result on the universal counter must be read out while CTEN=1 (when CTEN=0, the universal counter is reset).

It should be noted that the universal counter should be reset by setting CTEN to 0 before counting is started.

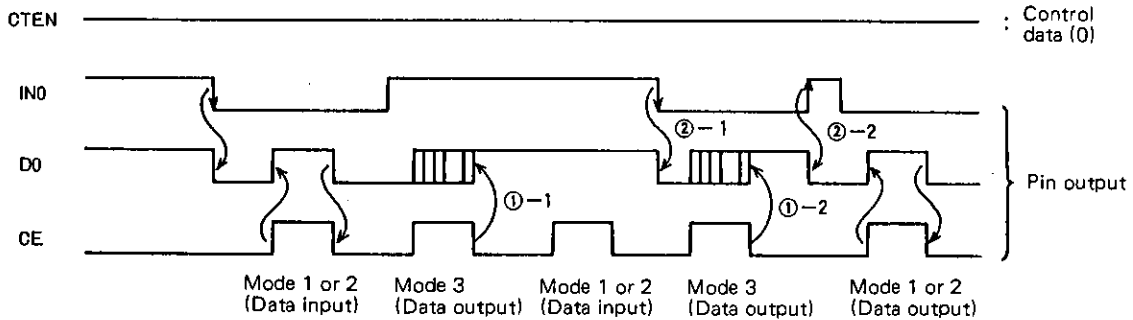
The signal input to the LCTR pin are sent directly to the universal counter while those input to the HCTR pin are 1/8 divided before being sent to the universal counter. The result on the universal counter is, therefore, 1/8 value of the actual frequency input to HCTR.

When the universal counter is used as the IF counter, the state of the IF-IC SD (station detect) signal must be checked by the microcontroller and the IF counter buffer output turned on only after the SD signals are activated. Auto-search techniques using only the IF counter are not advisable since it is possible that the search can stop incorrectly at a location that does not have a station due to IF counter buffer leakage output.



The DO pin is forcibly set high when the universal counter starts counting (CTEN=1), and automatically goes low after the measurement is finished (i.e., after 120 or 60msec, or a signal input in 1- or 2-cycle). DO can, therefore, be used to check the measured value.

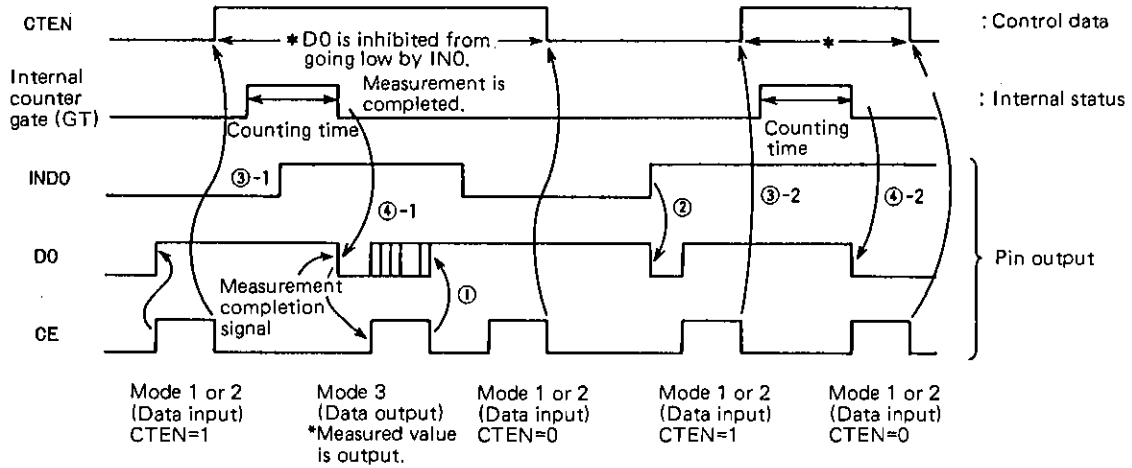
i) Universal counter is not used (CTEN=0) DO: Changes in external signals can be checked.



- 1) Select mode 3 to output data from DO. DO automatically goes high after outputting data (CE Low).
- 2) When IN0 changes, DO automatically goes low.  
(i.e., changes in external signals input to IN0 can be checked).

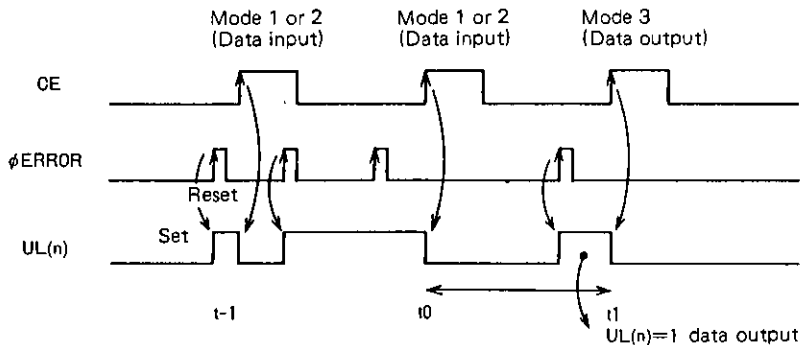


ii) Universal counter is used DO: Completion of counting by universal counter can be checked.



- 3) While CTEN=1, DO is inhibited from going low by IN0, and is automatically set high.
- 4) When the measurement with the universal counter is finished, DO automatically goes low (i.e., the completion of measurement can be checked).

PLL Unlock Detector



Internal data UL(n) is set/reset on the positive transition of phi ERROR signal/CE signal, respectively. In mode 3 (data output), phi ERROR data UL(n) after the previous positive transition of CE signal is read. In the example shown above, data for the period of t<sub>0</sub> to t<sub>1</sub> is read.

		UL(n)
		3210
	phi ERROR < 0.55µs	0000
0.55µs ≤ phi ERROR < 1.11µs	→	1000
1.11µs ≤ phi ERROR < 2.22µs	→	1001
2.22µs ≤ phi ERROR < 3.33µs	→	1011
3.33µs ≤ phi ERROR	→	1111

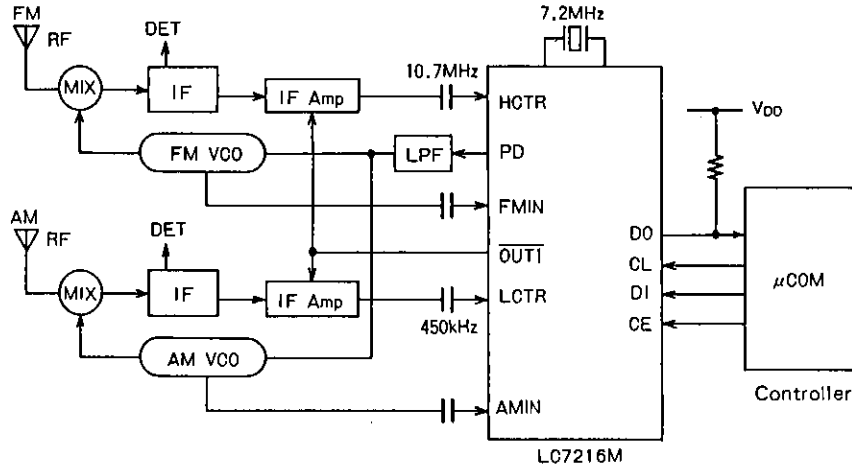
When phi ERROR mode than shown below occurs, each of UL3 to UL0 is set to "1".

- UL0: 1.11µs
- UL1: 2.22µs
- UL2: 3.33µs
- UL3: 0.55µs
- phi ERROR: Phase difference (Crystal 7.2MHz)

## LC7216M

### Sample Application System

- FM/AM (IF counting is carried out.)



Note 1) The capacitance of the coupling capacitors for the FMIN, AMIN, HCTR and LCTR pins should be set between 50 and 100pF (it may be 1000 pF if LCTR is selected at 100kHz or less).

Note 2) Place the coupling capacitor near the pin.

Note 3) The IF signals measurement should be done after the IF-IC SD (station detect) signals are activated.

1) FM: For 100kHz step

When FM RF = 90MHz (IF = +10.7MHz),

FM VCO = 100.7MHz

Select PLL fref = 50kHz

DV = 1 } (FMIN)  
SP = \* }

Set N = 1007

When N is the number of frequency divisions on the programmable divider (decimal).

2) AM: For 10kHz step

When AM RF = 1000kHz (IF = +450kHz),

AM VCO = 1450kHz

Select PLL fref = 10kHz

DV = 0 } (AMIN: Low speed)  
SP = 0 }

Set N = 145

Where N is the number of frequency divisions on the programmable divider (decimal).

\* : Don't care