

SANYO

No. 3355A

LC7216M

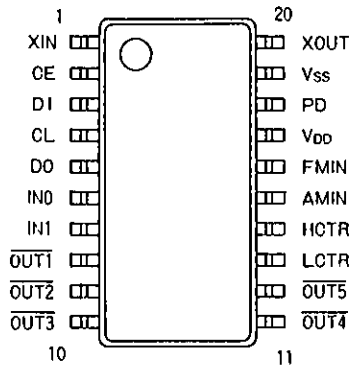
PLL Frequency Synthesizer for
Electronic Tuning

Features

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

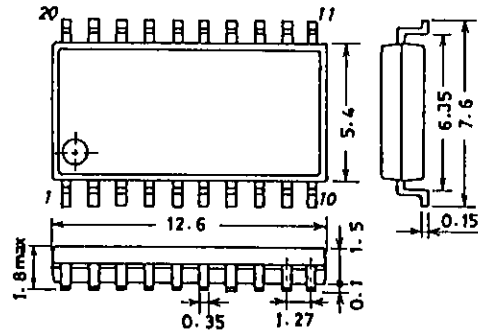
- (1) Programmable divider
 - FMIN pin: 130MHz: 70mVrms/160MHz: 110mVrms input (Prescaler built-in)
 - AMIN pin: Pulse swallow and direct frequency-divide method.
- (2) Reference frequency: 10 user selectable reference frequencies.
100, 50, 25, 12.5, 6.25, 3.125, 10, 9, 5, and 1kHz
- (3) Output port: 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

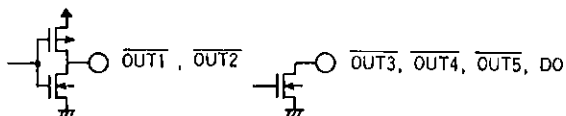
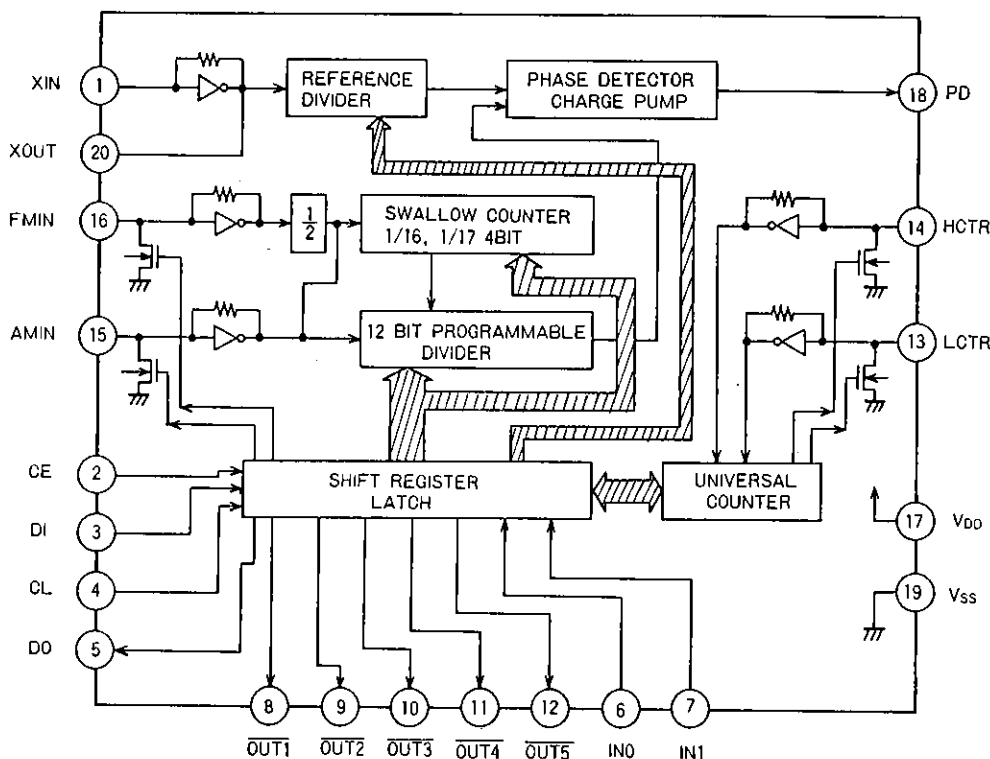
(unit: mm)



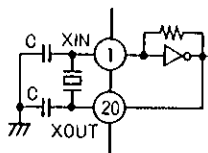
SANYO: MFP20

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

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

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

Note 6) f_{IN}(4) 10 to 70MHz/V_{IN}(4)
0.11Vrms (min)

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Electrical Characteristics under allowable operating conditions

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

Note) Use a capacitor of 2000pF or more between power supplies V_{DD} and V_{SS}.

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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"> • FMIN is selected by specifying serial data input: DV=1 • Frequency between 10 and 130MHz is input (70mVrms min). • Signals are set to the swallow counter via built-in prescaler (1/2). • From 256 to 65536 frequency divisions are selected but this value can be doubled with built-in prescaler (1/2). | Input |
| AMIN | 15 | Local oscillation signal input | <ul style="list-style-type: none"> • AMIN is selected by specifying serial data input: DV=0. • When serial data input: SP=1 is specified. <ul style="list-style-type: none"> – Input frequency is between 2 and 40 MHz (70mVrms min). – Signals are not sent to built-in prescaler (1/2), but are directly transferred to swallow counter. – From 256 to 65536 frequency divisions are selected and used as is. • When serial data input: SP=0 is specified, <ul style="list-style-type: none"> – Input frequency is between 0.5 and 10MHz (70mVrms min). – Signals are directly transferred to a 12-bit programmable divider. – From 4 to 4095 frequency divisions are selected and used as is. | 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"> • Power is supplied to LC7216M via this pin. During PLL operation, 4.5 to 6.5V is applied. 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. | — |

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| Symbol | Pin No. | Description | Function | Input/output |
|---|--------------------------|--|---|----------------------------------|
| VSS | 19 | Ground | <ul style="list-style-type: none"> This pin is tied to the ground of LC7216M. | — |
| CE | 2 | Chip enable | <ul style="list-style-type: none"> High level signals are input during serial data input (DI) or output (DO). | Input * |
| CL | 4 | Clock | <ul style="list-style-type: none"> Data is synchronized by this clock signal during serial data input (DI) or output (DO). | Input * |
| DI | 3 | Input data | <ul style="list-style-type: none"> Serial data transferred from controller to LC7216M is input to this pin. A total of 36 bits of data should be input for initialization. | Input * |
| DO | 5 | Output data | <ul style="list-style-type: none"> Serial data transferred from the controller to LC7216M output from this pin. By synchronizing it with CL, 28 bits of the contents of the internal shift register can be output. | 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"> Bits 0₁ to 0₅ of serial data, transferred from the controller, are latched, and the data is inverted and output in parallel. <u>OUT1</u> and <u>OUT2</u> are complementary outputs. <u>OUT3</u>, <u>OUT4</u>, and <u>OUT5</u> are N-ch open drain outputs (voltage durability: 13V). | Output |
| IN0 IN1 | 6 7 | Input port | <ul style="list-style-type: none"> Contents of input ports IN0 and IN1 are converted from parallel to serial form and are output from output pin DO. | Input * |
| HCTR | 14 | Universal counter frequency measuring signal input pin | <ul style="list-style-type: none"> HCTR is selected by specifying serial data input: SC=1. Input frequency is between 10 and 60 MHz (70mVrms min). Since signals are sent to a universal counter (20-bit binary counter) via a 1/8 of the actual frequency input to HCTR. 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) Result can be output from MSB of the universal counter via output pin DO. | Input |

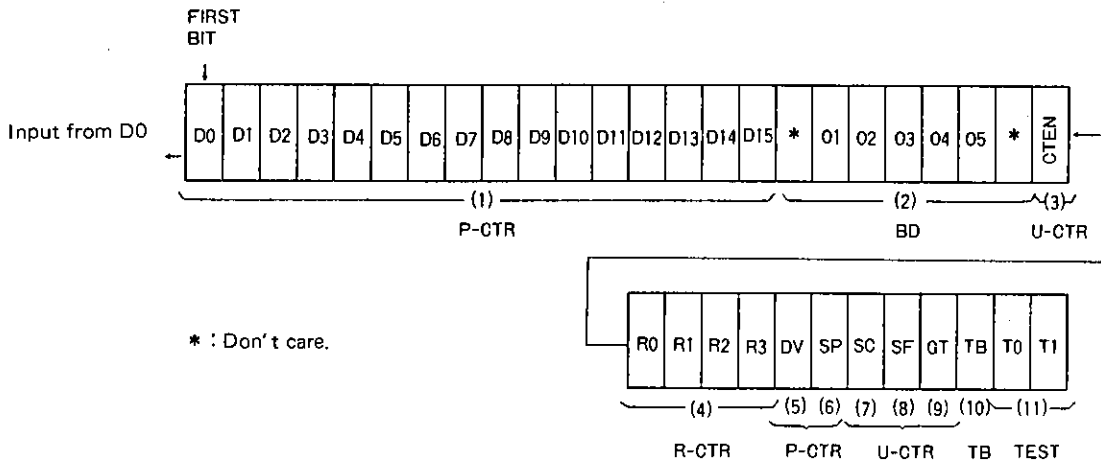
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| Symbol | Pin No. | Description | Function | Input/output |
|--------|---------|---|--|--------------|
| LCTR | 13 | Universal counter frequency/period measuring signal input pin | <ul style="list-style-type: none"> LCTR is selected by specifying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



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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) | <p>Programmable divider data</p> <p>D0 to D15</p> | <ul style="list-style-type: none"> 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) <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>1</td> <td>*</td> <td>D0</td> <td>256 to 65535</td> <td>Twice the set value</td> </tr> <tr> <td>0</td> <td>1</td> <td>D0</td> <td>256 to 65535</td> <td>Set value</td> </tr> <tr> <td>0</td> <td>0</td> <td>D4</td> <td>4 to 4095</td> <td>Set value</td> </tr> </tbody> </table> <p>* : 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 | <p>DV</p> <p>SP</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 | | | | | | | | | | | | | | | | | | | |
| (2) | <p>Output port data</p> <p>O1 to O5</p> | <ul style="list-style-type: none"> 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. Can be used to switch bands and for various other operations. | | | | | | | | | | | | | | | | | | | | | |
| (3) | <p>Universal counter starting data</p> <p>CTEN</p> | <ul style="list-style-type: none"> 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.). Universal counter is reset when CTEN=0, note that count data should be transferred to the controller while CTEN=1. | <p>SC</p> <p>SF</p> <p>GT</p> | | | | | | | | | | | | | | | | | | | | |

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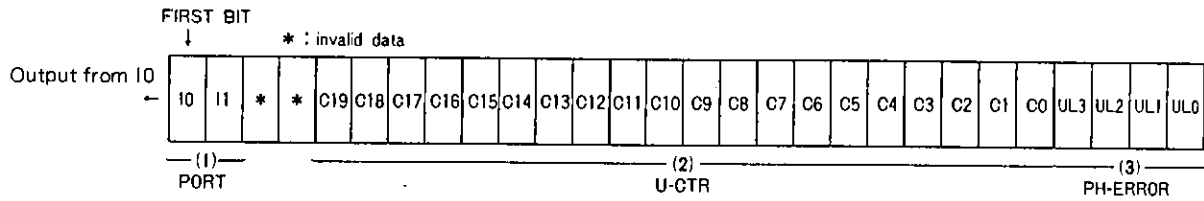
| Symbol | Control section/data | Description | Related data | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------|--|---|-----------------------|---------------------|-----------|-----------------------|---------------------|---|------|--------------|---|-----|------|------------|---|---|------|--------------|---|---|---|----|---|---|---|---|----|---|---|---|---|------|---|---|---|---|------|---|---|---|---|-------|---|---|---|---|-------|---|---|---|---|----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---------------|---|---|---|---|---|---|---|---|---|---|---|---|--|
| (4) | Reference frequency data R0 to R3 | <ul style="list-style-type: none"> Used to select a reference frequency from among 10 options, and inhibit PLL operation of LC7216M, i.e., put it into backup mode. <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">* 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 | |
| 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (5) (6) | Divider select data DV Sensitivity select data SP | <ul style="list-style-type: none"> DV is used to select the input pin (either FMIN or AMIN) of local oscillation signal. SP is used to switch the input frequency range for AMIN selection. <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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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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| Symbol | Control section/data | Description | Related data | | | | | | | | | | | | | | | |
|--------|--|--|-----------------------|----|----|-----------|-----------------------|---|---|------|-----------------------|---|---|------|-----------------------|---|---|------|
| (7) | Universal counter input pin select data SC | <ul style="list-style-type: none"> • SC is used to select the input pin (either HCTR or LCTR) of the universal counter. • 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. | 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"> • GT is used to select the measuring time for frequency measurement, or the number of cycles for period measurement. <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"> • T0 and T1 are used to switch LSI test modes, not user-related data. <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 ₀ , I ₁ | <ul style="list-style-type: none"> Latched contents of input ports IN0 and IN1 are placed in I₀ and I₁, respectively. |
| (2) | Universal counter binary data C ₁₉ to C ₀ | <ul style="list-style-type: none"> Latched contents of universal counter (20-bit binary counter) are placed in C₁₉ to C₀. C₁₉ ←MSB or 20-bit binary counter. C₀ ←LSB of 20-bit binary counter. |
| (3) | PLL unlock data UL3 to UL0 | <ul style="list-style-type: none"> Latched contents of unlocked detector are placed in UL3 to UL0. When phase difference more than shown below occurs, each of UL3 to UL0 is set to "1". UL0 : 1.11μsec. UL1 : 2.22μsec. UL2 : 3.33μsec. UL3 : 0.55μsec. (Crystal : 7.2MHz) |

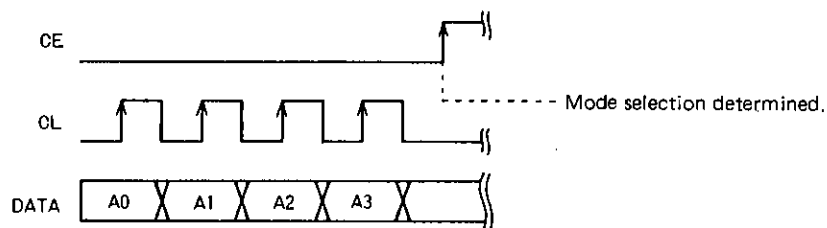
LC7216M

Input/Output of Serial Data

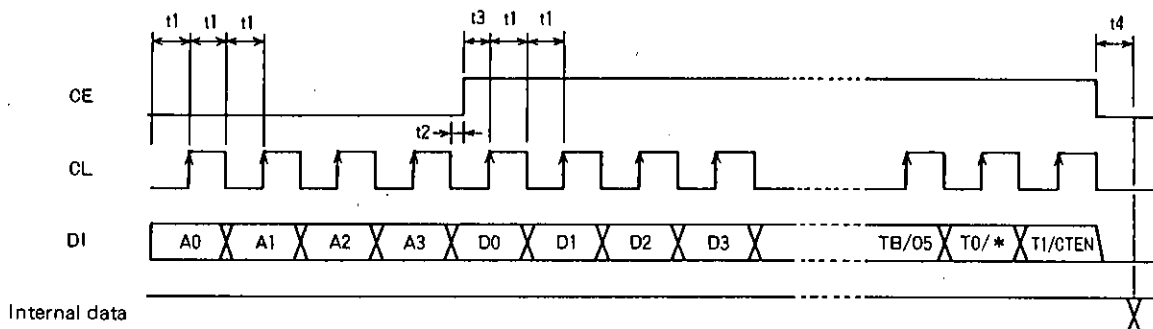
The LC7216M provides two input modes for control data (serial data input) and one output mode for DO output (serial data output). Data is input or output when one of these modes is selected.

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"> All bits (36 bits) of control data (serial data) are input in this mode. It is used during initialization following power ON sequence, or when data that cannot be changed in mode 2 is to be changed. All 36 bits are input from the DI pin of LC7216M. |
| 2 | 0 | 0 | 1 | 0 | Serial data (part of bits) input | <ul style="list-style-type: none"> A part (24 bits) of control data (serial data) is input in this mode. It is used to change the 24 bits comprising (1) the programmable divider data (D_0 to D_{15}), (2) the output port data (O_1 to O_5), 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.) |
| 3 | 0 | 0 | 1 | 1 | Serial data output | <ul style="list-style-type: none"> This mode is used to output (1) input port data, and (2) universal counter binary data from DO. |
| | 0 to 0 | 1 to 0 | 0 to 0 | 0 to 0 | Invalid setting | Serial data is neither input nor output. |

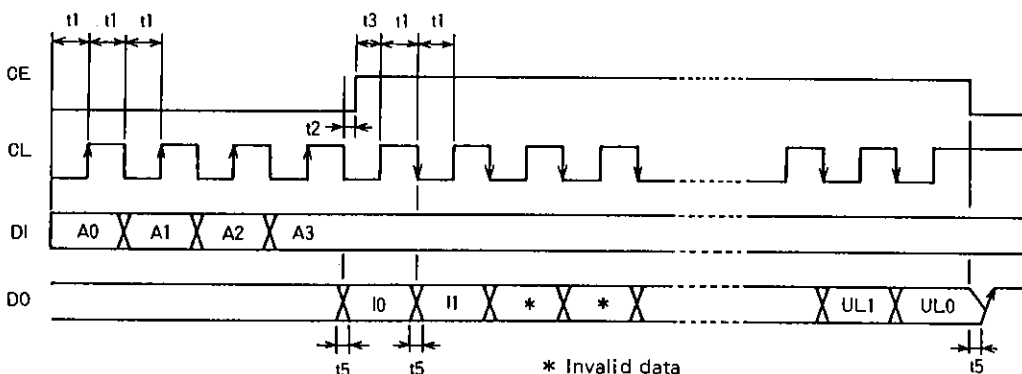


i) Input of serial data (mode 1, mode 2) $t_1 \geq 1.5\mu s$. $t_2 \geq 0\mu s$. $t_3 \geq 1.5\mu s$. $t_4 < 1.5\mu s$.



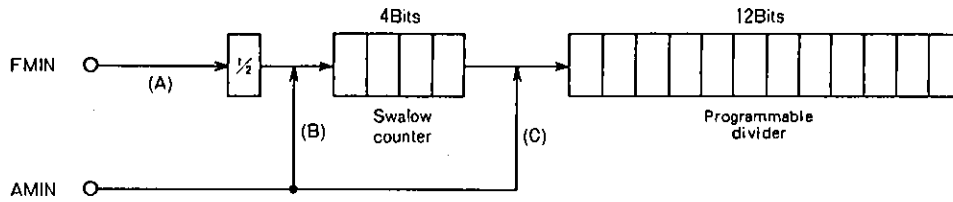
- 1) In mode 1: A total of 40 bits consisting of mode select data (4 bits) and control data (36 bits) are synchronized with the clock (CL) and input from the DI pin (data from D₆ to T₁).
- 2) In mode 2: A total of 28 bits consisting of mode select data (4 bits) and control data (24 bits) are synchronized with the clock and input from the DI pin (data from D₆ 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 I₀ 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 UL₀, 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



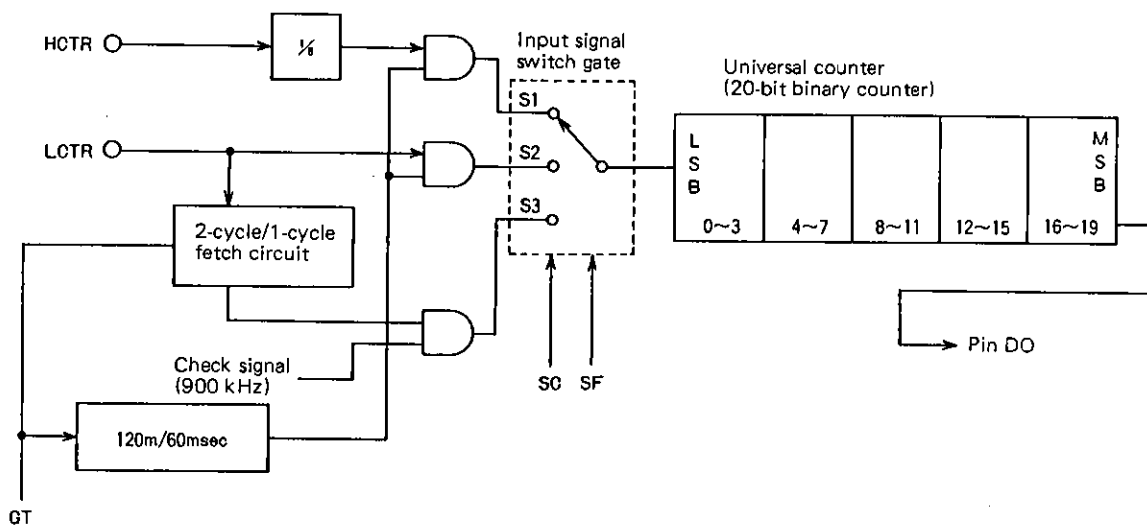
| | DV | SP | Input pin | No. of divisions | Actual No. of divisions | Input frequency range |
|-----|----|----|-----------|------------------|-------------------------|-----------------------|
| (A) | 1 | * | FMIN | 256 to 65535 | Twice the set value | 10 to 130MHz |
| (B) | 0 | 1 | AMIN | 256 to 65535 | 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.

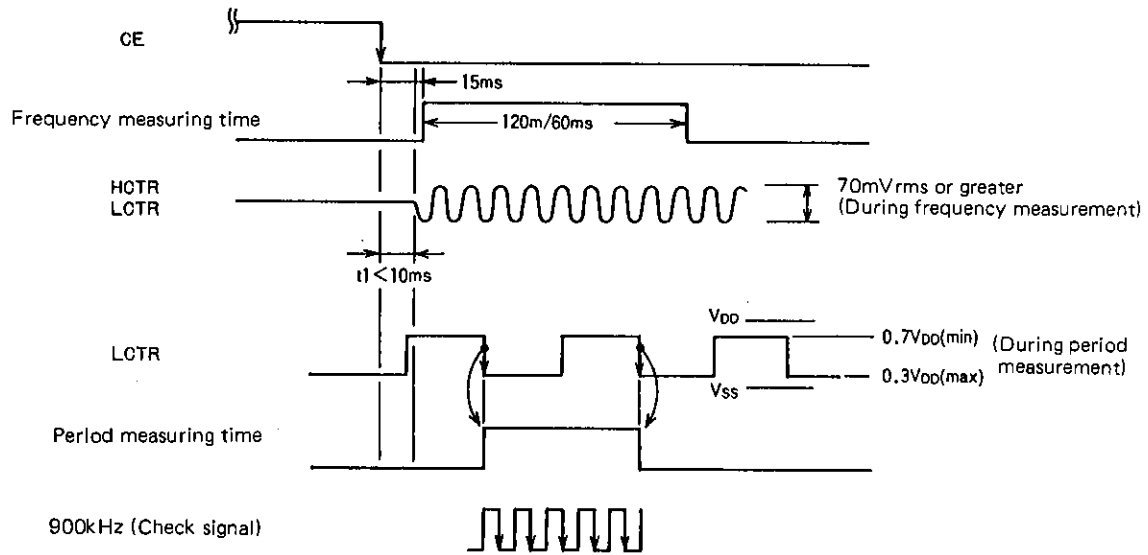
The universal counter starts counting when serial data CTEN is set to 1. Serial data is determined inside the LC7216M by dropping CE from high to low. However, signal must be input to the HCTR or LCTR pin within 10ms after CE goes low.

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.

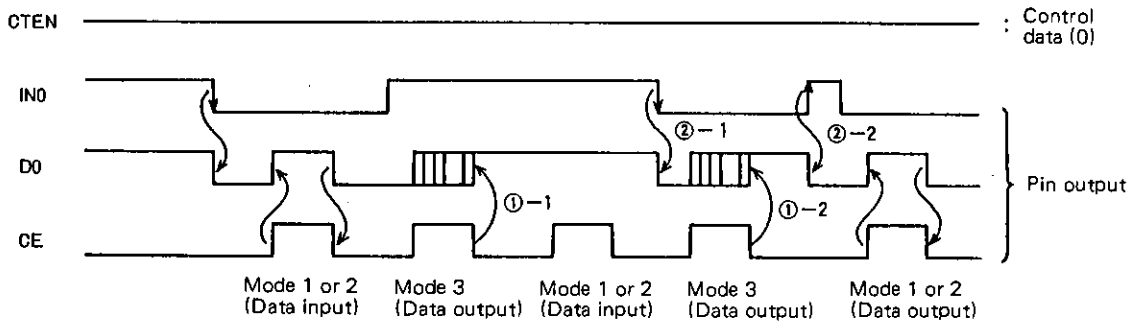
The signal input to the LCTR pin are sent directly to the universal counter while those input to the HCTR pin are 1/8 divided before being sent to the universal counter. The result on the universal counter is, therefore, 1/8 value of the actual frequency input to HCTR.

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.



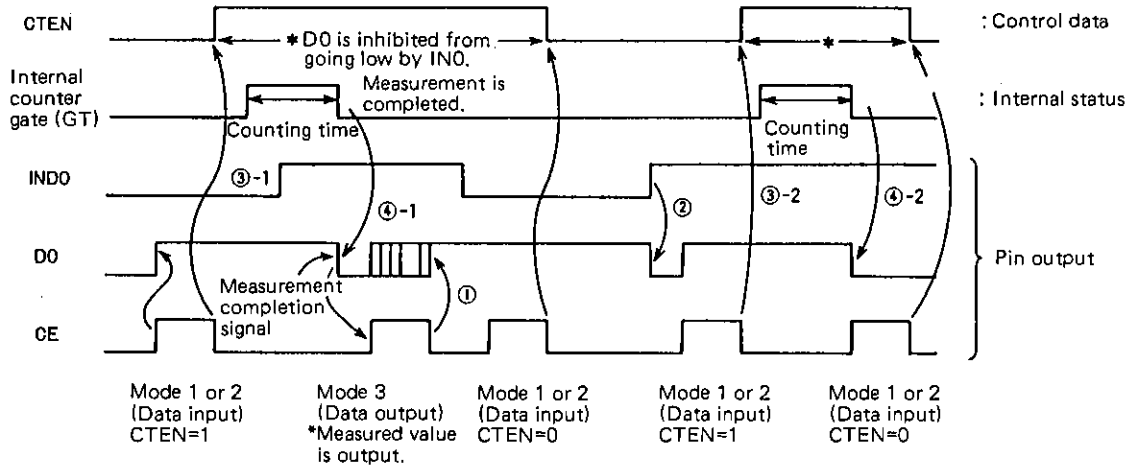
The DO pin is forcibly set high when the universal counter starts counting (CTEN=1), and automatically goes low after the measurement is finished (i.e., after 120 or 60msec, or a signal input in 1- or 2-cycle). DO can, therefore, be used to check the measured value.

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



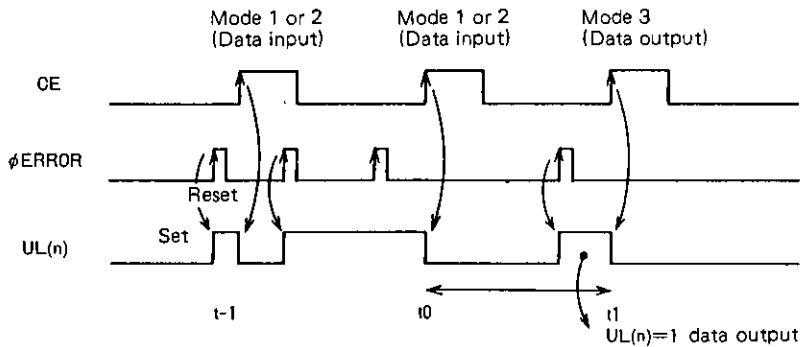
- 1) Select mode 3 to output data from DO. DO automatically goes high after outputting data (CE Low).
- 2) When IN0 changes, DO automatically goes low.
(i.e., changes in external signals input to IN0 can be checked).

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 ϕ ERROR signal/CE signal, respectively. In mode 3 (data output), ϕ 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_0 to t_1 is read.

| | | |
|---------------------|-----------------------------|-------|
| | | UL(n) |
| | | 3210 |
| | ϕ ERROR < 0.55 μ s | 0000 |
| 0.55 μ s \leq | ϕ ERROR < 1.11 μ s | 1000 |
| 1.11 μ s \leq | ϕ ERROR < 2.22 μ s | 1001 |
| 2.22 μ s \leq | ϕ ERROR < 3.33 μ s | 1011 |
| 3.33 μ s \leq | ϕ ERROR | 1111 |

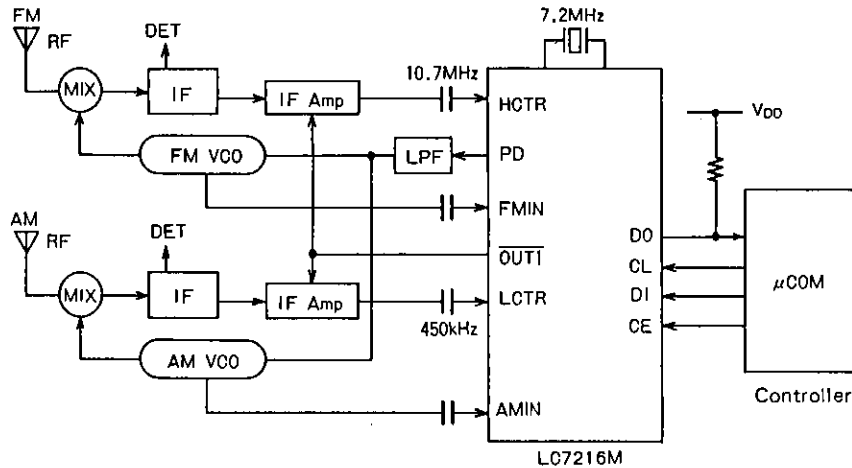
When ϕ ERROR mode than shown below occurs, each of UL3 to UL0 is set to "1".

- UL0: 1.11 μ s
- UL1: 2.22 μ s
- UL2: 3.33 μ s
- UL3: 0.55 μ s
- ϕ 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