

# Model 358P/L

## Advanced PLL LVPECL or LVDS VCXO



Part Dimensions:  
5.0 x 3.2 x 1.3mm • 58.1mg

### Features

- Ceramic Surface Mount Package
- Low Phase Jitter Performance, 500fs Typical
- Advanced PLL Design w/ Low Fundamental Crystal
- Frequency Range 10MHz – 800MHz \*
- +2.5V or +3.3V Operation
- Output Enable Standard
- Tape and Reel Packaging, EIA-418

### Applications

- Broadcast Video
- Storage Area Networking
- Broadband Access
- Phase-Locked Loop
- Networking Equipment
- Ethernet/GbE/SyncE
- Fiber Channel
- Test and Measurement

#### Standard Frequencies

|             |             |             |
|-------------|-------------|-------------|
| - 25.00MHz  | - 122.88MHz | - 200.00MHz |
| - 50.00MHz  | - 125.00MHz | - 250.00MHz |
| - 74.25MHz  | - 148.50MHz | - 300.00MHz |
| - 77.76MHz  | - 155.52MHz | - 312.50MHz |
| - 100.00MHz | - 156.25MHz |             |

\* See Page 11 for additional developed frequencies.  
Check with factory for availability of frequencies not listed.

### Description

CTS Model 358P/L is a low cost, high performance PLL voltage controlled oscillator supporting differential LVPECL or LVDS outputs. Employing the latest IC technology, M358P/L has excellent stability and low phase jitter performance.

### Ordering Information

| Model | Output Type | Frequency Code [MHz] | Absolute Pull Range                 | Frequency Stability | Temperature Range   | Supply Voltage | Packaging |              |
|-------|-------------|----------------------|-------------------------------------|---------------------|---------------------|----------------|-----------|--------------|
| 358   | P           | XXX or XXXX          | B                                   | 3                   | I                   | 3              | T         |              |
|       | Code        | Output               | Code                                | APR                 | Code                | Temp. Range    | Code      | Packing      |
|       | P           | LVPECL               | B                                   | ±50ppm              | C                   | -20°C to +70°C | T         | 1k pcs./reel |
|       | L           | LVDS                 |                                     |                     | I                   | -40°C to +85°C |           |              |
|       |             | Code                 | Frequency                           | Code                | Stability           | Code           | Voltage   |              |
|       |             |                      | Product Frequency Code <sup>1</sup> | 5                   | ±25ppm <sup>2</sup> | 2              | +2.5Vdc   |              |
|       |             |                      |                                     | 4                   | ±30ppm              | 3              | +3.3Vdc   |              |
|       |             |                      |                                     | 3                   | ±50ppm              |                |           |              |

Notes:

- 1] Refer to document 016-1454-0, Frequency Code Tables.  
3-digits for frequencies <100MHz, 4-digits for frequencies 100MHz or greater.
- 2] Check factory availability when paired with "I" temperature code.

**Not all performance combinations and frequencies may be available.  
Contact your local CTS Representative or CTS Customer Service for availability.**

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## Electrical Specifications

### Operating Conditions

| PARAMETER               | SYMBOL    | CONDITIONS                    | MIN   | TYP | MAX   | UNIT |
|-------------------------|-----------|-------------------------------|-------|-----|-------|------|
| Maximum Supply Voltage  | $V_{CC}$  | -                             | -0.5  | -   | 4.0   | V    |
| Maximum Control Voltage | $V_C$     | $V_{CC} = +2.5V$              | -0.5  | -   | 3.0   | V    |
|                         |           | $V_{CC} = +3.3V$              | -0.5  | -   | 3.8   | V    |
| Supply Voltage          | $V_{CC}$  | $\pm 5\%$                     | 2.375 | 2.5 | 2.625 | V    |
|                         |           |                               | 3.135 | 3.3 | 3.465 |      |
| Supply Current          |           |                               |       |     |       |      |
| LVPECL                  | $I_{CC}$  | Maximum Load                  | -     | 54  | 88    | mA   |
| LVDS                    |           | Maximum Current Value @ +3.3V | -     | 45  | 65    |      |
| Operating Temperature   | $T_A$     | -                             | -20   | +25 | +70   | °C   |
|                         |           |                               | -40   |     | +85   |      |
| Storage Temperature     | $T_{STG}$ | -                             | -55   | -   | +125  | °C   |

### Frequency Stability

| PARAMETER                       | SYMBOL            | CONDITIONS                           | MIN | TYP          | MAX | UNIT      |
|---------------------------------|-------------------|--------------------------------------|-----|--------------|-----|-----------|
| Frequency Range                 | $f_O$             | -                                    |     | 10 - 800     |     | MHz       |
| Frequency Stability<br>[Note 1] | $\Delta f/f_O$    | -                                    |     | 25, 30 or 50 |     | $\pm$ ppm |
| Absolute Pull Range<br>[Note 2] | APR               | -                                    | 50  | -            | -   | $\pm$ ppm |
| Aging                           | $\Delta f/f_{25}$ | First Year @ +25°C, nominal $V_{CC}$ | -3  | -            | 3   | ppm       |

1.] Inclusive of initial tolerance at time of shipment, changes in supply voltage, load, temperature and 1st year aging.

2.] Minimum guaranteed frequency shift from  $f_O$  over variations in temperature, aging, power supply and load.

### Output Parameters

| PARAMETER                   | SYMBOL     | CONDITIONS                         | MIN             | TYP    | MAX             | UNIT |
|-----------------------------|------------|------------------------------------|-----------------|--------|-----------------|------|
| Output Type                 | -          | -                                  |                 | LVPECL |                 | -    |
| Output Load                 | $R_L$      | Terminated to $V_{CC} - 2.0V$      | -               | 50     | -               | Ohms |
| Output Voltage Levels       | $V_{OH}$   | PECL Load                          | $V_{CC} - 1.03$ | -      | $V_{CC} - 0.60$ | V    |
|                             | $V_{OL}$   |                                    | $V_{CC} - 1.85$ | -      | $V_{CC} - 1.60$ |      |
| Output Duty Cycle           | SYM        | @ $V_{CC} - 1.3V$                  | 45              | -      | 55              | %    |
| Rise and Fall Time          | $T_R, T_F$ | @ 20%/80% Levels, $R_L = 50$ Ohms  | -               | 0.25   | 0.70            | ns   |
| Output Type                 | -          | -                                  |                 | LVDS   |                 | -    |
| Output Load                 | $R_L$      | Between Outputs                    | -               | 100    | -               | Ohms |
| Output Voltage Levels       | $V_{OH}$   | LVDS Load                          | -               | 1.43   | 1.60            | V    |
|                             | $V_{OL}$   |                                    | 0.90            | 1.10   | -               |      |
| Output Duty Cycle           | SYM        | @ 1.25V                            | 45              | -      | 55              | %    |
| Differential Output Voltage | $V_{OD}$   | $R_L = 100$ Ohms                   | 175             | 330    | 454             | mV   |
| Offset Voltage              | $V_{OS}$   | LVDS Load                          | 1.20            | 1.25   | 1.30            | V    |
| Rise and Fall Time          | $T_R, T_F$ | @ 20%/80% Levels, $R_L = 100$ Ohms | -               | 0.4    | 0.7             | ns   |



## Electrical Specifications

### Output Parameters

| PARAMETER                          | SYMBOL       | CONDITIONS                       | MIN         | TYP | MAX         | UNIT |
|------------------------------------|--------------|----------------------------------|-------------|-----|-------------|------|
| Start Up Time                      | $T_S$        | Application of $V_{CC}$          | -           | 3   | 5           | ms   |
| <b>Enable Function [Tri-State]</b> |              |                                  |             |     |             |      |
| Enable Input Voltage               | $V_{IH}$     | Pin 1 Logic '1', Output Enabled  | $0.7V_{CC}$ | -   | -           | V    |
| Disable Input Voltage              | $V_{IL}$     | Pin 1 Logic '0', Output Disabled | -           | -   | $0.3V_{CC}$ | V    |
| Disable Current                    | $I_{IL}$     | Pin 1 Logic '0', Output Disabled | -           | 16  | 22          | mA   |
| Enable Time                        | $T_{PLZ}$    | Pin 1 Logic '1', Output Enabled  | -           | -   | 200         | ns   |
| Phase Jitter, RMS                  | $t_{jrms}$   | Bandwidth 12 kHz - 20 MHz        | -           | 500 | <1000       | fs   |
| Period Jitter, RMS                 | $p_{jrms}$   | -                                | -           | 2.5 | -           | ps   |
| Period Jitter, pk-pk               | $p_{jpk-pk}$ | -                                | -           | 25  | -           | ps   |

### Control Voltage

| PARAMETER           | SYMBOL         | CONDITIONS   | MIN | TYP         | MAX      | UNIT  |
|---------------------|----------------|--|-----|-------------|----------|-------|
| Control Voltage     | $V_C$          | $V_{CC} = 2.5V$  | 0.2 | 1.25        | 2.3      | V     |
|                     |                | $V_{CC} = 3.3V$  | 0.3 | 1.65        | 3.0      |       |
| Frequency Deviation | $\Delta f/f_0$ | $V_C = 0.2V$   | -   | -60 to -180 | -        | ppm   |
|                     |                | $V_C = 2.3V$   | -   | 60 to 180   | -        |       |
|                     |                | $V_C = 0.3V$   | -   | -60 to -180 | -        | ppm   |
|                     |                | $V_C = 3.0V$   | -   | 60 to 180   | -        |       |
| Linearity           | L              | Best Straight Line Fit   | -   | -           | $\pm 15$ | %     |
| Gain Transfer       | $K_V$          | Pull Sensitivity; @ +1.25V, +25°C<br>Pull Sensitivity; @ +1.65V, +25°C | -   | 80          | 260      | ppm/V |
| Input Impedance     | $Z_{Vc}$       | -  | 1   | -           | -        | MOhms |
| Modulation Roll-off | -              | @ -3dB   | 10  | -           | -        | kHz   |
| Transfer Function   | -              | -  | -   | Positive    | -        | -     |

### Enable Truth Table

| Pin 2     | Pin 4 & Pin 5 |
|-----------|---------------|
| Logic '1' | Output        |
| Open      | Output        |
| Logic '0' | High Imp.     |

## Electrical Specifications

Test Circuit  
LVPECL



LVDS



### Output Waveform

LVPECL or LVDS



## Electrical Specifications

### Performance Data

#### Phase Noise [typical]

19.44MHz, LVDS,  $V_{CC} = +3.3V$ ,  $V_C = +1.65V$ ,  $T_A = +25^\circ C$



#### Phase Noise Tabulated

19.44MHz, LVDS,  $V_{CC} = +3.3V$ ,  $V_C = +1.65V$ ,  $T_A = +25^\circ C$

| PARAMETER              | SYMBOL            | CONDITIONS                         | TYP       | UNIT   |
|------------------------|-------------------|------------------------------------|-----------|--------|
| <b>LVDS @ 19.44MHz</b> |                   |                                    |           |        |
| Phase Noise            |                   | Single Side Band                   |           |        |
|                        |                   | @ 10Hz                             | -69.4772  |        |
|                        |                   | @ 100Hz                            | -106.4545 |        |
|                        |                   | @ 1kHz                             | -129.7966 |        |
|                        | -                 | @ 10kHz                            | -140.9102 | dBc/Hz |
|                        |                   | @ 100kHz                           | -145.9181 |        |
|                        |                   | @ 1MHz                             | -153.5518 |        |
|                        |                   | @ 5MHz                             | -167.1949 |        |
|                        |                   | @ 5MHz                             | -167.1949 |        |
| Phase Jitter, RMS      | tj <sub>rms</sub> | Integration Bandwidth 12kHz - 5MHz | 473.5920  | fs     |



## Electrical Specifications

### Performance Data

#### Phase Noise [typical]

100MHz, LVPECL,  $V_{CC} = +3.3V$ ,  $V_C = +1.65V$ ,  $T_A = +25^\circ C$



#### Phase Noise Tabulated

100MHz, LVPECL,  $V_{CC} = +3.3V$ ,  $V_C = +1.65V$ ,  $T_A = +25^\circ C$

| PARAMETER                | SYMBOL  | CONDITIONS                          | TYP       | UNIT   |
|--------------------------|---------|-------------------------------------|-----------|--------|
| <b>LVPECL @ 100MHz</b>   |         |                                     |           |        |
| <b>Phase Noise</b>       |         | Single Side Band                    |           |        |
|                          |         | @ 10Hz                              | -60.0468  |        |
|                          |         | @ 100Hz                             | -87.7044  |        |
|                          |         | @ 1kHz                              | -114.7894 |        |
|                          | -       | @ 10kHz                             | -125.5298 | dBc/Hz |
|                          |         | @ 100kHz                            | -129.3706 |        |
|                          |         | @ 1MHz                              | -140.0562 |        |
|                          |         | @ 10MHz                             | -155.0085 |        |
|                          | @ 20MHz | -155.3269                           |           |        |
| <b>Phase Jitter, RMS</b> | tjrms   | Integration Bandwidth 12kHz - 20MHz | 580.0190  | fs     |



## Electrical Specifications

### Performance Data

#### Phase Noise [typical]

155.52MHz, LVPECL,  $V_{CC} = +3.3V$ ,  $V_C = +1.65V$ ,  $T_A = +25^\circ C$



#### Phase Noise Tabulated

155.52MHz, LVPECL,  $V_{CC} = +3.3V$ ,  $V_C = +1.65V$ ,  $T_A = +25^\circ C$

| PARAMETER                 | SYMBOL | CONDITIONS                          | TYP       | UNIT   |
|---------------------------|--------|-------------------------------------|-----------|--------|
| <b>LVPECL @ 155.52MHz</b> |        |                                     |           |        |
| <b>Phase Noise</b>        |        | Single Side Band                    |           |        |
|                           |        | @ 10Hz                              | -54.7395  |        |
|                           |        | @ 100Hz                             | -84.2366  |        |
|                           |        | @ 1kHz                              | -111.2290 |        |
|                           | -      | @ 10kHz                             | -123.6860 | dBc/Hz |
|                           |        | @ 100kHz                            | -128.8000 |        |
|                           |        | @ 1MHz                              | -136.0835 |        |
|                           |        | @ 10MHz                             | -156.0579 |        |
|                           |        | @ 20MHz                             | -157.3111 |        |
| <b>Phase Jitter, RMS</b>  | tjrms  | Integration Bandwidth 12kHz - 20MHz | 443.0400  | fs     |

## Mechanical Specifications

### Package Drawing



### Marking Information

- \*\* – Manufacturing Site Code.
- D – Date Code. See Table I for codes.
- O – Output Type; P = LVPECL, L = LVDS.
- ST – Frequency Stability/Temperature Code.  
[Refer to Ordering Information]
- V – Voltage Code; 3 = 3.3V, 2 = 2.5V.
- xxxx – Frequency Code.  
3-digits, frequencies below 100MHz  
4-digits, frequencies 100MHz or greater  
[See document 016-1454-0, Frequency Code Tables.]

### Recommended Pad Layout



### Notes

- JEDEC termination code (e4). Barrier-plating is nickel [Ni] with gold [Au] flash plate.
- Reflow conditions per JEDEC J-STD-020; +260°C maximum, 20 seconds.
- MSL = 1.

### Pin Assignments

| Pin | Symbol          | Function                 |
|-----|-----------------|--------------------------|
| 1   | V <sub>C</sub>  | Voltage Control          |
| 2   | EOH             | Enable [tri-state]       |
| 3   | GND             | Circuit & Package Ground |
| 4   | Output          | RF Output                |
| 5   | Output          | Complimentary RF Output  |
| 6   | V <sub>CC</sub> | Supply Voltage           |

Table I - Date Code

| YEAR |      | MONTH |      |      |      |      | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|------|------|-------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|      |      | 2001  | 2005 | 2009 | 2013 | 2017 |     |     |     |     |     |     |     |     |     |     |     |     |
| 2001 | 2005 | 2009  | 2013 | 2017 |      | A    | B   | C   | D   | E   | F   | G   | H   | J   | K   | L   | M   |     |
| 2002 | 2006 | 2010  | 2014 | 2018 |      | N    | P   | Q   | R   | S   | T   | U   | V   | W   | X   | Y   | Z   |     |
| 2003 | 2007 | 2011  | 2015 | 2019 |      | a    | b   | c   | d   | e   | f   | g   | h   | j   | k   | l   | m   |     |
| 2004 | 2008 | 2012  | 2016 | 2020 |      | n    | p   | q   | r   | s   | t   | u   | v   | w   | x   | y   | z   |     |



### Packaging - Tape and Reel

Tape Drawing – 12mm Width



Tape Drawing – 16mm Width



### Packaging - Tape and Reel

Reel Drawing – 12mm Width



Reel Drawing – 16mm Width



### Notes

1. Device quantity is 1k pieces per 180mm reel.
2. Complete CTS part number, frequency value and date code information must appear on reel and carton labels.



## Addendum

### Additional Developed Frequencies – MHz

| FREQUENCY | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE |
|-----------|----------------|------------|----------------|------------|----------------|------------|----------------|
| 27.000000 | 270            | 74.175800  | 74A            | 144.500000 | 1445           | 322.265625 | 322A           |
| 38.840000 | 38D            | 76.800000  | 768            | 148.351648 | 148B           | 349.400000 | 3494           |
| 38.880000 | 388            | 86.700000  | 867            | 150.000000 | 1500           | 400.000000 | 4000           |
| 43.350000 | 433            | 87.351542  | 873            | 153.600000 | 1536           | 448.000000 | 4480           |
| 45.000000 | 450            | 92.160000  | 921            | 156.253906 | 156A           | 622.080000 | 6220           |
| 54.000000 | 540            | 106.250000 | 1062           | 160.000000 | 1600           |            |                |
| 62.500000 | 625            | 132.000000 | 1320           | 184.320000 | 1843           |            |                |

### Frequency Codes for Cover Page Table – MHz

| FREQUENCY  | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE |
|------------|----------------|------------|----------------|------------|----------------|
| 25.000000  | 250            | 122.880000 | 1228           | 200.000000 | 2000           |
| 50.000000  | 500            | 125.000000 | 1250           | 250.000000 | 2500           |
| 74.250000  | 742            | 148.500000 | 1485           | 300.000000 | 3000           |
| 77.760000  | 777            | 155.520000 | 1555           | 312.500000 | 3125           |
| 100.000000 | 1000           | 156.250000 | 1562           |            |                |

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