



# Model 358P/L

## Advanced PLL LVPECL or LVDS VCXO



Part Dimensions:  
5.0 × 3.2 × 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        |      |
| 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<br>-40 | +25 | +70<br>+85 | °C   |
| 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   |
| Enable Function [Tri-State] |              |                                  |             |     |             |      |
| 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 | $\Delta f/f_O$ | $V_C = 0.2V$                                                           | -   | -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                                                 | -   | -           | ±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   |
|-------------------|------------------|------------------------------------|-----------|--------|
| LVDS @ 19.44MHz   |                  |                                    |           |        |
| 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 | tjrms            | 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   |
|-------------------|------------------|-------------------------------------|-----------|--------|
| LVPECL @ 100MHz   |                  |                                     |           |        |
| Phase Noise       | 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 |        |
| Phase Jitter, RMS | 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   |
|--------------------|------------------|-------------------------------------|-----------|--------|
| LVPECL @ 155.52MHz |                  |                                     |           |        |
| Phase Noise        | 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 |        |
| Phase Jitter, RMS  | tjrms            | Integration Bandwidth 12kHz - 20MHz | 443.0400  | fs     |

## Mechanical Specifications

### Package Drawing



### Marking Information

1. \*\* – Manufacturing Site Code.
2. D – Date Code. See Table I for codes.
3. O – Output Type; P = LVPECL, L = LVDS.
4. ST – Frequency Stability/Temperature Code.  
[Refer to Ordering Information]
5. V – Voltage Code; 3 = 3.3V, 2 = 2.5V.
6. 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

1. JEDEC termination code (e4). Barrier-plating is nickel [Ni] with gold [Au] flash plate.
2. Reflow conditions per JEDEC J-STD-020; +260°C maximum, 20 seconds.
3. 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

| MONTH |      |      |      |      | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| YEAR  |      |      |      |      |     |     |     |     |     |     |     |     |     |     |     |     |
| 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           |            |                |