

# Model 635

## Low Jitter LVPECL or LVDS Clock

### Features

- Ceramic Surface Mount Package
- Low Phase Jitter Performance, 700fs Maximum
- Fundamental or 3<sup>rd</sup> Overtone Crystal Design
- Frequency Range 10 – 320MHz \*
- +2.5V or +3.3V Operation
- Output Enable Standard
- Tape and Reel Packaging, EIA-481



Part Dimensions:  
7.0 × 5.0 × 2.0mm • 178.462mg

### Applications

- SerDes
- Storage Area Networking
- Broadband Access
- SONET/SDH/DWDM
- PON
- Ethernet/GbE/SyncE
- Fiber Channel
- Test and Measurement

#### Standard Frequencies

|              |               |             |
|--------------|---------------|-------------|
| - 25.00MHz   | - 125.00MHz   | - 187.50MHz |
| - 50.00MHz   | - 150.00MHz   | - 200.00MHz |
| - 74.1758MHz | - 155.52MHz   | - 212.50MHz |
| - 74.25MHz   | - 156.25MHz   | - 250.00MHz |
| - 100.00MHz  | - 161.1328MHz | - 312.50MHz |

\* See Page 9 for additional developed frequencies.  
Check with factory for availability of frequencies not listed.

### Description

CTS Model 635 is a low cost, high performance clock oscillator supporting differential LVPECL or LVDS outputs. Employing the latest IC technology, M635 has excellent stability and low jitter/phase noise performance.

### Ordering Information

| Model | Output Type | Frequency Stability | Temperature Range | Supply Voltage | Frequency Code [MHz] |
|-------|-------------|---------------------|-------------------|----------------|----------------------|
| 635   | P           | 3                   | I                 | 3              | XXXMXXXX             |

| Code | Output                |
|------|-----------------------|
| P    | LVPECL - Pin 1 Enable |
| L    | LVDS - Pin 1 Enable   |
| E    | LVPECL - Pin 2 Enable |
| V    | LVDS - Pin 2 Enable   |

| Code | Temp. Range    |
|------|----------------|
| A    | -10°C to +60°C |
| C    | -20°C to +70°C |
| I    | -40°C to +85°C |

| Code                                | Frequency |
|-------------------------------------|-----------|
| Product Frequency Code <sup>2</sup> |           |

| Code | Stability           |
|------|---------------------|
| 6    | ±20ppm <sup>1</sup> |
| 5    | ±25ppm              |
| 3    | ±50ppm              |
| 2    | ±100ppm             |

| Code | Voltage |
|------|---------|
| 2    | +2.5Vdc |
| 3    | +3.3Vdc |

Notes:

- 1] Consult factory for availability of 6I Stability/Temperature combination.
- 2] Frequency is recorded with 3 significant digits before the 'M' and 4 significant digits after the 'M', including zeros. See Table I for frequency codes that exceed 4 significant digits.

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

Table I

| Nominal Frequency [MHz] | Part Number Frequency Code |
|-------------------------|----------------------------|
| 025.000625              | 025M0006                   |
| 074.175824              | 074M175B                   |
| 101.575694              | 101M5756                   |
| 125.009375              | 125M0093                   |
| 148.351648              | 148M351A                   |
| 153.600770              | 153M6007                   |
| 156.253906              | 156M2539                   |
| 178.018970              | 178M0189                   |

Example: P/N Frequency = Actual Frequency.  
148M351A = 148.351648MHz

This product is specified for use only in standard commercial applications. Supplier disclaims all express and implied warranties and liability in connection with any use of this product in any non-commercial applications or in any application that may expose the product to conditions that are outside of the tolerances provided in its specification.



## Electrical Specifications

### Operating Conditions

| PARAMETER              | SYMBOL    | CONDITIONS   | MIN            | TYP        | MAX            | UNIT |
|------------------------|-----------|--------------|----------------|------------|----------------|------|
| Maximum Supply Voltage | $V_{CC}$  | -            | -0.5           | -          | 5.0            | V    |
| Supply Voltage         | $V_{CC}$  | ±5%          | 2.375<br>3.135 | 2.5<br>3.3 | 2.625<br>3.465 | V    |
| <b>Supply Current</b>  |           |              |                |            |                |      |
| LVPECL                 | $I_{CC}$  | Maximum Load | -              | 55         | 88             | mA   |
| LVDS                   |           |              | -              | 45         | 66             |      |
| Operating Temperature  | $T_A$     | -            | -20<br>-40     | +25        | +70<br>+85     | °C   |
| Storage Temperature    | $T_{STG}$ | -            | -40            | -          | +125           | °C   |

### Frequency Stability

| PARAMETER                       | SYMBOL            | CONDITIONS                           | MIN | TYP               | MAX | UNIT |
|---------------------------------|-------------------|--------------------------------------|-----|-------------------|-----|------|
| <b>Frequency Range</b>          |                   |                                      |     |                   |     |      |
| LVPECL                          | $f_0$             | -                                    |     | 10 - 320          |     | MHz  |
| LVDS                            |                   |                                      |     | 80 - 320          |     |      |
| Frequency Stability<br>[Note 1] | $\Delta f/f_0$    | -                                    |     | 20, 25, 50 or 100 |     | ±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.

### 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, -20°C to +70°C          | $V_{CC} - 1.025$ | -      | $V_{CC} - 0.880$ | V    |
|                             | $V_{OL}$   |                                    | $V_{CC} - 1.810$ | -      | $V_{CC} - 1.620$ |      |
|                             | $V_{OH}$   | PECL Load, -40°C to +85°C          | $V_{CC} - 1.085$ | -      | $V_{CC} - 0.880$ | V    |
|                             | $V_{OL}$   |                                    | $V_{CC} - 1.830$ | -      | $V_{CC} - 1.555$ |      |
| 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  | -                | 0.3    | 0.7              | ns   |
| <b>LVDS</b>                 |            |                                    |                  |        |                  |      |
| 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                   | 247              | 330    | 454              | mV   |
| Offset Voltage              | $V_{OS}$   | LVDS Load                          | 1.125            | 1.25   | 1.375            | 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

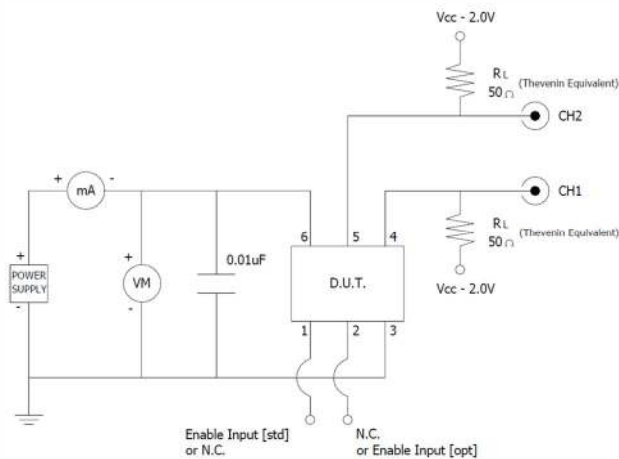
| PARAMETER                        | SYMBOL       | CONDITIONS                            | MIN         | TYP | MAX         | UNIT |
|----------------------------------|--------------|---------------------------------------|-------------|-----|-------------|------|
| Start Up Time                    | $T_S$        | Application of $V_{CC}$               | -           | 2   | 5           | ms   |
| <b>Enable Function [Standby]</b> |              |                                       |             |     |             |      |
| Enable Input Voltage             | $V_{IH}$     | Pin 1 or 2 Logic '1', Output Enabled  | $0.7V_{CC}$ | -   | -           | V    |
| Disable Input Voltage            | $V_{IL}$     | Pin 1 or 2 Logic '0', Output Disabled | -           | -   | $0.3V_{CC}$ | V    |
| Disable Time                     | $T_{PLZ}$    | Pin 1 or 2 Logic '0', Output Disabled | -           | -   | 200         | ns   |
| Enable Time                      | $T_{PLZ}$    | Pin 1 or 2 Logic '1', Output Enabled  | -           | -   | 2           | ms   |
| Phase Jitter, RMS                | $t_{jrms}$   | Bandwidth 12 kHz - 20 MHz             | -           | 300 | 700         | fs   |
| Period Jitter, RMS               | $pj_{rms}$   | -                                     | -           | 2.6 | -           | ps   |
| Period Jitter, pk-pk             | $pj_{pk-pk}$ | -                                     | -           | 25  | -           | ps   |

### Enable Truth Table

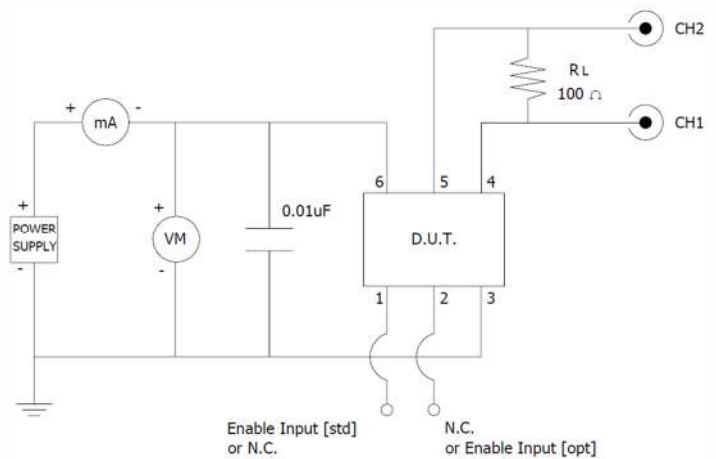
| Pin 1 or Pin 2 | Pin 4 & Pin 5                      |
|----------------|------------------------------------|
| Logic '1'      | Output Enabled                     |
| Open           | Output Enabled                     |
| Logic '0'      | Output Disabled,<br>High Impedance |

### Test Circuit

LVPECL

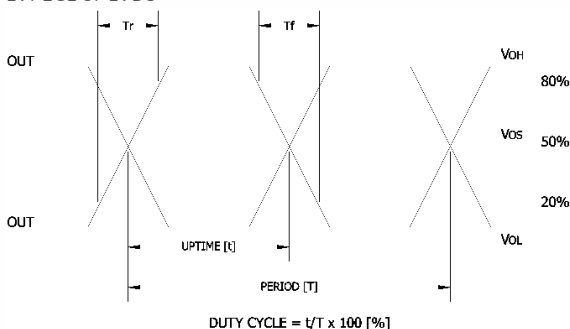


LVDS



### Output Waveform

LVPECL or LVDS

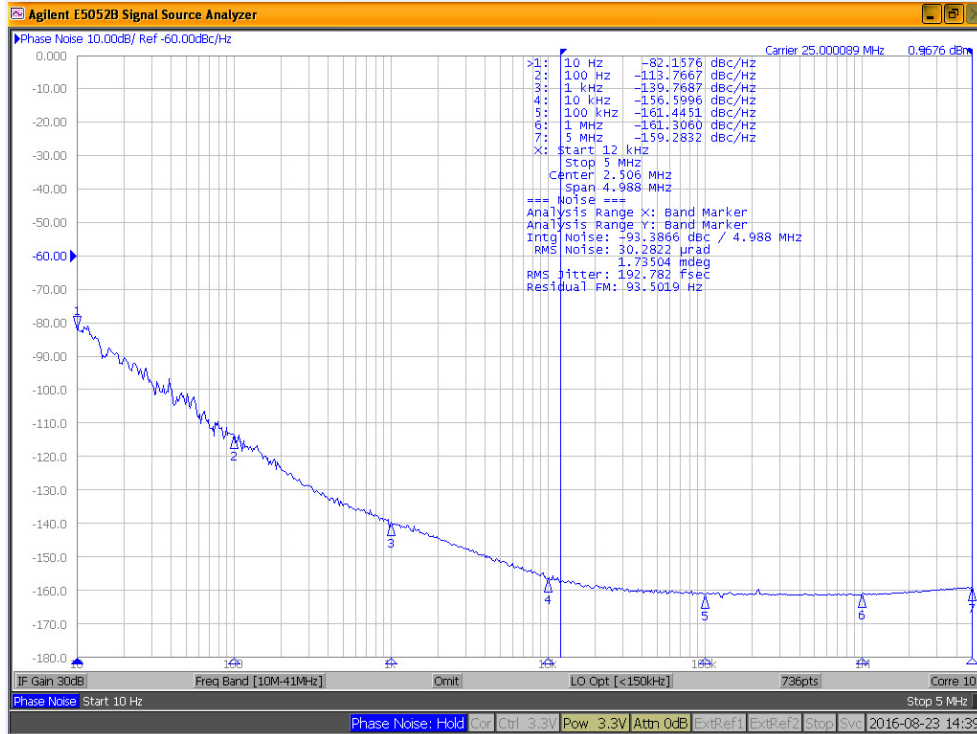


## Electrical Specifications

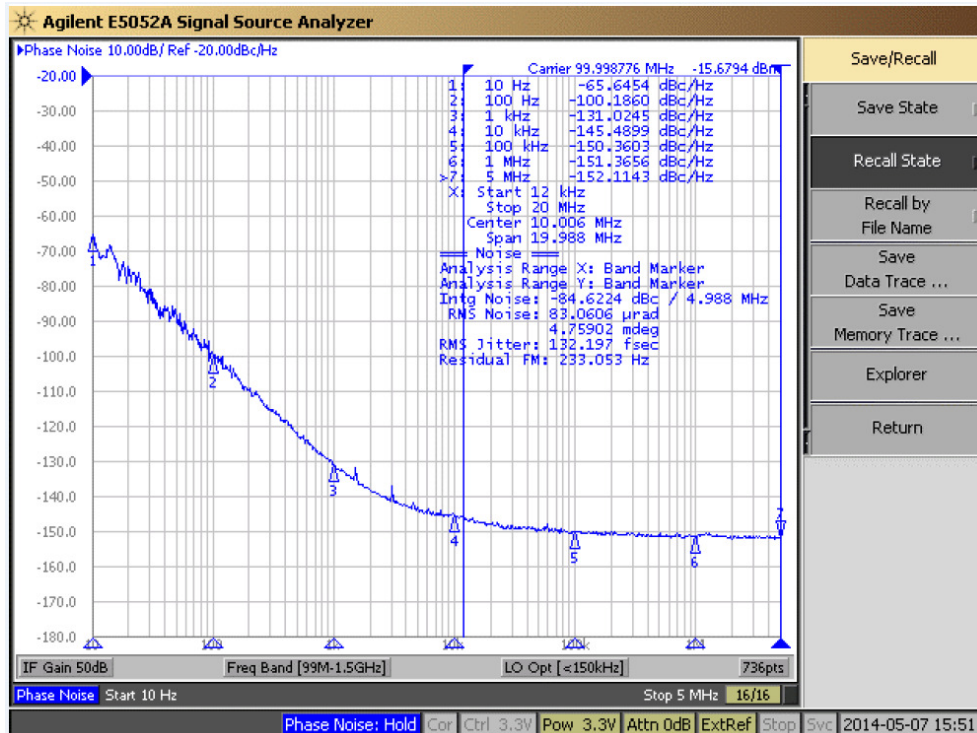
### Performance Data

#### Phase Noise [typical]

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



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

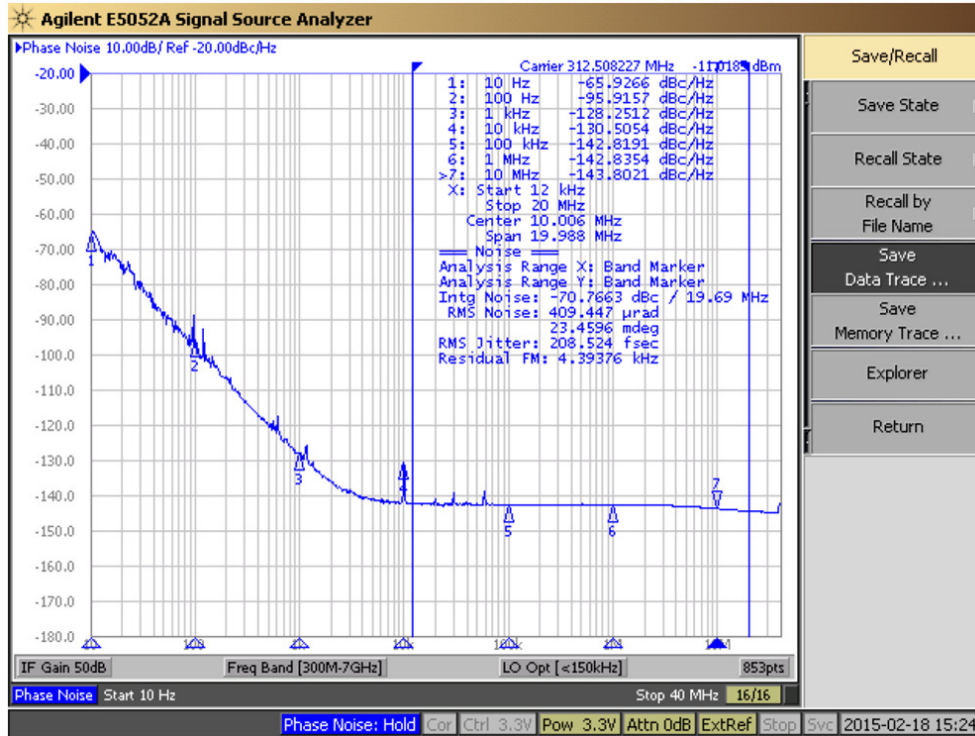


## Electrical Specifications

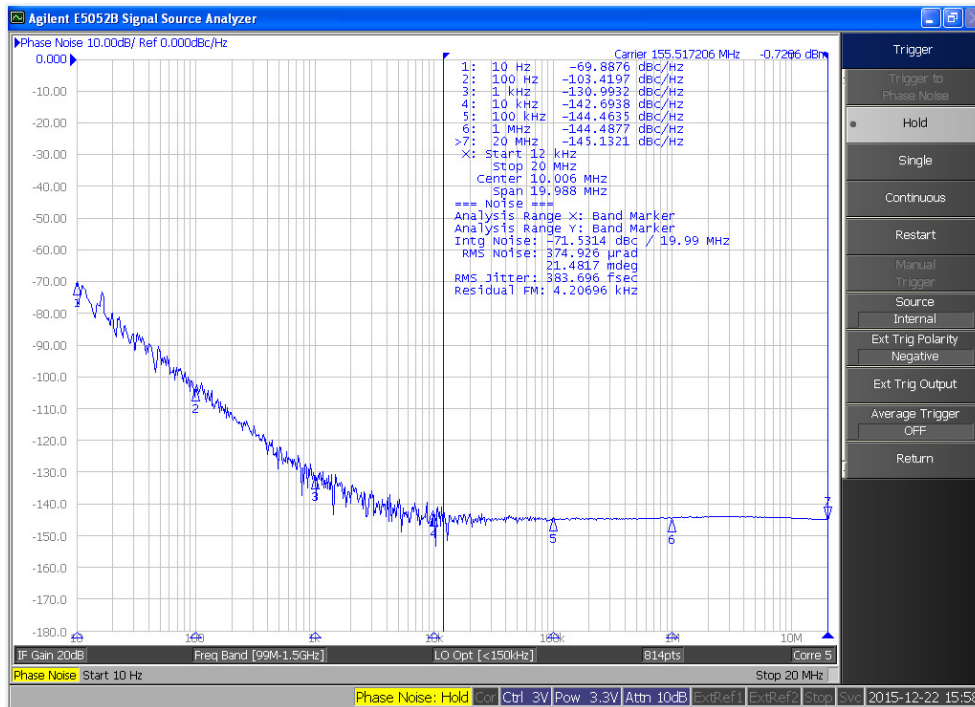
### Performance Data

#### Phase Noise [typical]

312.50MHz, LVPECL,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$



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





## Electrical Specifications

### Phase Noise Tabulated

Typical,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$

| PARAMETER                | SYMBOL | CONDITIONS                          | TYP     | UNIT   |
|--------------------------|--------|-------------------------------------|---------|--------|
| <b>LVPECL @ 25.00MHz</b> |        |                                     |         |        |
| <b>Phase Noise</b>       |        | Single Side Band                    |         |        |
|                          |        | @ 10Hz                              | -82.16  |        |
|                          |        | @ 100Hz                             | -113.77 |        |
|                          |        | @ 1kHz                              | -139.77 | dBc/Hz |
|                          |        | @ 10kHz                             | -156.60 |        |
|                          |        | @ 100kHz                            | -161.45 |        |
|                          |        | @ 1MHz                              | -161.31 |        |
|                          | @ 5MHz | -159.28                             |         |        |
| <b>Phase Jitter, RMS</b> | tjrms  | Integration Bandwidth 12kHz - 20MHz | 192.78  | fs     |

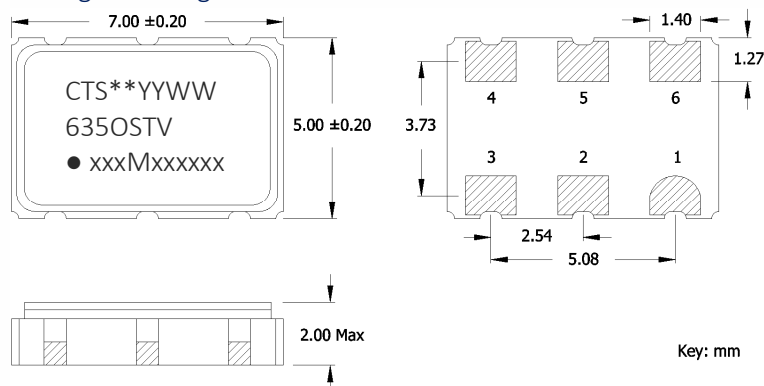
| PARAMETER                 | SYMBOL  | CONDITIONS                          | TYP     | UNIT   |
|---------------------------|---------|-------------------------------------|---------|--------|
| <b>LVPECL @ 312.20MHz</b> |         |                                     |         |        |
| <b>Phase Noise</b>        |         | Single Side Band                    |         |        |
|                           |         | @ 10Hz                              | -65.93  |        |
|                           |         | @ 100Hz                             | -95.92  |        |
|                           |         | @ 1kHz                              | -128.25 | dBc/Hz |
|                           |         | @ 10kHz                             | -130.51 |        |
|                           |         | @ 100kHz                            | -142.82 |        |
|                           |         | @ 1MHz                              | -142.84 |        |
|                           | @ 10MHz | -143.80                             |         |        |
| <b>Phase Jitter, RMS</b>  | tjrms   | Integration Bandwidth 12kHz - 20MHz | 208.52  | fs     |

| PARAMETER                 | SYMBOL | CONDITIONS                          | TYP     | UNIT   |
|---------------------------|--------|-------------------------------------|---------|--------|
| <b>LVPECL @ 100.00MHz</b> |        |                                     |         |        |
| <b>Phase Noise</b>        |        | Single Side Band                    |         |        |
|                           |        | @ 10Hz                              | -65.65  |        |
|                           |        | @ 100Hz                             | -100.19 |        |
|                           |        | @ 1kHz                              | -131.02 | dBc/Hz |
|                           |        | @ 10kHz                             | -145.49 |        |
|                           |        | @ 100kHz                            | -150.36 |        |
|                           |        | @ 1MHz                              | -151.37 |        |
|                           | @ 5MHz | -152.11                             |         |        |
| <b>Phase Jitter, RMS</b>  | tjrms  | Integration Bandwidth 12kHz - 20MHz | 132.20  | fs     |

| PARAMETER                | SYMBOL  | CONDITIONS                          | TYP     | UNIT   |
|--------------------------|---------|-------------------------------------|---------|--------|
| <b>LVDS @ 155.52MHz</b>  |         |                                     |         |        |
| <b>Phase Noise</b>       |         | Single Side Band                    |         |        |
|                          |         | @ 10Hz                              | -69.89  |        |
|                          |         | @ 100Hz                             | -103.42 |        |
|                          |         | @ 1kHz                              | -130.99 | dBc/Hz |
|                          |         | @ 10kHz                             | -142.69 |        |
|                          |         | @ 100kHz                            | -144.46 |        |
|                          |         | @ 1MHz                              | -144.49 |        |
|                          | @ 20MHz | -145.13                             |         |        |
| <b>Phase Jitter, RMS</b> | tjrms   | Integration Bandwidth 12kHz - 20MHz | 383.70  | fs     |

## Mechanical Specifications

### Package Drawing

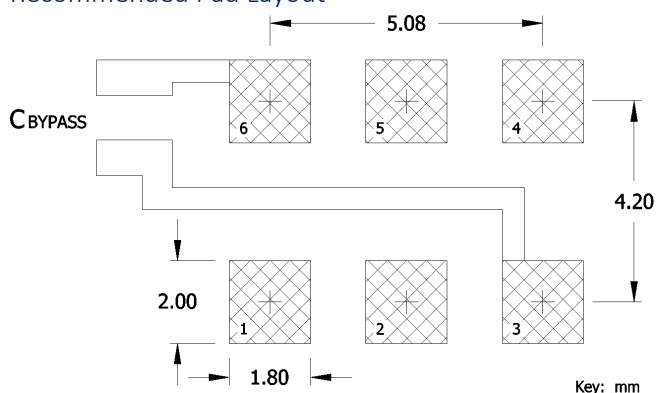


### Marking Information

- \*\* - Manufacturing Site Code.
- YYWW – Date Code; YY – year, WW – week.
- O – Output Type; P or E = LVPECL, L or V = LVDS.
- ST – Frequency Stability/Temperature Code. [Refer to Ordering Information]
- V – Voltage Code; 3 = 3.3V, 2 = 2.5V.
- xxxMxxxxxx – Frequency is marked with only leading significant digits before the “M” and 4 – 6 digits after the “M” [including zeros].

| Ex. | Frequency    | Marking    |
|-----|--------------|------------|
|     | 19.44MHz     | 19M4400    |
|     | 153.60077MHz | 153M60077  |
|     | 148.351648   | 148M351648 |

### Recommended Pad Layout



### Notes

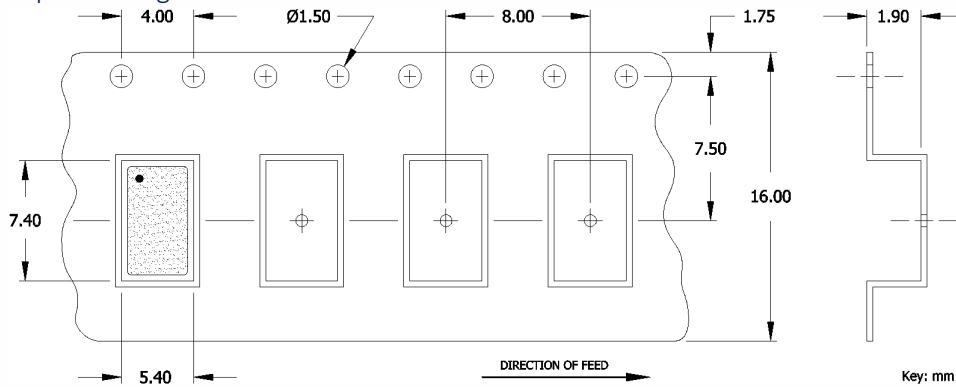
- JEDEC termination code (e4). Barrier-plating is nickel [Ni] with gold [Au] flash plate.
- Reflow conditions per JEDEC J-STD-020; +260°C maximum, 20 seconds.
- MSL = 1.

### Pin Assignments

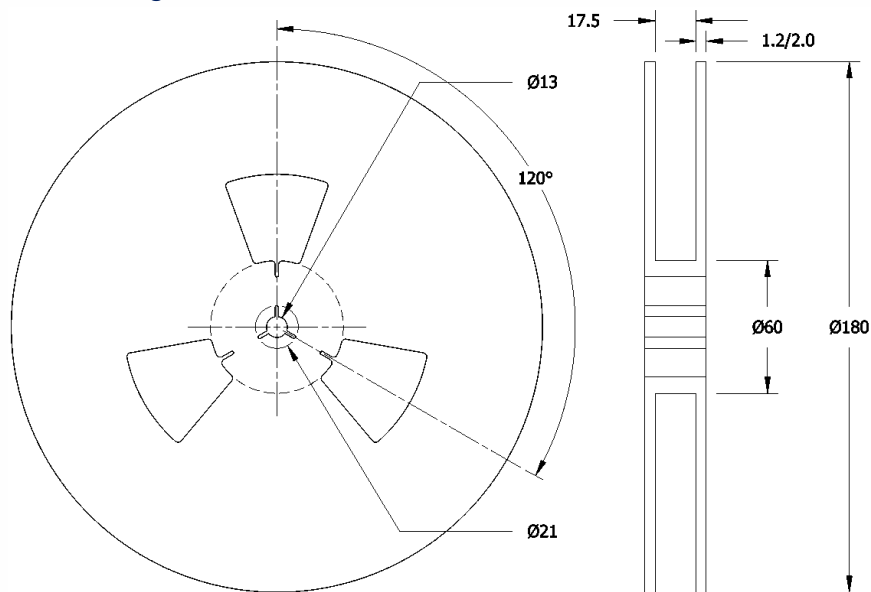
| Pin | Symbol          | Function                   |
|-----|-----------------|----------------------------|
| 1   | EOH or N.C.     | Enable [std] or No Connect |
| 2   | N.C. or EOH     | No Connect or Enable [opt] |
| 3   | GND             | Circuit & Package Ground   |
| 4   | Output          | RF Output                  |
| 5   | Output          | Complimentary RF Output    |
| 6   | V <sub>CC</sub> | Supply Voltage             |

### Packaging - Tape and Reel

#### Tape Drawing



#### Reel Drawing



#### Notes

1. Device quantity is 1k pieces maximum 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 |
|------------|----------------|------------|----------------|------------|----------------|-----------|----------------|
| 10.000000  | 010M0000       | 125.009375 | 125M0093       | 175.000000 | 175M0000       |           |                |
| 19.440000  | 019M4400       | 133.000000 | 133M0000       | 178.018970 | 178M0189       |           |                |
| 25.000625  | 025M0006       | 148.351600 | 148M3516       | 178.500000 | 178M5000       |           |                |
| 27.000000  | 027M0000       | 148.351648 | 148M351A       | 180.000000 | 180M0000       |           |                |
| 40.000000  | 040M0000       | 148.500000 | 148M5000       | 184.320000 | 184M3200       |           |                |
| 44.736000  | 044M7360       | 153.600000 | 153M6000       | 225.000000 | 225M0000       |           |                |
| 74.175824  | 074M175B       | 153.600770 | 153M6007       |            |                |           |                |
| 80.000000  | 080M0000       | 156.253906 | 156M2539       |            |                |           |                |
| 101.575694 | 101M5756       | 167.372800 | 167M3728       |            |                |           |                |
| 120.000000 | 120M0000       | 173.370800 | 173M3708       |            |                |           |                |

### Frequency Codes for Cover Page Table – MHz

| FREQUENCY | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE | FREQUENCY  | FREQUENCY CODE |
|-----------|----------------|------------|----------------|------------|----------------|------------|----------------|
| 25.000000 | 025M0000       | 100.000000 | 100M0000       | 156.250000 | 156M2500       | 212.500000 | 212M5000       |
| 50.000000 | 050M0000       | 125.000000 | 125M0000       | 161.132800 | 161M1328       | 250.000000 | 250M0000       |
| 74.175800 | 074M1758       | 150.000000 | 150M0000       | 187.500000 | 187M5000       | 312.500000 | 312M5000       |
| 74.250000 | 074M2500       | 155.520000 | 155M5200       | 200.000000 | 200M0000       |            |                |