

# Model 347

## HFF LVPECL VCXO

### Features

- Ceramic Surface Mount Package
- Ultra-Low Phase Jitter Performance
- High Frequency Fundamental Crystal Design
- Frequency Range 100 – 250MHz \*
- +3.3V Operation
- Output Enable Standard
- Tape and Reel Packaging, EIA-418



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

### Applications

- Small Cells
- Wireless Communication
- Broadband Access
- SONET/SDH/DWDM
- Base Stations
- Ethernet/GbE/SyncE
- Digital Video
- Test and Measurement

#### Standard Frequencies

- 100.00MHz
- 122.88MHz
- 125.00MHz
- 153.60MHz
- 155.52MHz
- 156.25MHz
- 166.00MHz
- 200.00MHz
- 204.08MHz
- 245.76MHz \*

\* Check with factory for availability.

### Description

CTS Model 347 is a low cost, small size, high performance VCXO. Employing the latest IC technology, coupled with a high frequency fundamental crystal, M347 has excellent stability and low jitter/phase noise performance.

### Ordering Information

| Model                               | Supply Voltage                                                                             | Absolute Pull Range                                                                             | Frequency Stability | Temperature Range | Frequency Code [MHz] | Packaging           |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
|-------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------|-------------------|----------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---|----------------|---|----------------|---|-----------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------|------|--------------|-------------------------------------|--|--|
| 347                                 | L                                                                                          | B                                                                                               | 3                   | I                 | XXX or XXXX          | T                   |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
|                                     | <table><tr><th>Code</th><th>Voltage</th></tr><tr><td>L</td><td>+3.3V ±5%</td></tr></table> | Code                                                                                            | Voltage             | L                 | +3.3V ±5%            |                     | <table><tr><th>Code</th><th>Stability</th></tr><tr><td>3</td><td>±50ppm</td></tr><tr><td>5</td><td>±25ppm</td></tr><tr><td>6</td><td>±20ppm<sup>1</sup></td></tr></table> | Code | Stability   | 3 | ±50ppm         | 5 | ±25ppm         | 6 | ±20ppm <sup>1</sup>                                                                           |      | <table><tr><th>Code</th><th>Frequency</th></tr><tr><td colspan="2">Product Frequency Code<sup>2</sup></td></tr></table> | Code | Frequency    | Product Frequency Code <sup>2</sup> |  |  |
| Code                                | Voltage                                                                                    |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| L                                   | +3.3V ±5%                                                                                  |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| Code                                | Stability                                                                                  |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| 3                                   | ±50ppm                                                                                     |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| 5                                   | ±25ppm                                                                                     |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| 6                                   | ±20ppm <sup>1</sup>                                                                        |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| Code                                | Frequency                                                                                  |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| Product Frequency Code <sup>2</sup> |                                                                                            |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
|                                     |                                                                                            | <table><tr><th>Code</th><th>APR</th></tr><tr><td>B</td><td>±50ppm<sup>3</sup></td></tr></table> | Code                | APR               | B                    | ±50ppm <sup>3</sup> | <table><tr><th>Code</th><th>Temp. Range</th></tr><tr><td>C</td><td>-20°C to +70°C</td></tr><tr><td>I</td><td>-40°C to +85°C</td></tr></table>                             | Code | Temp. Range | C | -20°C to +70°C | I | -40°C to +85°C |   | <table><tr><th>Code</th><th>Packing</th></tr><tr><td>T</td><td>1k pcs./reel</td></tr></table> | Code | Packing                                                                                                                 | T    | 1k pcs./reel |                                     |  |  |
| Code                                | APR                                                                                        |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| B                                   | ±50ppm <sup>3</sup>                                                                        |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| Code                                | Temp. Range                                                                                |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| C                                   | -20°C to +70°C                                                                             |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| I                                   | -40°C to +85°C                                                                             |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| Code                                | Packing                                                                                    |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |
| T                                   | 1k pcs./reel                                                                               |                                                                                                 |                     |                   |                      |                     |                                                                                                                                                                           |      |             |   |                |   |                |   |                                                                                               |      |                                                                                                                         |      |              |                                     |  |  |

Notes:

- 1] Only available with "C" temperature range.
- 2] Refer to document 016-1454-0, Frequency Code Tables.  
3-digits for frequencies <100MHz, 4-digits for frequencies 100MHz or greater.
- 3] Frequencies ≥200MHz, APR is ±30ppm.

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

## Electrical Specifications

### Operating Conditions

| PARAMETER               | SYMBOL    | CONDITIONS                                       | MIN        | TYP | MAX        | UNIT             |
|-------------------------|-----------|--------------------------------------------------|------------|-----|------------|------------------|
| Maximum Supply Voltage  | $V_{CC}$  | -                                                | -0.3       | -   | 5.0        | V                |
| Maximum Control Voltage | $V_C$     | -                                                | -0.5       | -   | $V_{CC}$   | V                |
| Supply Voltage          | $V_{CC}$  | $\pm 5\%$                                        | 3.14       | 3.3 | 3.47       | V                |
| Supply Current          | $I_{CC}$  | Typical @ LVPECL Load, $T_A = +25^\circ\text{C}$ | -          | 65  | 80         | mA               |
| Output Load             | $R_L$     | Terminated to $V_{CC} - 2.0\text{V}$             | -          | 50  | -          | Ohms             |
| Operating Temperature   | $T_A$     | -                                                | -20<br>-40 | +25 | +70<br>+85 | $^\circ\text{C}$ |
| Storage Temperature     | $T_{STG}$ | -                                                | -40        | -   | +100       | $^\circ\text{C}$ |

### Frequency Stability

| PARAMETER                       | SYMBOL            | CONDITIONS                                                                    | MIN | TYP          | MAX | UNIT            |
|---------------------------------|-------------------|-------------------------------------------------------------------------------|-----|--------------|-----|-----------------|
| Frequency Range                 | $f_0$             | -                                                                             |     | 100 - 250    |     | MHz             |
| Frequency Stability<br>[Note 1] | $\Delta f/f_0$    | $\pm 20\text{ppm}$ stability, $-20^\circ\text{C}$ to $+70^\circ\text{C}$ only |     | 20, 25 or 50 |     | $\pm\text{ppm}$ |
| Absolute Pull Range<br>[Note 2] | APR               | Frequencies $\geq 200\text{MHz}$ , APR is $\pm 30\text{ppm}$                  | 50  | -            | -   | $\pm\text{ppm}$ |
| Aging                           | $\Delta f/f_{25}$ | First Year @ $+25^\circ\text{C}$ , nominal $V_{CC}$ and $V_C$                 | -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  $f_0$  over variations in temperature, aging, power supply and load.

### Output Parameters

| PARAMETER             | SYMBOL     | CONDITIONS                                              | MIN              | TYP    | MAX              | UNIT          |
|-----------------------|------------|---------------------------------------------------------|------------------|--------|------------------|---------------|
| Output Type           | -          | -                                                       |                  | LVPECL |                  | -             |
| Output Voltage Levels | $V_{OH}$   | LVPECL Load, $-40^\circ\text{C}$ to $+85^\circ\text{C}$ | $V_{CC} - 1.085$ | -      | $V_{CC} - 0.880$ | V             |
|                       | $V_{OL}$   | LVPECL Load, $-40^\circ\text{C}$ to $+85^\circ\text{C}$ | $V_{CC} - 1.810$ | -      | $V_{CC} - 1.620$ |               |
| Output Duty Cycle     | SYM        | @ $V_{CC} - 1.3\text{V}$                                | 45               | -      | 55               | %             |
| Rise and Fall Time    | $T_R, T_F$ | @ 20%/80% Levels                                        | -                | 0.3    | 1.0              | ns            |
| Start Up Time         | $T_S$      | Application of $V_{CC}$                                 | -                | 5      | 10               | ms            |
| Enable Function       |            |                                                         |                  |        |                  |               |
| Enable Input Voltage  | $V_{IH}$   | Pin 2 Logic '1', Output Enabled                         | $0.7V_{CC}$      | -      | -                | V             |
| Disable Input Voltage | $V_{IL}$   | Pin 2 Logic '0', Output Disabled                        | -                | -      | $0.3V_{CC}$      | V             |
| Standby Current       | $I_{STB}$  | Pin 2 Logic '0', Output Standby                         | -                | -      | 10               | $\mu\text{A}$ |
| Enable Time           | $T_{PLZ}$  | Pin 2 Logic '1'                                         | -                | -      | 20               | $\mu\text{s}$ |
| Phase Jitter, RMS     | $t_{jrms}$ | Bandwidth 12 kHz - 20 MHz                               | -                | 90     | 500              | fs            |
| Phase Noise           | -          | See Typical Plots                                       | -                | -      | -                | -             |

### Enable Truth Table

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

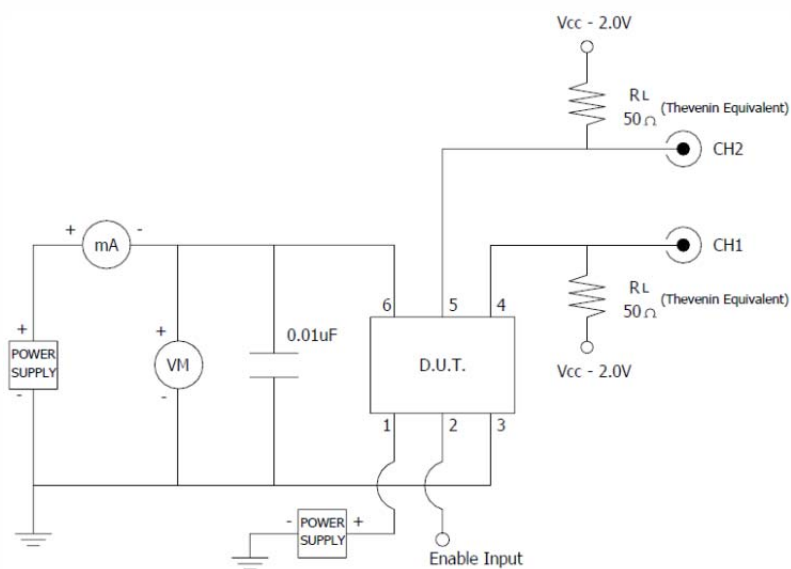
## Electrical Specifications

### Control Voltage

| PARAMETER           | SYMBOL         | CONDITIONS                        | MIN  | TYP         | MAX  | UNIT  |
|---------------------|----------------|-----------------------------------|------|-------------|------|-------|
| Control Voltage     | $V_C$          | -                                 | 0.30 | 1.65        | 3.00 | V     |
| Frequency Deviation | $\Delta f/f_0$ | $V_C = 0.0V$                      |      | -155 to -75 |      | ppm   |
|                     |                | $V_C = 3.3V$                      |      | 75 to 155   |      |       |
| Linearity           | L              | Best Straight Line Fit            | -    | 5           | 10   | %     |
| Gain Transfer       | $K_V$          | Pull Sensitivity; @ +1.65V, +25°C | -    | 75          | -    | ppm/V |
| Input Impedance     | $Z_{Vc}$       | -                                 | 10   | -           | -    | MOhms |
| Modulation Roll-off | -              | @ -3dB                            | 25   | -           | -    | kHz   |
| Transfer Function   | -              | -                                 |      | Positive    |      | -     |

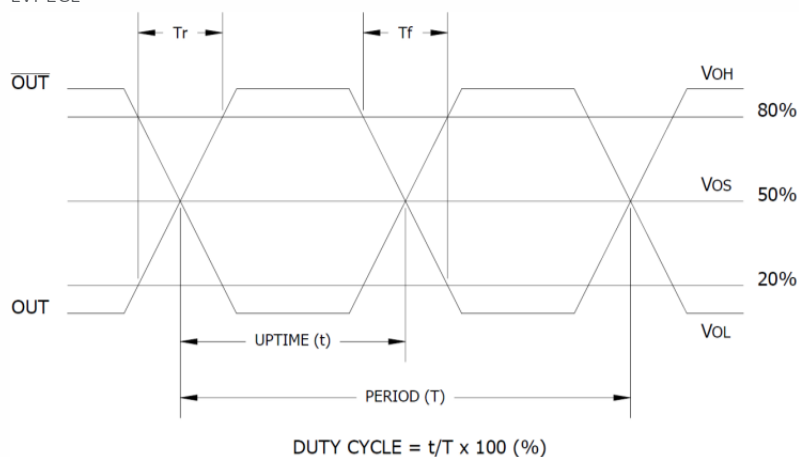
### Test Circuit

LVPECL



### Output Waveform

LVPECL

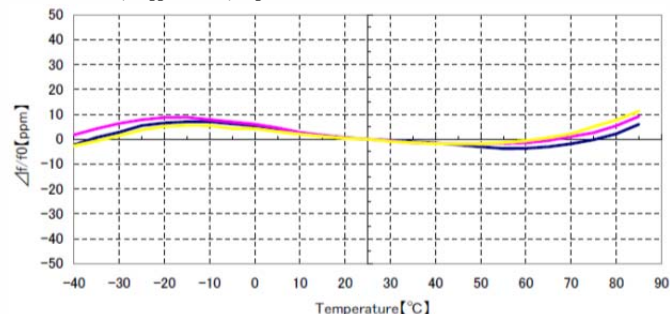


## Electrical Specifications

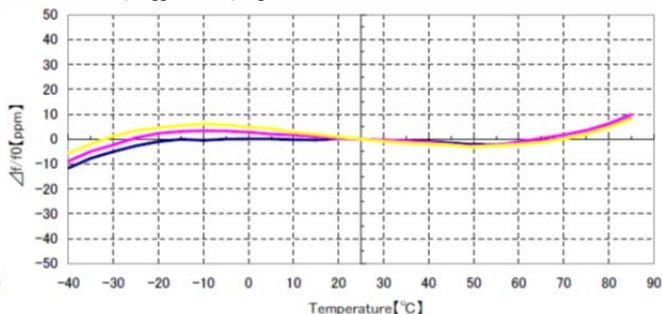
### Performance Data

#### Frequency Deviation – Over Temperature [typical]

122.88MHz,  $V_{CC} = 3.3V$ ,  $V_C = 1.65V$

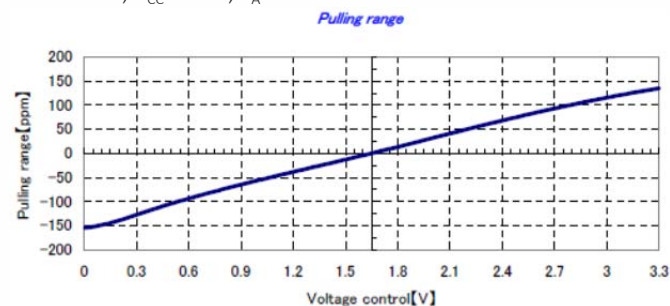


156.25MHz,  $V_{CC} = 3.3V$ ,  $V_C = 1.65V$

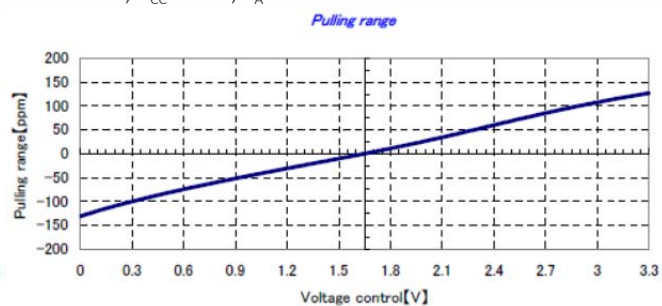


#### Frequency Deviation – Pulling Range [typical]

122.88MHz,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ V$

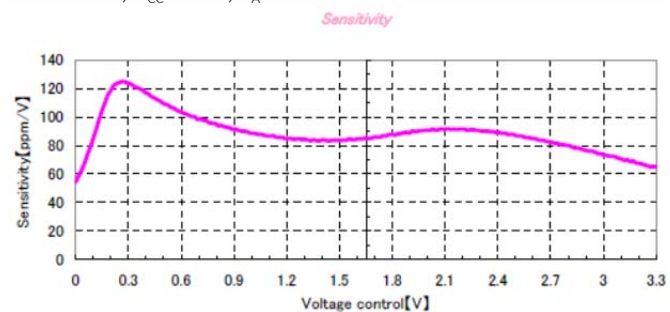


156.25MHz,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ V$

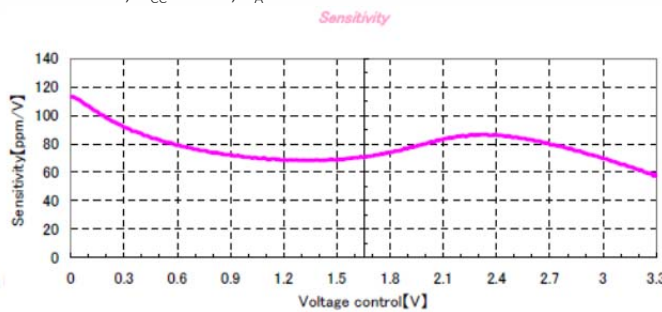


#### Frequency Deviation – Gain Transfer [typical]

122.88MHz,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ V$



156.25MHz,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ V$

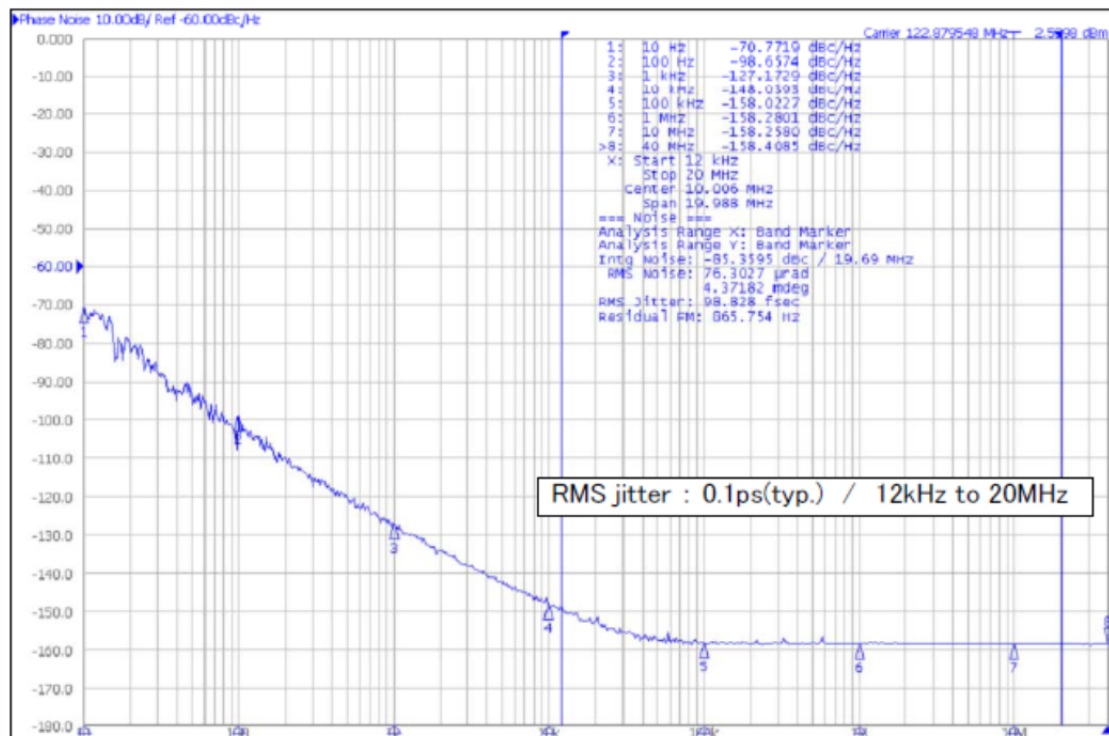


## Electrical Specifications

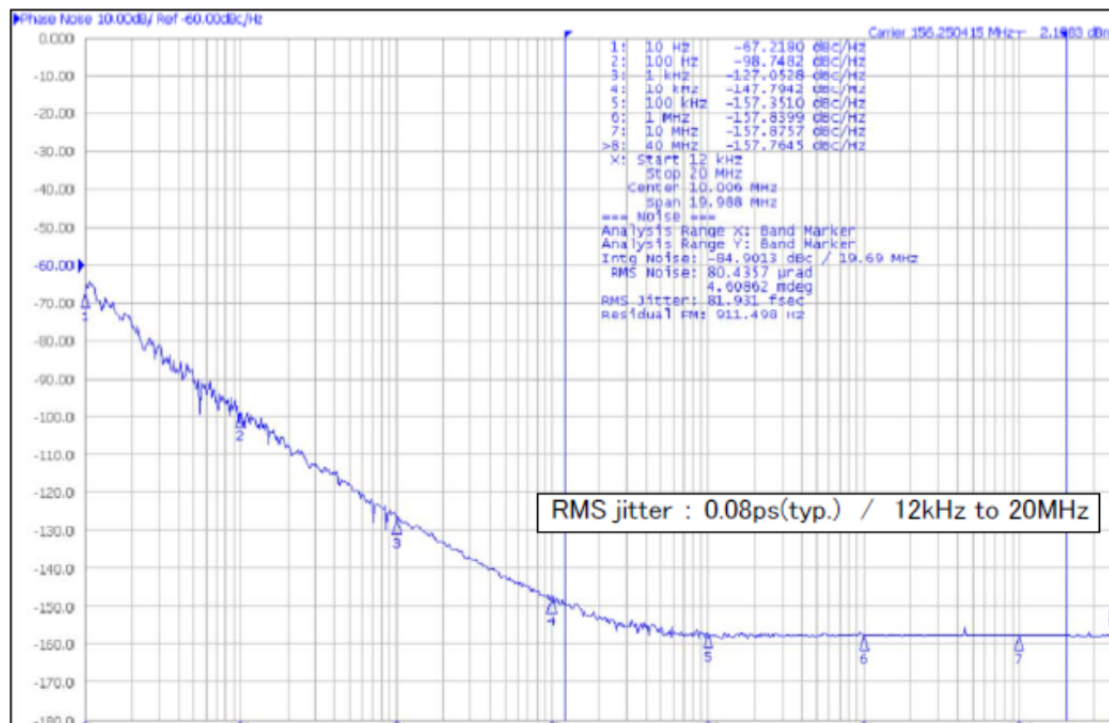
### Performance Data

#### Phase Noise [typical]

122.88MHz,  $V_{CC} = 3.3V$ ,  $V_C = 1.65V$ ,  $T_A = +25^\circ C$

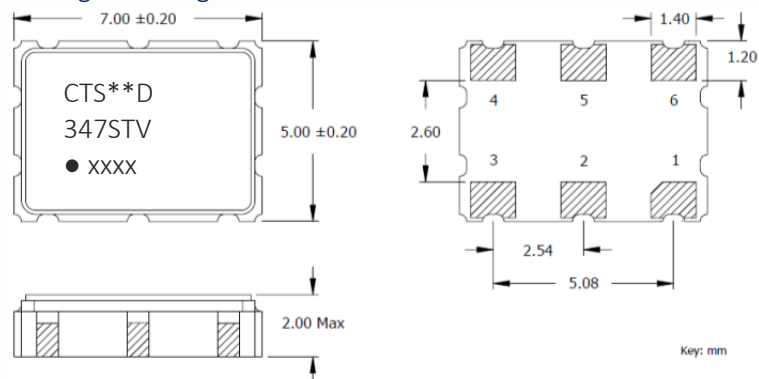


156.25MHz,  $V_{CC} = 3.3V$ ,  $V_C = 1.65V$ ,  $T_A = +25^\circ C$



## Mechanical Specifications

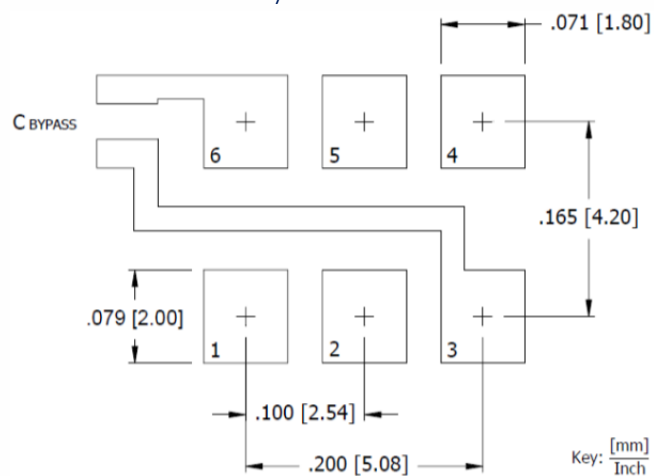
### Package Drawing



### Marking Information

1. \*\* - Manufacturing Site Code.
2. D – Date Code. See Table I for codes.
3. ST – Frequency Stability/Temperature Code. [Refer to Ordering Information]
4. V – Voltage Code. L = 3.3V
5. xxxx – Frequency Code. 4-digits required for frequencies 100MHz and above. [See document 016-1454-0, Frequency Code Tables.]

### Recommended Pad Layout



### Notes

1. Termination pads (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

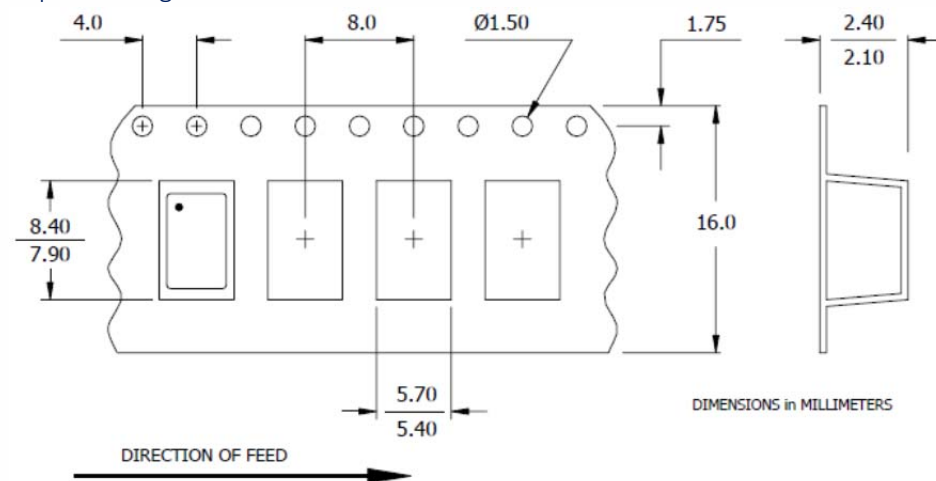
| Pin | Symbol   | Function                 |
|-----|----------|--------------------------|
| 1   | $V_C$    | Control Voltage          |
| 2   | EOH      | Enable                   |
| 3   | GND      | Circuit & Package        |
| 4   | Output   | RF Output                |
| 5   | Output   | RF Output, Complementary |
| 6   | $V_{CC}$ | Supply Voltage           |

Table I - Date Code

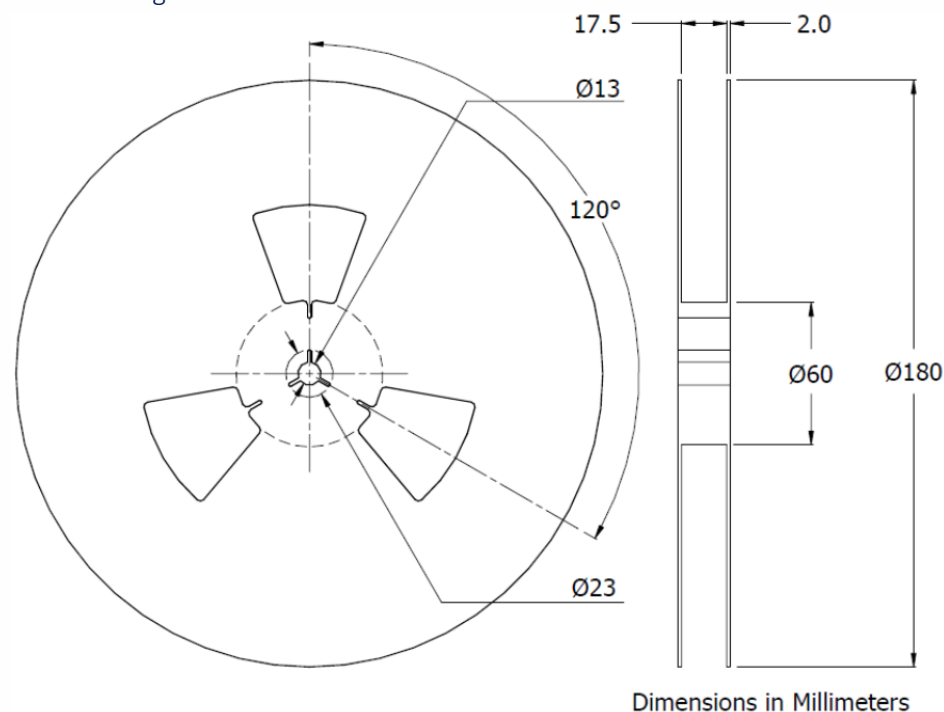
| MONTH |      |      |      |      | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| YEAR  |      |      |      |      |     |     |     |     |     |     |     | 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



### 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.