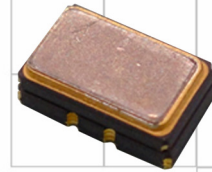


# Model 535

## High Stability Clipped Sine TCXO



Part Dimensions:  
5.0 × 3.2 × 2.0mm

### Features

- Fundamental Crystal Design
- Frequency Range 10 – 50MHz \*
- Operating Voltage +3.3V
- Frequency Stability, Overall  $\pm 4.6\text{ppm}$  [-40°C to +85°C]
- Operating Temperature Range to -40°C to +105°C
- Voltage Control Option for Frequency Tuning [VCTCXO]
- Enable Function Option Available
- Tape and Reel Packaging, EIA-481

Standard Frequencies – see Page 7 for common frequencies.  
\* Check with factory for availability of frequencies not listed.

### Applications

- 5G, 4G, LTE
- Femtocells, RRU, BBU
- Military Radio [Manpack]
- Inflight Entertainment
- Autonomous Technologies
- Synchronous Ethernet
- IP Networking
- Medical Imaging
- Stratum 3
- IEEE 1588 Timing
- Wireless Communication
- Test and Measurement

### Description

CTS Model 535 is a high performance Temperature Compensated Crystal Oscillator [TCXO] suitable for applications requiring tight stability, Stratum 3 performance and more. Employing IC technology with Clipped Sine output and analog temperature compensation engine; coupled with a fundamental quartz crystal M535 has excellent stability and low jitter/phase noise performance.

### Ordering Information

| Model | Output Enable   | Supply Voltage                | Frequency Code [MHz]                                    | Frequency Stability <sup>2</sup>  | Temperature Range  | Frequency Tuning   | Packaging                           |
|-------|---|-------------------------------|---|---|--|--|-------------------------------------|
| 535   |   | L                             | XXX   | X2  | I  | T  | 5                                   |
|       | Code   Function<br>Blank   No Enable<br>E   Enable, Pin 3 | Code   Voltage<br>L   +3.3Vdc | Code   Frequency<br>Product Frequency Code <sup>1</sup> | Code   Stability<br>01   $\pm 0.10\text{ppm}$<br>X2   $\pm 0.28\text{ppm}$<br>05   $\pm 0.50\text{ppm}$ | Code   Temp. Range<br>C   -10°C to +70°C<br>I   -40°C to +85°C<br>G   -40°C to +105°C <sup>3</sup> | Code   Frequency Deviation<br>T   TCXO [No Voltage Control]<br>A   $\pm 5\text{ppm} - \pm 10\text{ppm}$ [VCTCXO] | Code   Packing<br>5   500 pcs./reel |

Notes:

- 1] Refer to document 016-1454-0, Frequency Code Tables. 3-digits for frequencies <100MHz, 4-digits for frequencies 100MHz or greater.
- 2] Frequency vs. Temperature only.
- 3] Available with stability code X2 and 05 only.

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

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          | -   | 4.6      | V    |
| Maximum Control Voltage | $V_C$      | -          | -0.3          | -   | $V_{CC}$ | V    |
| Supply Voltage          | $V_{CC}$   | ±5%        | 3.14          | 3.3 | 3.47     | V    |
| Supply Current          | $I_{CC}$   | -          | -             | -   | 10       | mA   |
| Output Load             | $R_L//C_L$ | -          | 10k Ohm//10pF |     | -        | -    |
| Operating Temperature   | $T_A$      | -          | -10           | +25 | +70      | °C   |
|                         |            |            | -40           |     | +105     |      |
| Storage Temperature     | $T_{STG}$  | -          | -55           | -   | +125     | °C   |

### Frequency Stability

| PARAMETER                   | SYMBOL            | CONDITIONS   | MIN  | TYP                | MAX | UNIT |
|-----------------------------|-------------------|--|------|--------------------|-----|------|
| Frequency Range             | $f_0$             | Frequency stability ±0.10ppm<br>Frequency stability ±0.28ppm or ±0.50ppm |      | 10 - 40<br>10 - 50 |     | MHz  |
| Frequency Stability         |                   | <b>-10°C to +70°C &amp; -40°C to +85°C</b>                               |      |                    |     |      |
| Overall Frequency Stability |                   | Ref. $f_0$ , 20 Years Aging, ±0.28ppm over -40°C to +85°C                | -4.6 | -                  | 4.6 | ppm  |
| Initial Calibration         | $\Delta f/f_0$    | Initial Calibration @ +25°C, At Time of Shipment                         | -0.9 | -                  | 0.9 | ppm  |
| Temperature Only            |                   | [fmax - fmin]/2, Over Temperature Range                                  |      | 0.10, 0.28, 0.50   |     | ±ppm |
| Voltage Coefficient         | $\Delta f/f_{25}$ | Supply Voltage, ±5%  | -0.2 | -                  | 0.2 | ppm  |
| Load Coefficient            |                   | Load, ±10%   | -0.2 | -                  | 0.2 | ppm  |
| Aging                       | $\Delta f/f_{25}$ | First Year @ +25°C, nominal $V_{CC}$ and $V_C$                           | -1.0 | -                  | 1.0 | ppm  |
|                             |                   | 20 Years @ +25°C, nominal $V_{CC}$ and $V_C$                             | -3.0 | -                  | 3.0 | ppm  |
| Frequency Stability         |                   | <b>-40°C to +105°C</b>   |      |                    |     |      |
| Overall Frequency Stability |                   | Ref. $f_0$ , 20 Years Aging, ±0.28ppm over -40°C to +105°C               | -4.7 | -                  | 4.7 | ppm  |
| Initial Calibration         | $\Delta f/f_0$    | Initial Calibration @ +25°C, At Time of Shipment                         | -0.9 | -                  | 0.9 | ppm  |
| Temperature Only            |                   | [fmax - fmin]/2, Over Temperature Range                                  |      | 0.28, 0.5          |     | ±ppm |
| Voltage Coefficient         | $\Delta f/f_{25}$ | Supply Voltage, ±5%  | -0.2 | -                  | 0.2 | ppm  |
| Load Coefficient            |                   | Load, ±10%   | -0.2 | -                  | 0.2 | ppm  |
| Aging                       | $\Delta f/f_{25}$ | First Year @ +25°C, nominal $V_{CC}$ and $V_C$                           | -1.0 | -                  | 1.0 | ppm  |
|                             |                   | 20 Years @ +25°C, nominal $V_{CC}$ and $V_C$                             | -3.0 | -                  | 3.0 | ppm  |

## Electrical Specifications

### Output Parameters

| PARAMETER              | SYMBOL    | CONDITIONS                       | MIN         | TYP          | MAX         | UNIT      |
|------------------------|-----------|----------------------------------|-------------|--------------|-------------|-----------|
| Output Type            | -         | DC Coupled                       |             | Clipped Sine |             | -         |
| Output Voltage Levels  | $V_O$     | -                                | 0.8         | -            | -           | $V_{P-P}$ |
| Start Up Time          | $T_S$     | Application of $V_{CC}$          | -           | 2            | 5           | ms        |
| <b>Enable Function</b> |           |                                  |             |              |             |           |
| Enable Input Voltage   | $V_{IH}$  | Pin 3 Logic '1', Output Enabled  | $0.8V_{CC}$ | -            | -           | V         |
| Disable Input Voltage  | $V_{IL}$  | Pin 3 Logic '0', Output Disabled | -           | -            | $0.2V_{CC}$ | V         |
| Disabled Current       | $I_{STB}$ | Pin 3 Logic '0', Output Disabled | -           | -            | 3.5         | mA        |
| Enable Time            | $T_{PLZ}$ | Pin 3 Logic '1'                  | -           | -            | 5           | ms        |
| Phase Noise            | -         | See Typical Plots                | -           | -            | -           | -         |

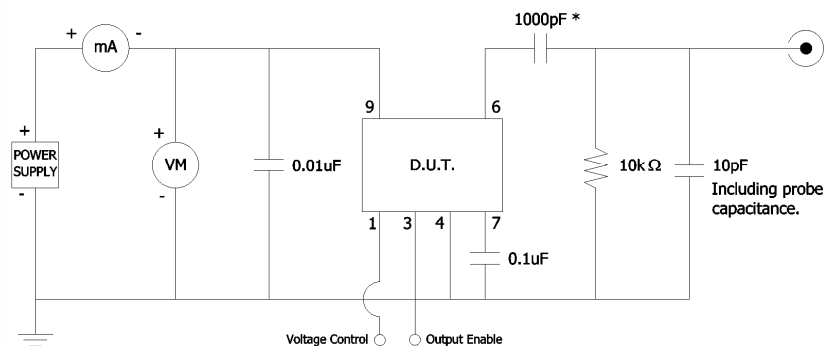
### Control Voltage

| PARAMETER                      | SYMBOL         | CONDITIONS             | MIN | TYP                 | MAX      | UNIT  |
|--------------------------------|----------------|------------------------|-----|---------------------|----------|-------|
| Control Voltage                | $V_C$          | $V_{CC} = +3.3V$       | 0.0 | 1.65                | 3.3      | V     |
| Frequency Tuning [VCTCXO Only] | $\Delta f/f_0$ | Specified $V_C$ Range  |     | $\pm 5$ to $\pm 10$ |          | ppm   |
| Input Impedance                | $Z_{Vc}$       | -                      | 100 | -                   | -        | kOhms |
| Linearity                      | L              | Best Straight Line Fit | -   | $\pm 5$             | $\pm 10$ | %     |
| Transfer Function              | -              | -                      |     | Positive            |          | -     |

### Test Circuit

#### Clipped Sine

\* DC-Cut Capacitor: Add 1000pF capacitor between the TCXO output and input of load.

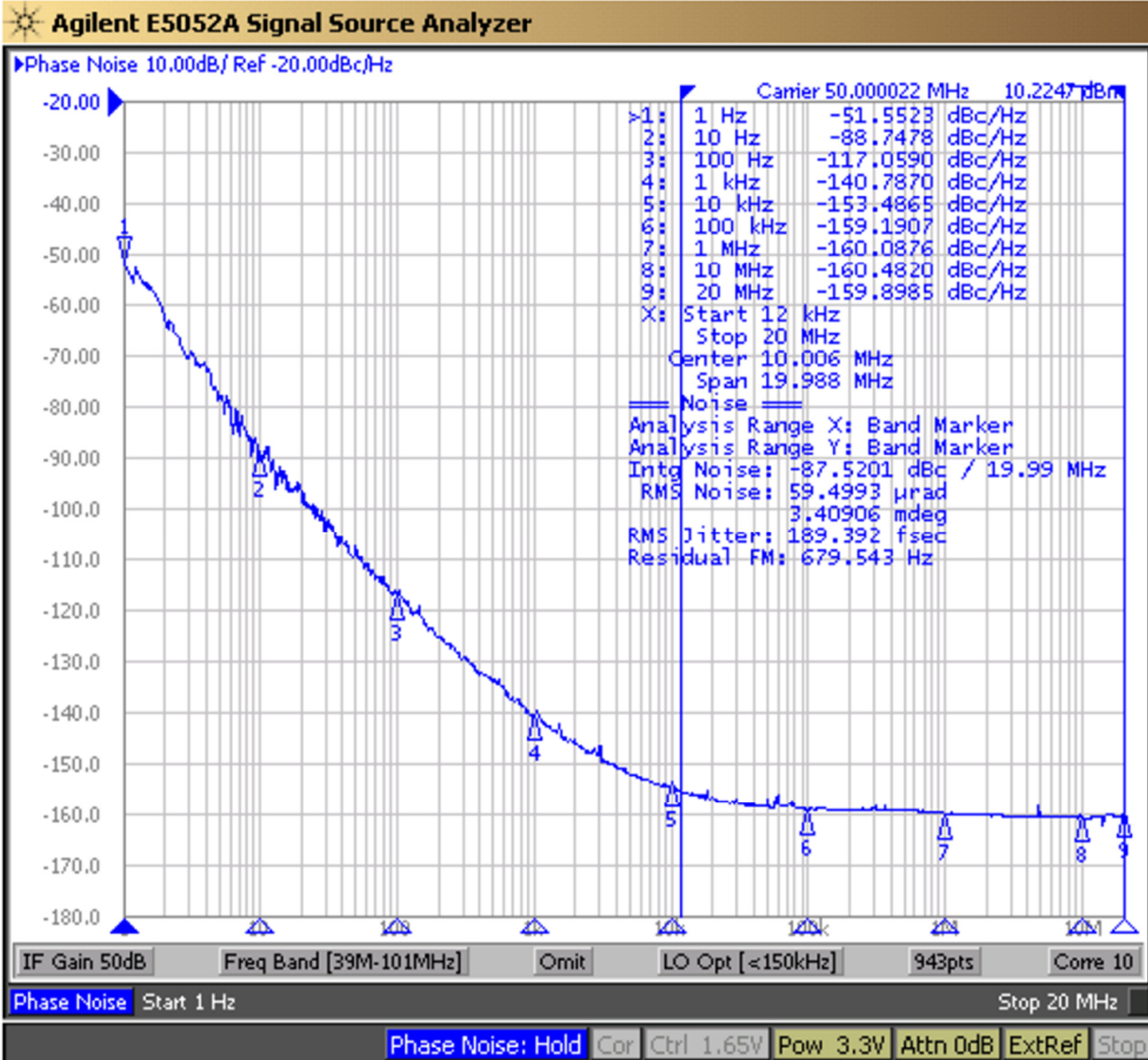


## Electrical Specifications

### Performance Data

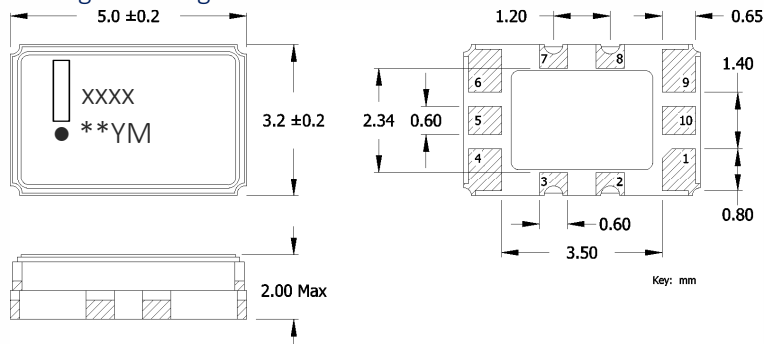
Phase Noise [typical]

50MHz,  $V_{CC} = +3.3V$ ,  $T_A = +25^\circ C$



## Mechanical Specifications

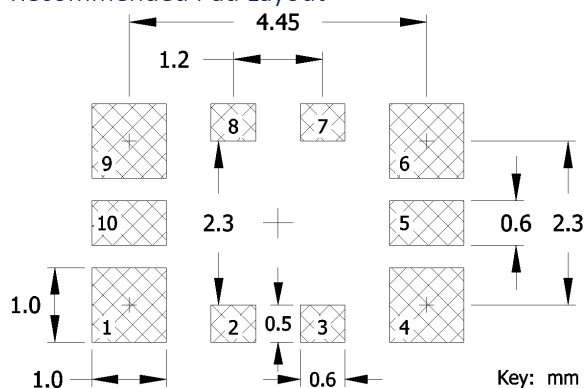
### Package Drawing



### Marking Information

1. xxxx – Frequency Code, 4-digits. See Page 7.
2. ● – Pin 1 Identifier.
3. \*\* – Manufacturing Site Code.
4. YM – Date Code; Y – year [last digit], M – month. [See Table I for month codes.]
5. – Area for Crystal Lot Code or Date Code.

### Recommended Pad Layout



### Notes

1. DO NOT make connections to non-labeled pins or castellations as they may have internal connections used in the manufacturing process.
2. JEDEC termination code (e4). Barrier-plating is nickel [Ni] with gold [Au] flash plate.
3. Reflow conditions per JEDEC J-STD-020; +260°C maximum, 10 seconds.
4. MSL = 1.

### Pin Assignments

| Pin | Symbol          | Function                        |
|-----|-----------------|---------------------------------|
| 1   | Vc              | Voltage Control Note 1          |
| 2   | -               | Do Not Connect                  |
| 3   | EOH             | Enable, Pin 3 [Optional] Note 2 |
| 4   | GND             | Circuit & Package               |
| 5   | -               | Do Not Connect                  |
| 6   | Output          | Clipped Sine                    |
| 7   | -               | Vcfilter                        |
| 8   | -               | Do Not Connect                  |
| 9   | V <sub>CC</sub> | Supply Voltage                  |
| 10  | -               | Do Not Connect                  |

### Notes

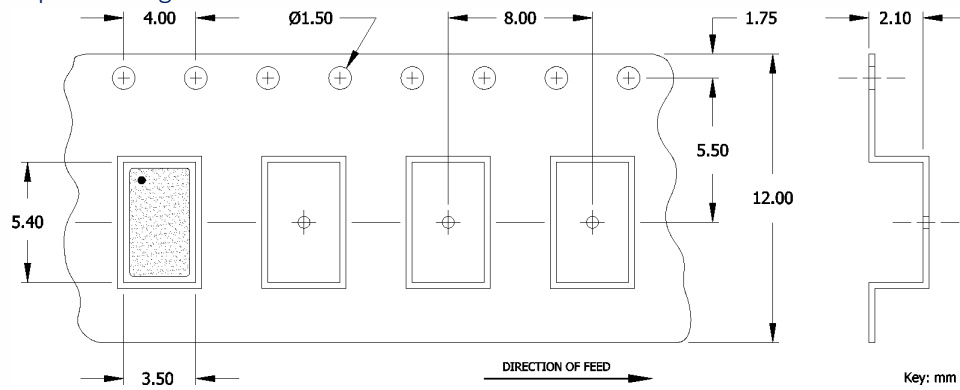
1. Do not connect to Pin 1, if Voltage Control function is not used [TCXO].
2. Do not connect to Pin 3, if Output Enable function is not used.
3. Add 0.1μF capacitor between Pin 7 and ground.
4. DC-Cut Capacitor Required. Add 1000pF capacitor between TCXO output and input of load.

### Table I - Month Code

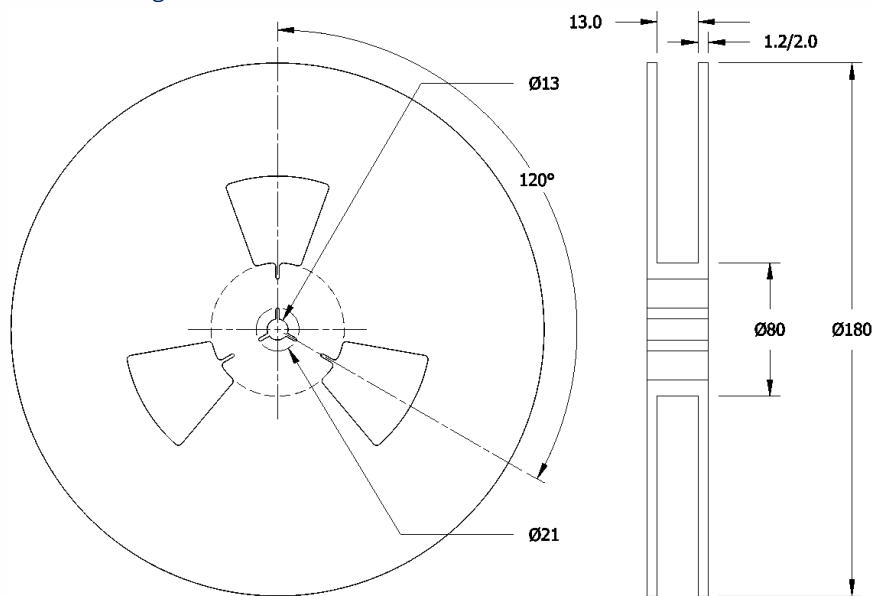
| MONTH      | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|            | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| MONTH CODE | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | X   | Y   | Z   |

### Packaging - Tape and Reel

#### Tape Drawing



#### Reel Drawing



#### Notes

1. Device quantity is 500 pieces maximum per 180mm reel.
2. Complete CTS part number, frequency value and date code information must appear on reel and carton labels.



## Addendum

### Available Frequencies for Stability $\pm 0.50\text{ppm}$ – MHz

| FREQUENCY | ORDERING CODE | MARKING CODE | FREQUENCY | ORDERING CODE | MARKING CODE | FREQUENCY | ORDERING CODE | MARKING CODE |
|-----------|---------------|--------------|-----------|---------------|--------------|-----------|---------------|--------------|
| 10.000000 | 100           | 1000         | 38.880000 | 388           | 3888         |           |               |              |
| 19.200000 | 192           | 1920         | 40.000000 | 400           | 4000         |           |               |              |
| 20.000000 | 200           | 2000         |           |               |              |           |               |              |
| 25.000000 | 250           | 2500         |           |               |              |           |               |              |
| 38.400000 | 384           | 3840         |           |               |              |           |               |              |

### Available Frequencies for Stability $\pm 0.28\text{ppm}$ – MHz

| FREQUENCY | ORDERING CODE | MARKING CODE | FREQUENCY | ORDERING CODE | MARKING CODE | FREQUENCY | ORDERING CODE | MARKING CODE |
|-----------|---------------|--------------|-----------|---------------|--------------|-----------|---------------|--------------|
| 10.000000 | 100           | 1000         | 38.880000 | 388           | 3888         |           |               |              |
| 19.200000 | 192           | 1920         | 40.000000 | 400           | 4000         |           |               |              |
| 20.000000 | 200           | 2000         |           |               |              |           |               |              |
| 25.000000 | 250           | 2500         |           |               |              |           |               |              |
| 38.400000 | 384           | 3840         |           |               |              |           |               |              |

### Available Frequencies for Stability $\pm 0.10\text{ppm}$ – MHz

| FREQUENCY | ORDERING CODE | MARKING CODE | FREQUENCY | ORDERING CODE | MARKING CODE | FREQUENCY | ORDERING CODE | MARKING CODE |
|-----------|---------------|--------------|-----------|---------------|--------------|-----------|---------------|--------------|
| 10.000000 | 100           | 1000         |           |               |              |           |               |              |
| 20.000000 | 200           | 2000         |           |               |              |           |               |              |
| 25.000000 | 250           | 2500         |           |               |              |           |               |              |