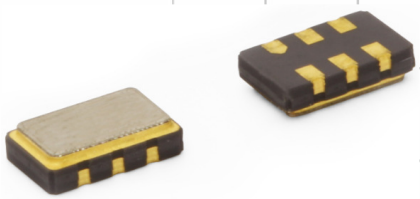
# Model 655

## Ultra Low Jitter LVPECL or LVDS Clock



Part Dimensions:
5.0 × 3.2 × 1.2mm • 62.00mg

### Features

- Ceramic Surface Mount Package
- Ultra Low Phase Jitter Performance, 100fs Typical
- Fundamental or 3rd Overtone Crystal Design
- Frequency Range 80 – 170MHz *
- +2.5V or +3.3V Operation [+1.8V LVDS only]
- Output Enable Standard
- Tape and Reel Packaging, EIA-481

Standard Frequencies

* See Page 8 for common frequencies.
Check with factory for availability of frequencies not listed.

### Applications

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

### Description

CTS Model 655 is a low cost, high performance clock oscillator supporting differential LVPECL or LVDS outputs. Employing the latest IC technology, M655 has excellent stability and very low jitter/phase noise performance.

### Ordering Information

| Model | Output Type | Frequency Code [MHz] | Frequency Stability | Temperature Range | Supply Voltage | Packaging |
|---|---|---|---|---|---|---|
| 655 | P | XXX or XXXX | 3 | G | 3 | T |

| Code | Frequency |
|---|---|
| Product Frequency Code [1] | |

| 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 |
| G | -40°C to +105°C [3] |

| Code | Voltage |
|---|---|
| M | +1.8Vdc [4] |
| 2 | +2.5Vdc |
| 3 | +3.3Vdc |

| Code | Packing |
|---|---|
| T | 1k pcs./reel |

| Code | Stability | Code | Stability | Code | Stability |
|---|---|---|---|---|---|
| 6 | ±20ppm [2] | 4 | ±30ppm | 2 | ±100ppm |
| 5 | ±25ppm | 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 for availability. Temperature codes A and C only.
3] Check factory for availability. Stability codes 2 and 3 only.
4] LVDS output only. Consult factory for availability.

**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 | - | 5.0 | V |
| **Supply Voltage** [Note 1] | $V_{CC}$ | ±5% | 1.710<br>2.375<br>3.135 | 1.8<br>2.5<br>3.3 | 1.890<br>2.625<br>3.465 | V |
| **Supply Current** | | | | | | |
| **LVPECL** | $I_{CC}$ | Maximum Load | - | 55 | 88 | mA |
| **LVDS** | | | - | 45 | 66 | |
| **Operating Temperature** | $T_A$ | - | -10<br>-20<br>-40<br>-40 | +25 | +60<br>+70<br>+85<br>+105 | °C |
| **Storage Temperature** | $T_{STG}$ | - | -50 | - | +125 | °C |

## Frequency Stability

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Frequency Range** | | | | | | |
| **LVPECL** | $f_O$ | - | | 80 - 170 | | MHz |
| **LVDS** | | | | 80 - 170 | | |
| **Frequency Stability** [Note 2] | $\Delta f/f_O$ | - | | 20, 25, 30, 50 or 100 | | ±ppm |
| **Aging** | $\Delta f/f_{25}$ | First Year @ +25°C, nominal $V_{CC}$ | -3 | - | 3 | ppm |

1.] LVDS output only for +1.8V option.

2.] 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 |
| | | | | | | |
| **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 |



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# Electrical Specifications

## Output Parameters

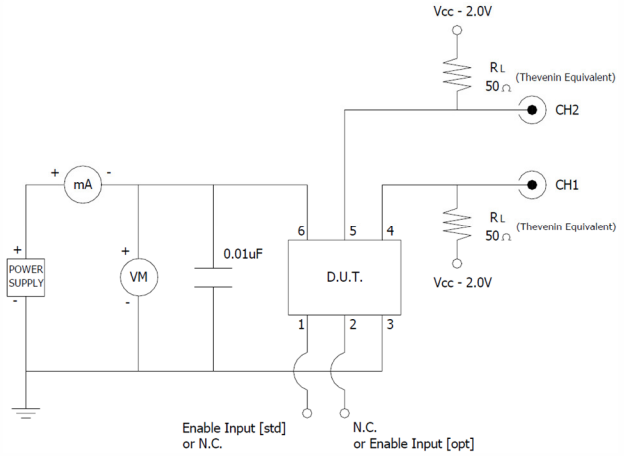
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Start Up Time** | $T_S$ | Application of $V_{CC}$ | - | 2 | 5 | ms |
| **Enable Function [Standby]** | | | | | | |
| **Enable Input Voltage** | $V_{IH}$ | Pin 1 or 2 Logic '1', Output Enabled | $0.7V_{CC}$ | - | - | 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** | tjrms | 80 - 124.9MHz, Bandwidth 12 kHz - 20 MHz | - | - | 200 | fs |
| | | 125 - 170MHz, Bandwidth 12 kHz - 20 MHz | | - | 100 | |
| **Period Jitter, RMS** | pjrms | - | - | 2.6 | - | ps |
| **Period Jitter, pk-pk** | pjpk-pk | - | - | 25 | - | ps |

## Enable Truth Table

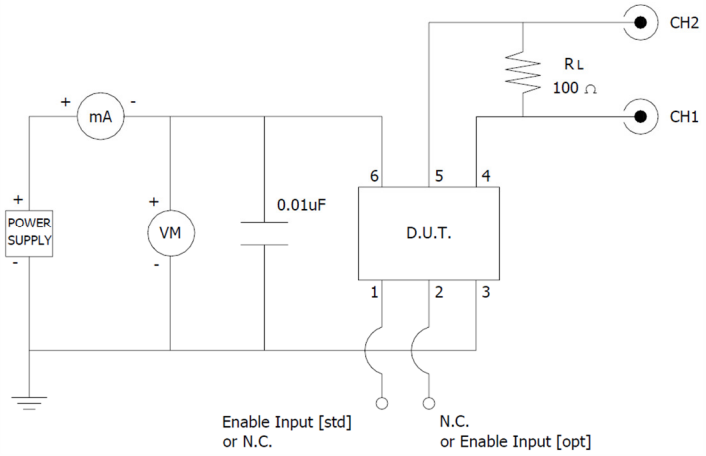
| Pin 1 or Pin 2 | Pin 4 & Pin 5 |
|---|---|
| Logic '1' | Output Enabled |
| Open | Output Enabled |
| Logic '0' | Output Disabled, High Impedance |

## Test Circuit

LVPECL

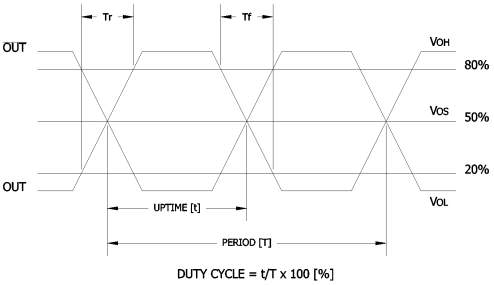



LVDS




## Output Waveform

LVPECL or LVDS



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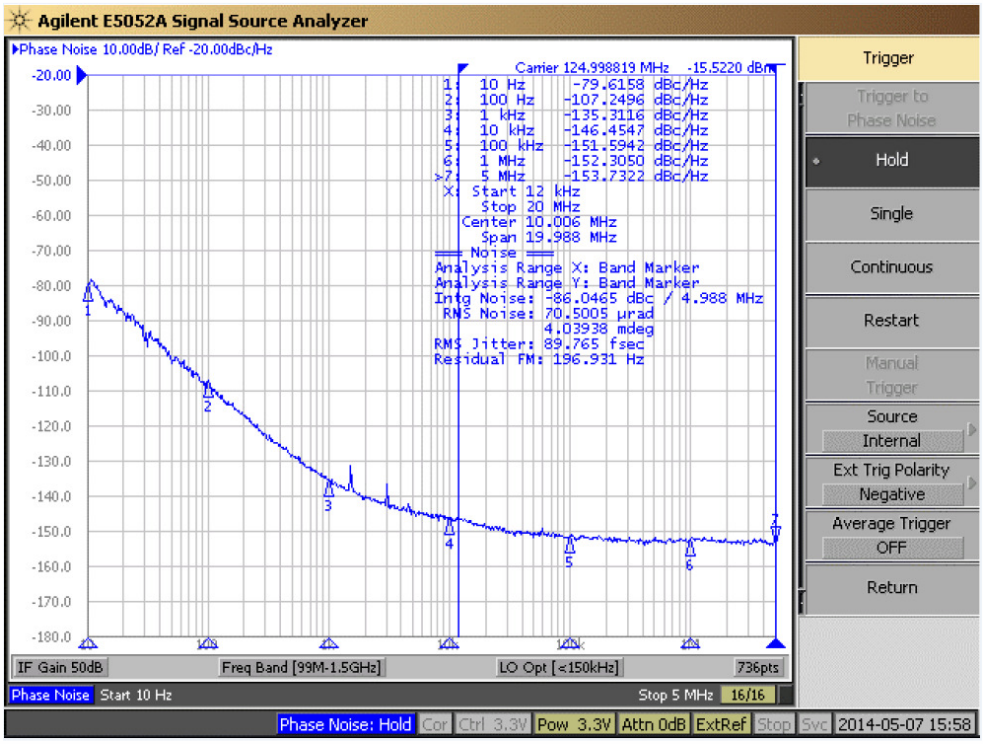
# Electrical Specifications

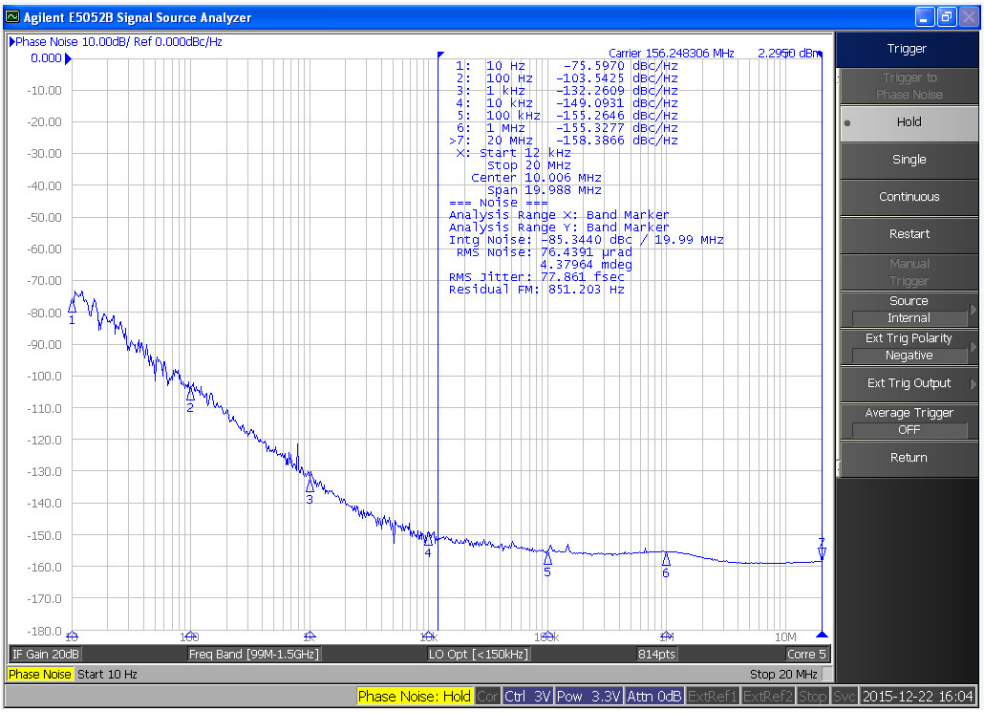
## Performance Data

### Phase Noise [typical]

125.00MHz, LVPECL, $V_{CC}$ = 3.3V, $T_A$ = +25°C




156.25MHz, LVPECL, $V_{CC}$ = 3.3V, $T_A$ = +25°C



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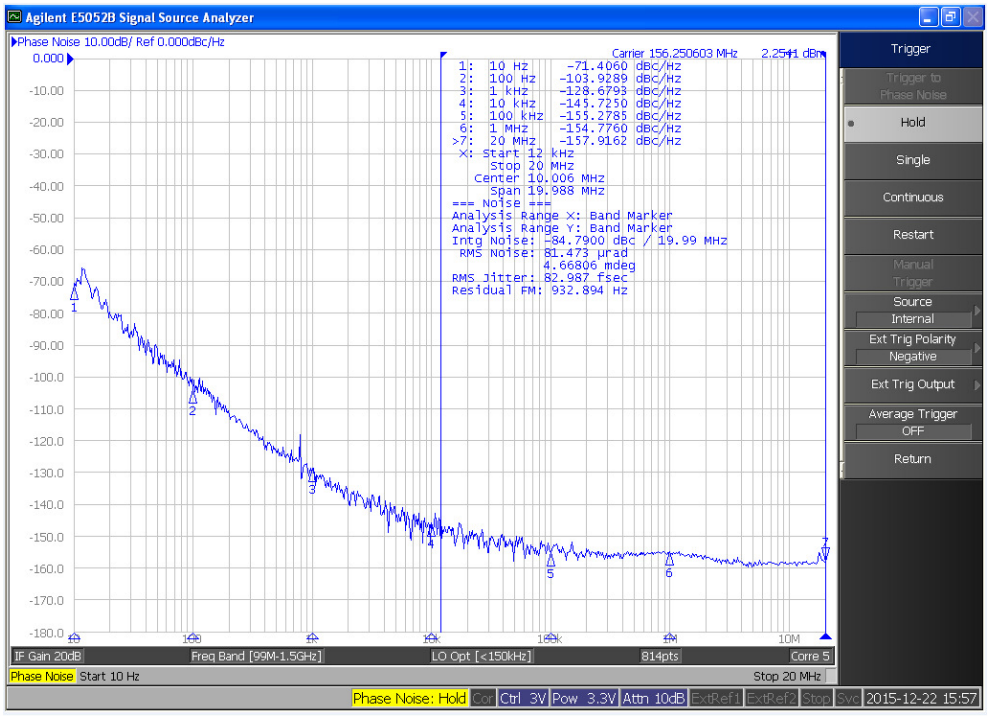
# Electrical Specifications

## Performance Data

### Phase Noise [typical]

156.25MHz, LVDS, $V_{CC}$ = 3.3V, $T_A$ = +25°C




### Phase Noise Tabulated

Typical, $V_{CC}$ = 3.3V, $T_A$ = +25°C

| PARAMETER | SYMBOL | CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| **LVPECL @ 125.00MHz** | | | | |
| **Phase Noise** | | Single Side Band | | |
| | | @ 10Hz | -79.62 | |
| | | @ 100Hz | -107.25 | |
| | | @ 1kHz | -135.31 | |
| | - | @ 10kHz | -146.45 | dBc/Hz |
| | | @ 100kHz | -151.59 | |
| | | @ 1MHz | -152.31 | |
| | | @ 5MHz | -153.73 | |
| **Phase Jitter, RMS** | tjrms | Integration Bandwidth 12kHz - 20MHz | 89.77 | fs |

| PARAMETER | SYMBOL | CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| **LVPECL @ 156.25MHz** | | | | |
| **Phase Noise** | | Single Side Band | | |
| | | @ 10Hz | -75.60 | |
| | | @ 100Hz | -103.54 | |
| | | @ 1kHz | -132.26 | |
| | - | @ 10kHz | -149.09 | dBc/Hz |
| | | @ 100kHz | -155.26 | |
| | | @ 1MHz | -155.33 | |
| | | @ 20MHz | -158.39 | |
| **Phase Jitter, RMS** | tjrms | Integration Bandwidth 12kHz - 20MHz | 77.86 | fs |

| PARAMETER | SYMBOL | CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| **LVDS @ 156.25MHz** | | | | |
| **Phase Noise** | | Single Side Band | | |
| | | @ 10Hz | -71.41 | |
| | | @ 100Hz | -103.93 | |
| | | @ 1kHz | -128.68 | |
| | - | @ 10kHz | -145.73 | dBc/Hz |
| | | @ 100kHz | -155.28 | |
| | | @ 1MHz | -154.78 | |
| | | @ 20MHz | -157.92 | |
| **Phase Jitter, RMS** | tjrms | Integration Bandwidth 12kHz - 20MHz | 82.99 | fs |



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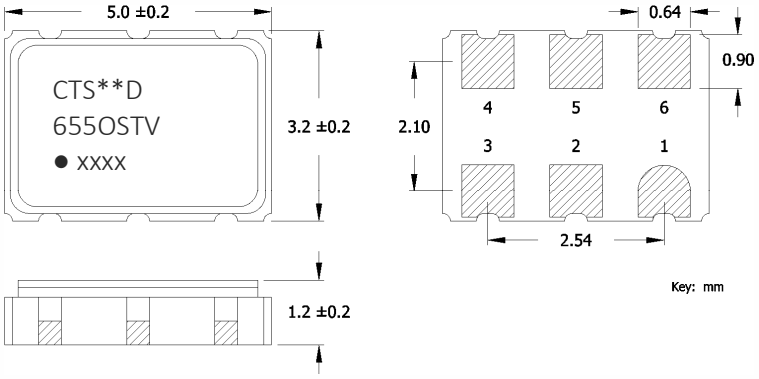
# Mechanical Specifications

## Package Drawing

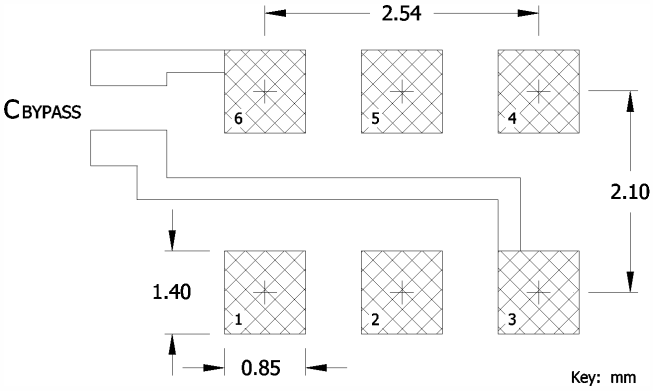



## Marking Information

1. ** - Manufacturing Site Code.
2. D – Date Code. See Table I for codes.
3. O – Output Type; P or E = LVPECL, L or V = LVDS.
3. ST – Frequency Stability/Temperature Code. [Refer to Ordering Information]
4. V – Voltage Code; 3 = 3.3V, 2 = 2.5V.
5. 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 | 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 | $\overline{\text{Output}}$ | Complimentary RF Output |
| 6 | $V_{CC}$ | Supply Voltage |

## Table I - Date Code, Beginning year 2021

| YEAR \ MONTH | | | | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 2025 | 2029 | 2033 | 2037 | A | B | C | D | E | F | G | H | J | K | L | M |
| 2022 | 2026 | 2030 | 2034 | 2038 | N | P | Q | R | S | T | U | V | W | X | Y | Z |
| 2023 | 2027 | 2031 | 2035 | 2039 | a | b | c | d | e | f | g | h | j | k | l | m |
| 2024 | 2028 | 2032 | 2036 | 2040 | n | p | q | r | s | t | u | v | w | x | y | z |



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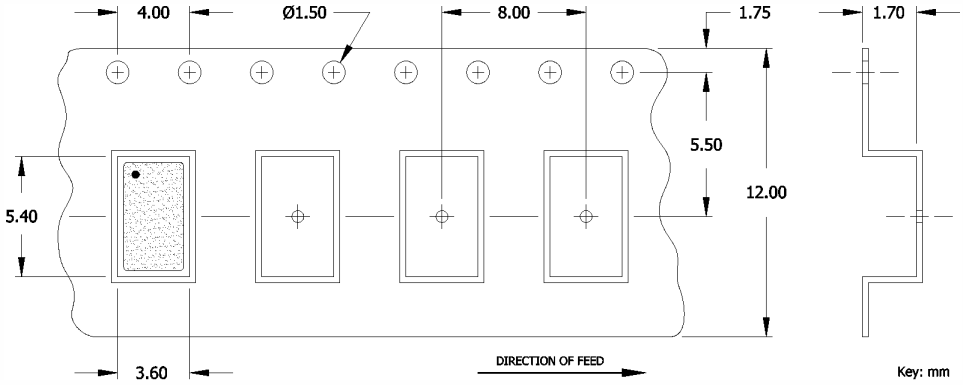
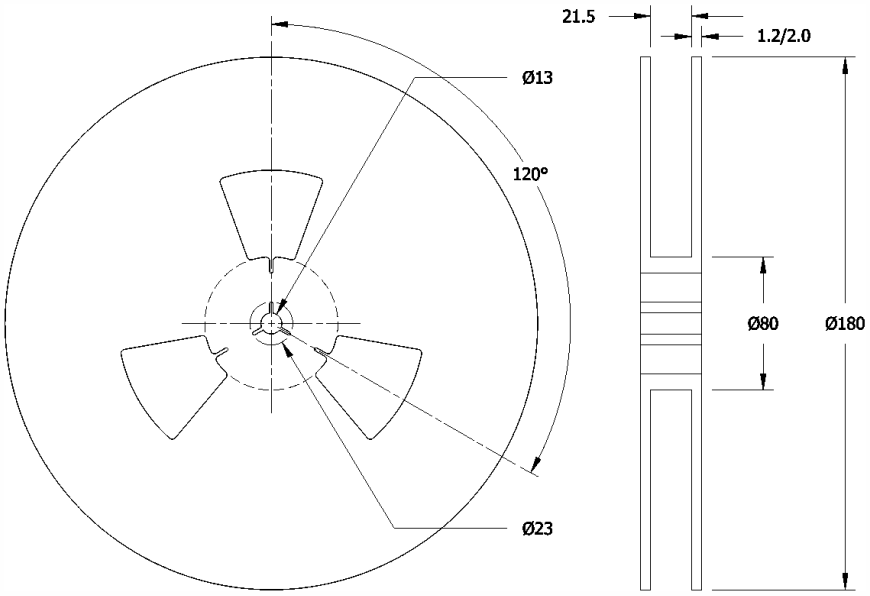
# Packaging - Tape and Reel

## Tape Drawing




## Reel Drawing




## Notes

1. Device quantity is 1k pieces minimum 3k pieces maximum per 180mm reel.
2. Complete CTS part number, frequency value and date code information must appear on reel and carton labels.



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## Addendum

### Common Frequencies Available – MHz

| FREQUENCY | FREQUENCY CODE | FREQUENCY | FREQUENCY CODE | FREQUENCY | FREQUENCY CODE | FREQUENCY | FREQUENCY CODE |
|---|---|---|---|---|---|---|---|
| 80.000000 | 800 | 156.250000 | 1562 | | | | |
| 100.000000 | 1000 | 156.253900 | 156E | | | | |
| 120.000000 | 1200 | 156.253906 | 156A | | | | |
| 125.000000 | 1250 | 161.132800 | 1611 | | | | |
| 133.000000 | 1330 | 167.372800 | 167A | | | | |
| 148.351600 | 148A | | | | | | |
| 148.500000 | 1485 | | | | | | |
| 150.000000 | 1500 | | | | | | |
| 153.600000 | 1536 | | | | | | |
| 155.520000 | 1555 | | | | | | |



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