# RClamp3552TQ
## Low Voltage RailClamp®
## 2-Line ESD Protection

**PROTECTION PRODUCTS**

## Description

RClamp®3552TQ is a low voltage RailClamp which can provide ESD protection to IEC 61000-4-2 on high speed ports. It is manufactured using Semtech's proprietary low voltage technology, designed to minimize both the ESD peak clamping and TLP clamping voltage. These devices "snap-back" to a low on-state voltage when the breakdown voltage of the device is exceeded. This has the advantage of lowering the overall ESD clamping voltage. When the device is in the on-state, the dynamic resistance is typically 0.3 Ohms, further minimizing the ESD clamping. Maximum capacitance is only 0.4pF allowing the RClamp3552TQ to be used in applications operating in excess of 6 GHz without appreciable signal attenuation. Each device will protect two lines operating at 3.5 volts.

RClamp3552TQ is in a DFN 1.0 x 0.6 x 0.40 mm 3-Lead package. The combination of low peak ESD clamping, low dynamic resistance, and low capacitance makes this device suitable for applications such as USB 3.1 Gen 1, LVDS, audio, and V-By-One interfaces.

## Features

- High ESD withstand Voltage: +/-17kV (Contact) & +/-20kV(Air) per IEC 61000-4-2
- Very small PCB area: 0.6 $mm^2$
- Protects up to two data lines
- Low ESD clamping voltage
- Working voltage: 3.5 V
- Low capacitance: 0.4pF Maximum
- Low dynamic resistance: 0.3 Ohms Typical
- Qualified to AEC-Q100, Grade 1 and AEC-Q101
- Solid-state silicon-avalanche technology

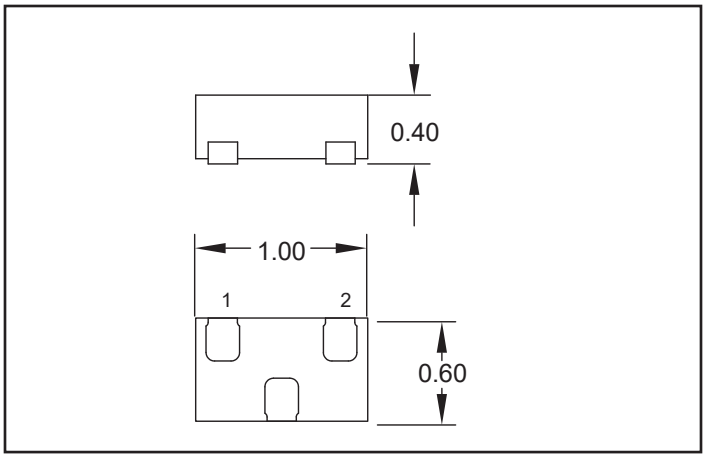
## Mechanical Characteristics

- Package: DFN 1.0 x 0.6 x 0.40 mm 3-Lead
- Pb-Free, Halogen Free, RoHS/WEEE compliant
- Lead Finish: Lead Free
- Molding compound flammability rating: UL 94V-0
- Marking: Marking code + dot matrix date code
- Packaging: Tape and Reel

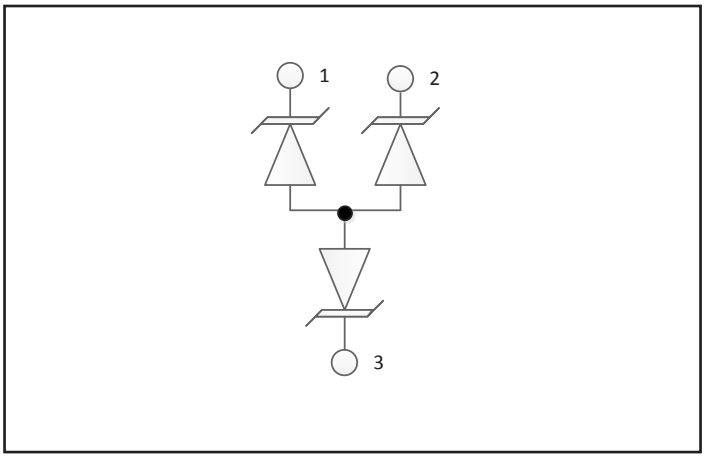
## Applications

- Automotive Applications
- USB 3.1 Gen 1
- V-By-One
- LVDS
- MIPI/MDDI
- MyDP
- Audio Ports

## Package Dimension (mm)




## Schematic & Pin Configuration



## Absolute Maximum Rating

| Rating | Symbol | Value | Units |
|---|---|---|---|
| Peak Pulse Current (tp = 8/20µs) | $I_{PP}$ | 4 | A |
| ESD per IEC 61000-4-2 (Air)(1)<br>ESD per IEC 61000-4-2 (Contact)(1) | $V_{ESD}$ | ±20<br>±17 | kV |
| ESD per ISO-10605 (Contact)(2) (3)<br>ESD per ISO-10605 (Air)(2) (3) | $V_{ESD}$ | ±25<br>±30 | kV |
| Operating Temperature | $T_{OP}$ | -40 to +125 | °C |
| Junction Temperature and Storage Temperature | $T_J$ & $T_{STG}$ | -55 to +150 | °C |

## Electrical Characteristics (T=25°C unless otherwise specified)

| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| Reverse Stand-Off Voltage | $V_{RWM}$ | Pin 1 to Pin 3 or Pin 2 to Pin 3 | | | | 3.5 | V |
| Reverse Breakdown Voltage | $V_{BR}$ | $I_{BR}$ = 10µA<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | | 7.5 | 8.8 | 9.8 | V |
| Reverse Leakage Current | $I_R$ | $V_{RWM}$ = 3.5V<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | | | 0.01 | 0.05 | µA |
| Clamping Voltage | $V_C$ | $t_p$ = 8/20µs<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | $I_{PP}$ = 1A | | 3.5 | 5 | V |
| | | | $I_{PP}$ = 4A | | 5 | 6.5 | |
| ESD Clamping Voltage[3] | $V_C$ | $t_p$ = 0.2/100ns,<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | $I_{PP}$ = 16A | | 9.5 | | V |
| | | | $I_{PP}$ = -16A | | -9.5 | | |
| Dynamic Resistance[3,4] (Positive) | $R_{DYN}$ | $t_p$ = 0.2/100ns<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | | | 0.3 | | Ω |
| Dynamic Resistance[3,4] (Negative) | $R_{DYN}$ | $t_p$ = 0.2/100ns<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | | | 0.3 | | |
| Junction Capacitance | $C_J$ | $V_R$ = 0V, f = 1MHz<br>Pin 1 to Pin 3 or Pin 2 to Pin 3 | | | 0.3 | 0.4 | pF |

Notes:

1) ESD gun return path connected to ESD ground plane

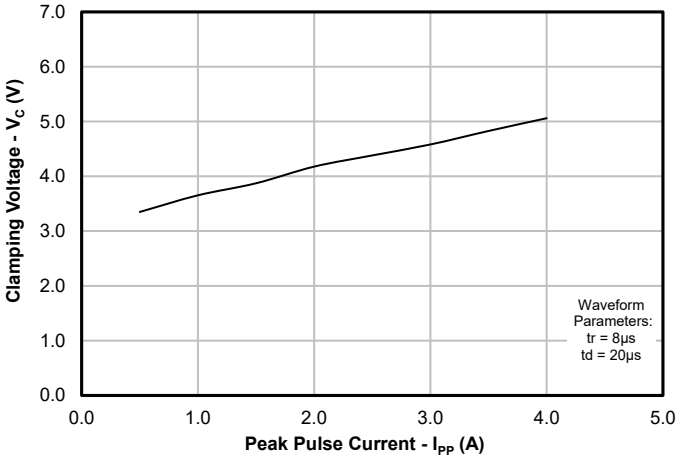
2) ESD Gun return path to Horizontal Coupling Plane (HCP); Test conditions: 150pF/330pF, 2kΩ

3) Transmission Line Pulse Test (TLP) Settings: tp = 100ns, tr = 0.2ns, $I_{TLP}$ and $V_{TLP}$ averaging window: t1 = 70ns to t2 = 90ns.

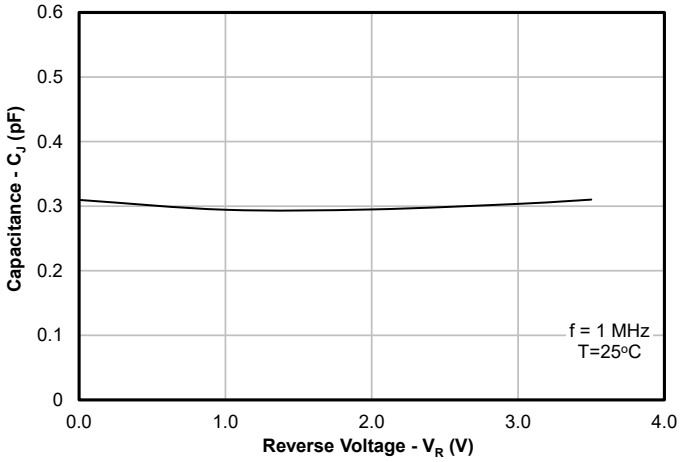
4) Dynamic resistance calculated from $I_{TLP}$ = 4A to $I_{TLP}$ = 16A

# Typical Characteristics

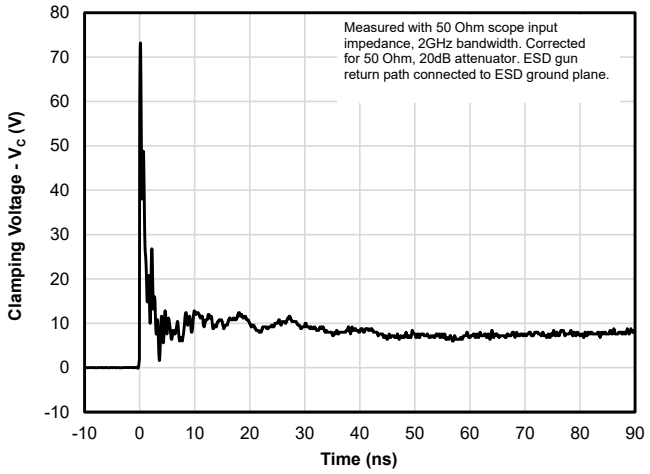
### Clamping Voltage vs. Peak Pulse Current (tp=8/20µs)
### Pin 1 to Pin 3 or Pin 2 to Pin 3



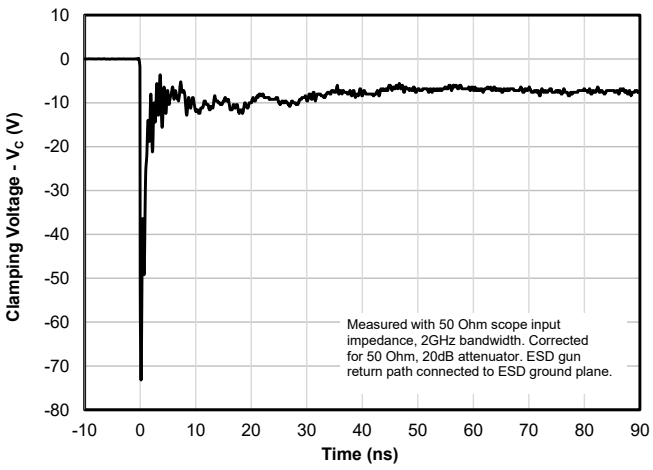

### Junction Capacitance vs. Reverse Voltage
### Pin 1 to Pin 3 or Pin 2 to Pin 3



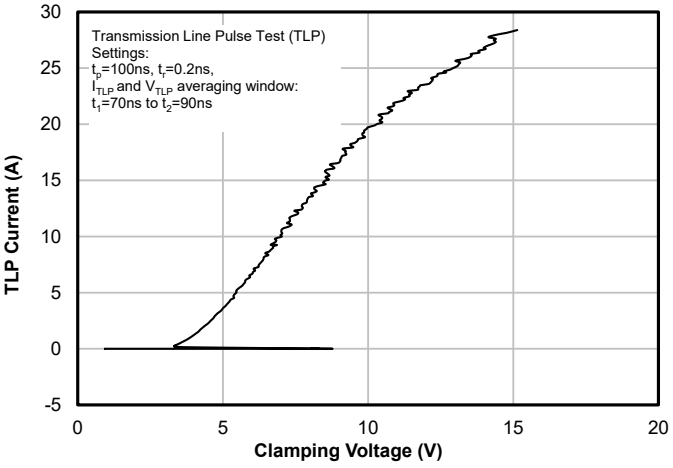

### ESD Clamping (+8kV Contact per IEC 61000-4-2)
### Pin 1 to Pin 3 or Pin 2 to Pin 3



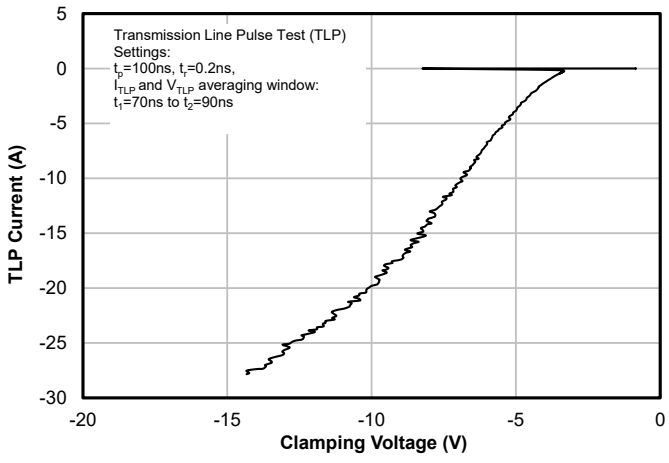

### ESD Clamping (-8kV Contact per IEC 61000-4-2)
### Pin 1 to Pin 3 or Pin 2 to Pin 3




### TLP Characteristic (Positive)

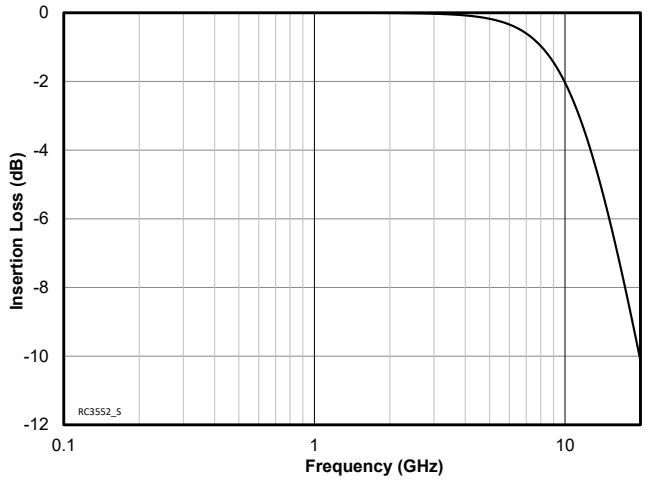



### TLP Characteristic (Negative)

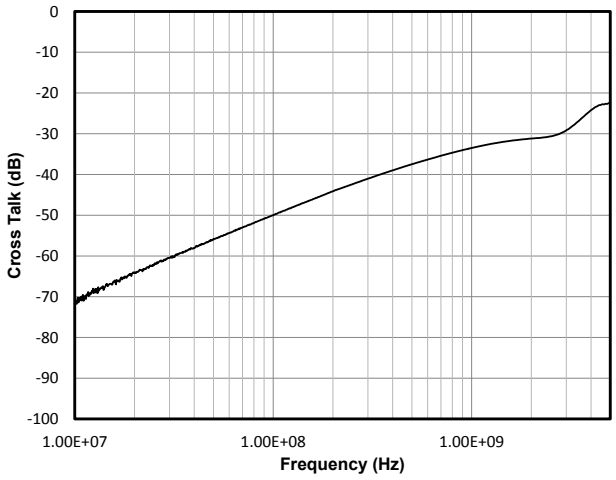


# Typical Characteristics (Continued)

**Typical Insertion Loss - S21**




**Analog Crosstalk**

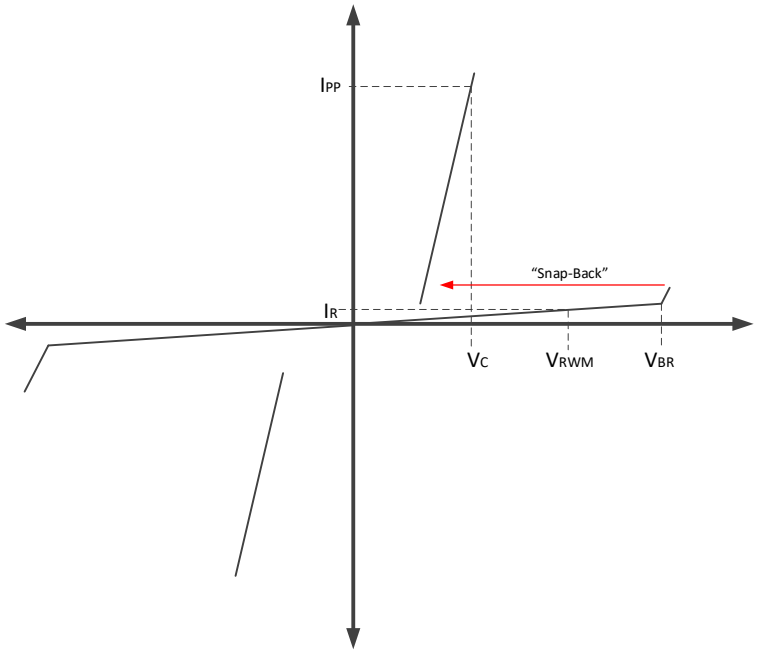


# Applications Information

### Device Operation

This device utilizes a multi-junction structure that is designed to switch to a low voltage state when triggered by ESD, EOS, or other transient events. During normal operation, the device will present a high impedance to the circuit for voltage up to the working voltage ($V_{RWM}$) of the device. When the voltage across the device terminals exceeds the breakdown voltage($V_{BR}$), avalanche breakdown occurs in the blocking junction causing the device to "snap-back" or switch to a low impedance on-state. This has the advantage of lowering the overall clamping voltage ($V_C$) as ESD peak pulse current ($I_{PP}$) flows through the device. Once the current subsides, the device will return to a high impedance off-state. Since this device is bidirectional, it will behave the same way for positive or negative polarity transient events.

| Symbol | Parameter |
|---|---|
| $V_{RWM}$ | Maximum Working Voltage |
| $V_{TRIG}$ | Trigger Voltage |
| $V_C$ | Clamping Voltage |
| $I_R$ | Reverse Leakage Current |
| $I_{PP}$ | Peak Pulse Current |




**Characteristic Curve**

# Applications Information

### Assembly Guidelines

The figure at the right details Semtech's recommended mounting pattern. Recommended assembly guidelines are shown in Table 2. Note that these are only recommendations and should serve only as a starting point for design since there are many factors that affect the assembly process. Exact manufacturing parameters will require some experimentation to get the desired solder application. Semtech's recommended mounting pattern is based on the following design guidelines:

### Land Pattern

The recommended land pattern follows IPC standards and is designed for maximum solder coverage. Detailed dimensions are shown elsewhere in this document.

### Solder Stencil

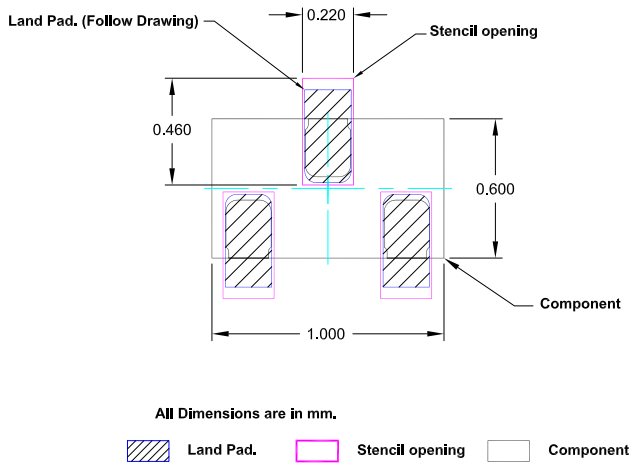
Stencil design is one of the key factors which will determine the volume of solder paste which is deposited onto the land pad. The area ratio of the stencil aperture will determine how well the stencil will print. The area ratio takes into account the aperture shape, aperture size, and stencil thickness. An area ratio of 0.70 – 0.75 is preferred for the subject package. The area ratio of a rectangular aperture is given as:

Area Ratio = (L * W )/ (2 * (L + W) * T)

Where:
L = Aperture Length
W = Aperture Width
T = Stencil Thickness

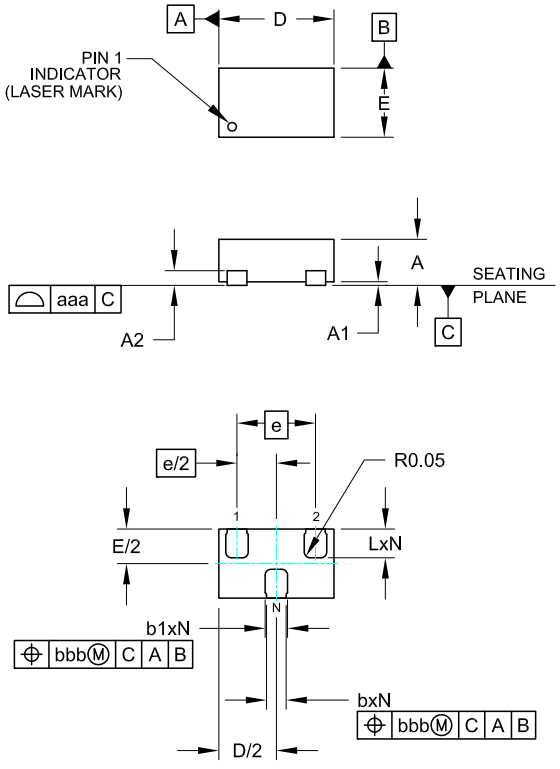
Semtech recommends a stencil thickness of 0.100mm for this device. The stencil should be laser cut with electro-polished finish. The stencil should have a positive taper of approximately 5 degrees. Electro polishing and tapering the walls results in reduced surface friction and better paste release. Due to the small aperture size, a solder paste with Type 4 or smaller particles are recommended. Assuming a 100um thick stencil, the aperture dimensions shown will yield an area ratio of approximately 0.75.

### Recommended Mounting Pattern




| Table 2 - Recommended Assembly Guidelines | |
|---|---|
| **Assembly Parameter** | **Recommendation** |
| Solder Stencil Design | Laser Cut, Electro-Polished |
| Aperture Shape | Rectangular |
| Solder Stencil Thickness | 0.100mm (0.004") |
| Solder Paste Type | Type 4 size sphere or smaller |
| Solder Reflow Profile | Per JEDEC J-STD-020 |
| PCB Solder pad Design | Non-Solder Mask Defined |
| PCB Pad Finish | OSP or NiAu |

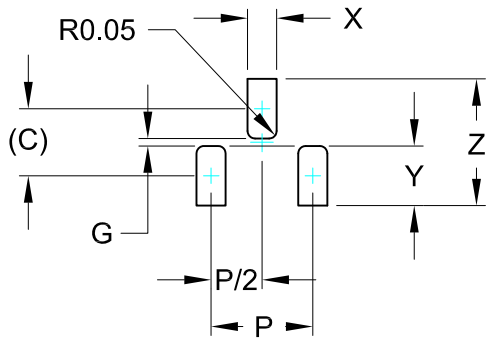
## Outline Drawing - DFN 1.0 x 0.6 x 0.40 mm 3-Lead




| DIMENSIONS | | | |
|---|---|---|---|
| DIM | MILLIMETERS | | |
| | MIN | NOM | MAX |
| A | 0.37 | 0.40 | 0.43 |
| A1 | 0.00 | 0.02 | 0.05 |
| A2 | | (0.13) | |
| b | 0.145 | 0.17 | 0.195 |
| b1 | 0.175 | 0.20 | 0.225 |
| D | 0.90 | 1.00 | 1.10 |
| E | 0.50 | 0.60 | 0.70 |
| e | | 0.68 BSC | |
| L | 0.225 | 0.25 | 0.275 |
| N | | 3 | |
| aaa | | 0.08 | |
| bbb | | 0.10 | |

NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).

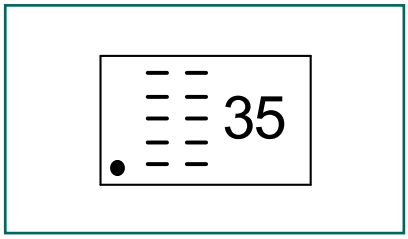
## Land Pattern - DFN 1.0 x 0.6 x 0.40 mm 3-Lead



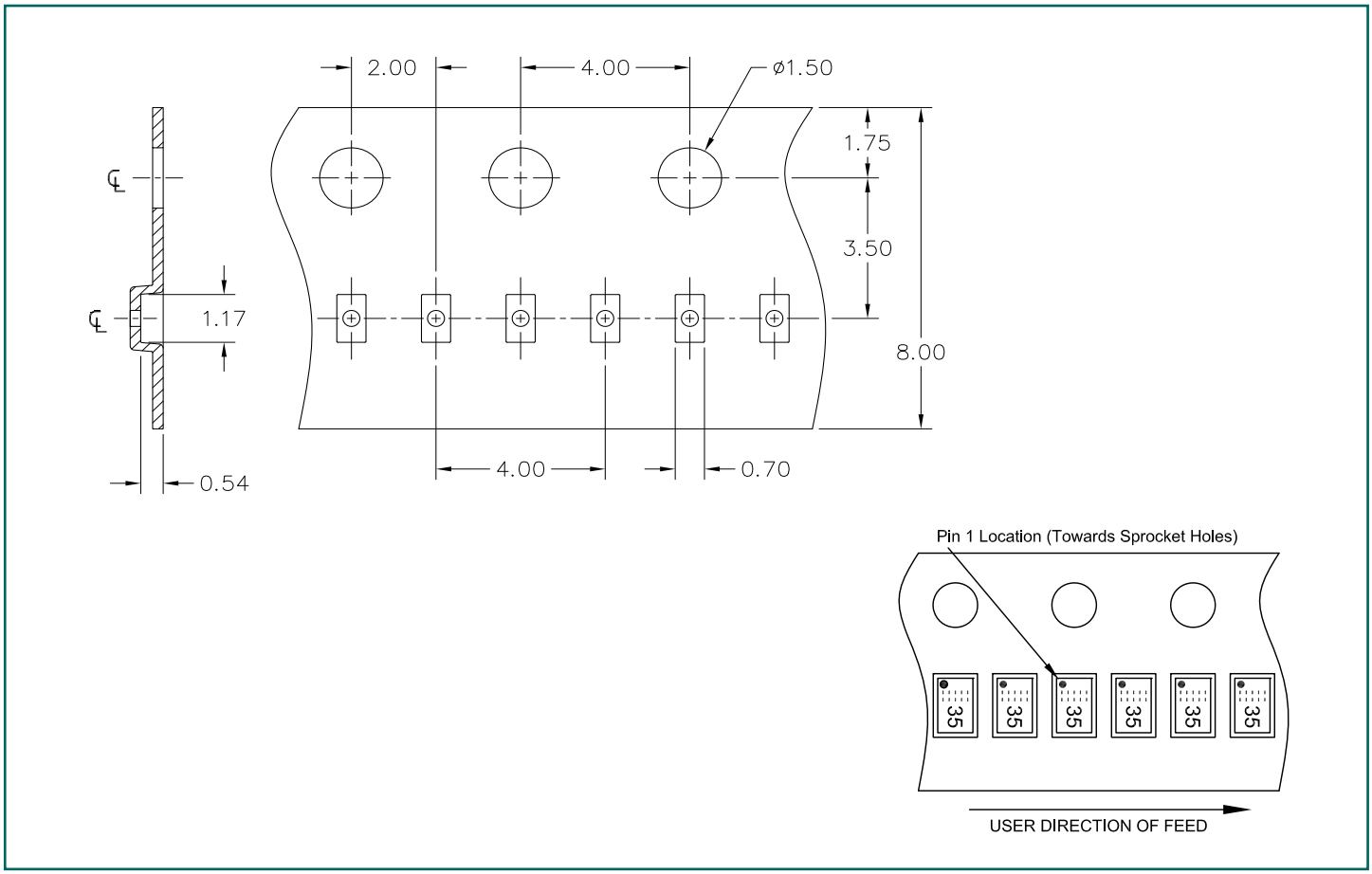

| DIMENSIONS | |
|---|---|
| DIM | MILLIMETERS |
| C | (0.45) |
| G | 0.05 |
| P | 0.68 |
| X | 0.20 |
| Y | 0.40 |
| Z | 0.85 |

NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

## Marking Code




## Tape and Reel Specification




## Ordering Information

| Part Number | Qty per Reel | Reel Size |
|---|---|---|
| RClamp3552TQTNT | 10,000 | 7” |

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