RClamp1631PQ
RClamp2831PQ
Low Capacitance RailClamp®

PROTECTION PRODUCTS

Description

RClamp1631PQ and RClamp2831PQ are low capacitance RailClamp TVS for ESD and EOS protection of high-speed interfaces in automotive applications. They are designed to provide minimal capacitive loading and low-harmonic generation on RF antenna lines.

These devices incorporate low clamping voltage and asymmetric trigger-voltages providing protection for RF pins which pass both DC input voltages and AC output signal voltages. ESD protection characteristics are highlighted by low typical dynamic resistance, low peak ESD clamping voltage, and high ESD withstand voltage (±30kV contact per IEC 61000-4-2). Each device will protect one high-speed data line operating at 16V or 28V and will withstand short-to-battery fault conditions in 12V and 24V systems without damage. These devices are qualified to AEC-Q100 (Grade 1) and AEC-Q101 .

Features

- High ESD withstand Voltage: ±30kV (Contact & Air) per IEC 61000-4-2
- Survives short-to-battery fault conditions in 12V and 24V systems
- Working voltage: 16V and 28V
- Low harmonic distortion
- Low ESD clamping voltage
- Low capacitance: 0.4pF Maximum
- Qualified to AEC-Q100(Grade 1) and AEC-Q101
- Solid-state silicon-avalanche technology

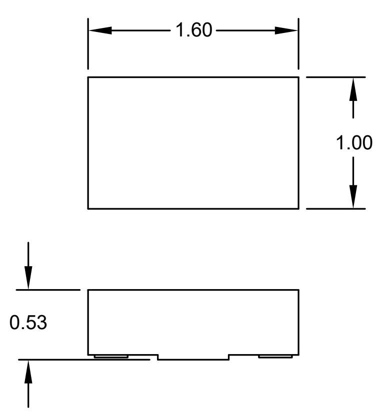
Mechanical Characteristics

- Package: DFN 1.60 x 1.00 x 0.53mm 2-Lead
- Pb-free, Halogen Free, RoHS/WEEE compliant
- Lead Finish: Pb-free
- Marking: Marking code
- Packaging: Tape and Reel

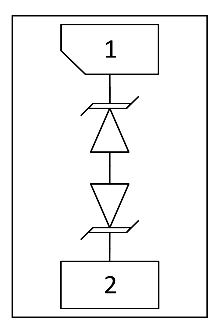
Applications

- RF Radio Antennas
- Automotive Ethernet
- CAN Bus

Package Dimension(mm)



Schematic & Pin Configuration



(Bottom View)

Absolute Maximum Rating

Rating	Symbol	Value	Units
ESD per IEC 61000-4-2 (Air)(1) ESD per IEC 61000-4-2 (Contact)(1)	V_{ESD}	±30 ±30	kV
ESD per ISO-10605 (Air)(2) ESD per ISO-10605 (Contact)(2)	V_{ESD}	±30 ±30	kV
Operating Temperature	T_{OP}	-40 to +125	°C
Storage Temperature	T_{STG}	-55 to +150	°C

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

RClamp1631PQ

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	V_{RWM}	Pin 1 to Pin 2	T = -40°C to 125°C			16	V
		Pin 2 to Pin 1				3.3	
Reverse Breakdown Voltage	V_{BR}	I_t = 1mA, Pin 1 to Pin 2	T = -40°C to 125°C	20	24.5	30	V
		I_t = 1mA, Pin 2 to Pin 1		6	8.2	11	V
Reverse Leakage Current	I_R	V_{RWM} = 16V, Pin 1 to Pin 2	T = 25°C		<5	150	nA
			T = 125°C		<10	250	
Peak Pulse Current	I_{PP}	tp = 1.2/50µs (Voltage), 8/20µs (Current) Combination Waveform, Rs = 2 Ohms	Pin 1 to Pin 2			8	A
			Pin 2 to Pin 1			10	
Clamping Voltage	V_C		I_{PP} = 8A, Pin 1 to Pin 2		27		V
			I_{PP} = 10A, Pin 2 to Pin 1		8		
ESD Clamping Voltage[3]	V_C	t_p = 0.2/100ns, Pin 1 to Pin 2	I_{PP} = 4A		21.5		V
			I_{PP} = 16A		26		
		t_p = 0.2/100ns, Pin 2 to Pin 1	I_{PP} = 4A		5		
			I_{PP} = 16A		8.6		
Dynamic Resistance[3,4]	R_{DYN}	t_p = 0.2/100ns, Pin 1 to Pin 2			0.38		Ω
Junction Capacitance	C_J	V_R = 0V, f = 1MHz, Pin 1 to 2 or Pin 2 to 1			0.33	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: a)150pF, 330Ω b) 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

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

RClamp2831PQ

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	V_{RWM}	Pin 1 to Pin 2	T = -40°C to 125°C			28	V
		Pin 2 to Pin 1				3.3	
Reverse Breakdown Voltage	V_{BR}	I_t = 1mA, Pin 1 to Pin 2	T = -40°C to 125°C	31.5	36	44.5	V
		I_t = 1mA, Pin 2 to Pin 1		6	8	11	V
Reverse Leakage Current	I_R	V_{RWM} = 28V, Pin 1 to Pin 2	T = 25°C		<5	150	nA
			T = 25°C		<10	250	
Peak Pulse Current	I_{PP}	tp = 1.2/50μs (Voltage), 8/20μs (Current) Combination Waveform R_S = 2 Ohms	Pin 1 to Pin 2			7	A
			Pin 2 to Pin 1			10	
Clamping Voltage	V_C		I_{PP} = 7A, Pin 1 to Pin 2		39		V
			I_{PP} = 10A, Pin 2 to Pin 1		10		
ESD Clamping Voltage[2]	V_C	t_p = 0.2/100ns, Pin 1 to Pin 2	I_{PP} = 4A		35		V
			I_{PP} = 16A		42		
		t_p = 0.2/100ns, Pin 2 to Pin 1	I_{PP} = 4A		4.8		
			I_{PP} = 16A		8.7		
Dynamic Resistance[2,3]	R_{DYN}	t_p = 0.2/100ns, Pin 1 to Pin 2			0.35		Ω
Junction Capacitance	C_J	V_R = 0V, f = 1MHz, Pin 1 to Pin 2 or Pin 2 to Pin 1			0.35	0.4	pF

Notes

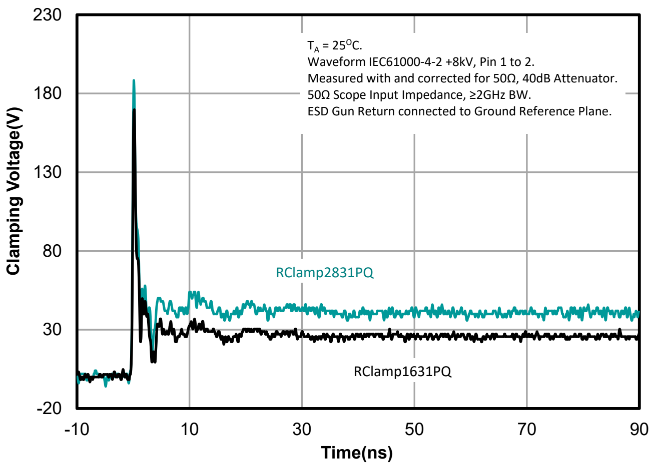
1) ESD gun return path connected to ESD ground plane.

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

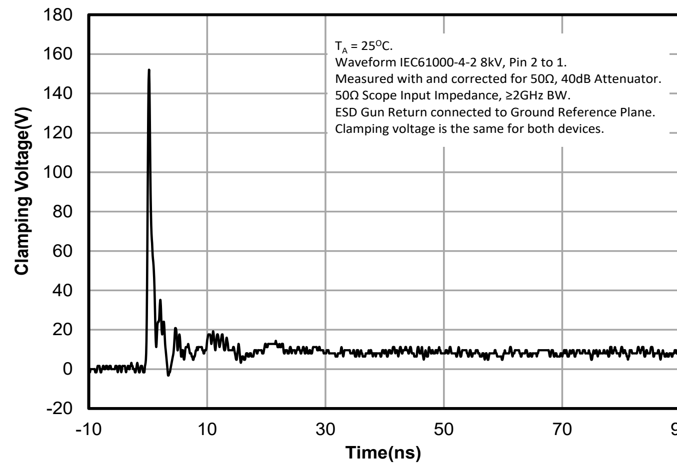
3) Dynamic resistance calculated from I_{TLP} = 4A to I_{TLP} = 16A

Typical Characteristics

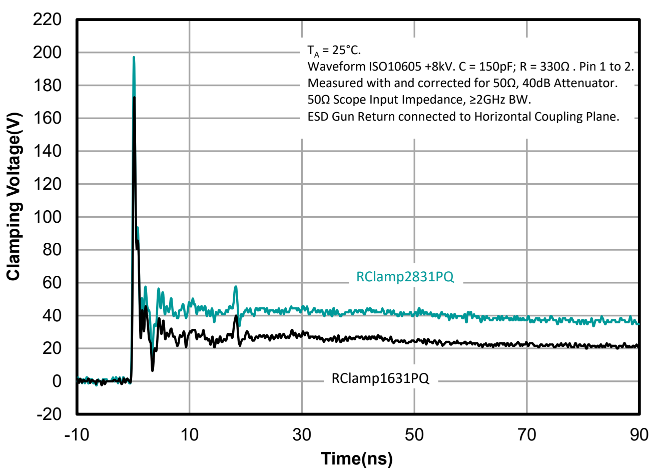
ESD Clamping Pin 1 to 2
(8kV Contact per IEC 61000-4-2)



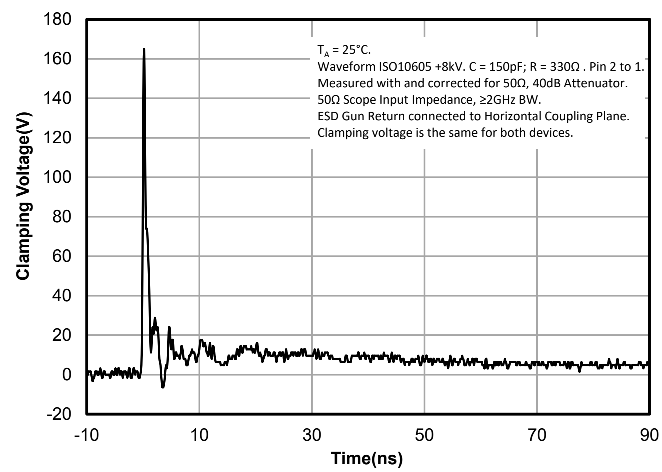
ESD Clamping Pin 2 to 1
(8kV Contact per IEC 61000-4-2)



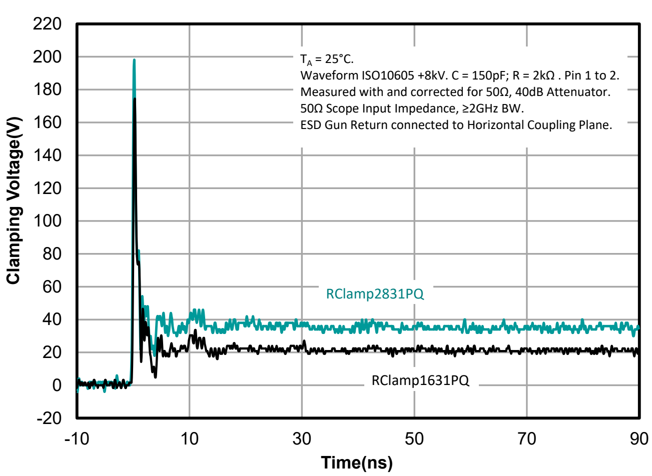
ESD Clamping Pin 1 to 2
(8kV Contact per ISO-10605 150pF, 330Ω)



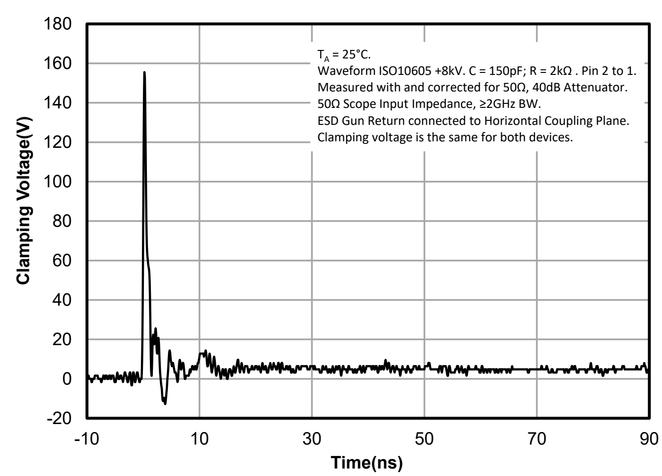
ESD Clamping Pin 2 to 1
(8kV Contact per ISO-10605 150pF, 330Ω)



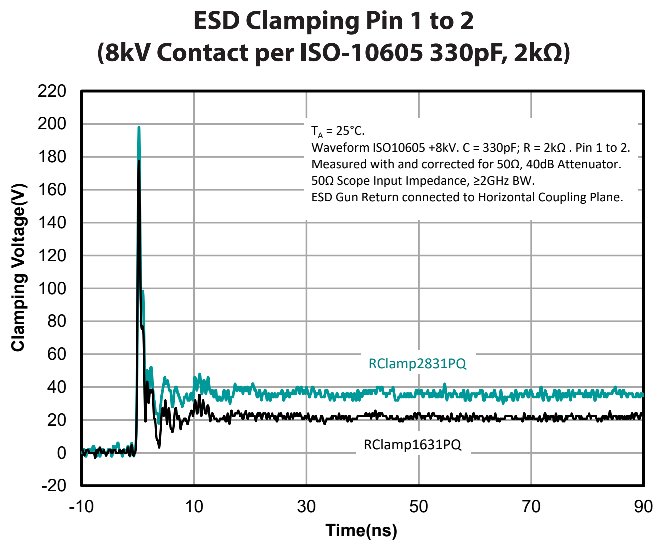
ESD Clamping Pin 1 to 2
(8kV Contact per ISO-10605 150pF, 2kΩ)

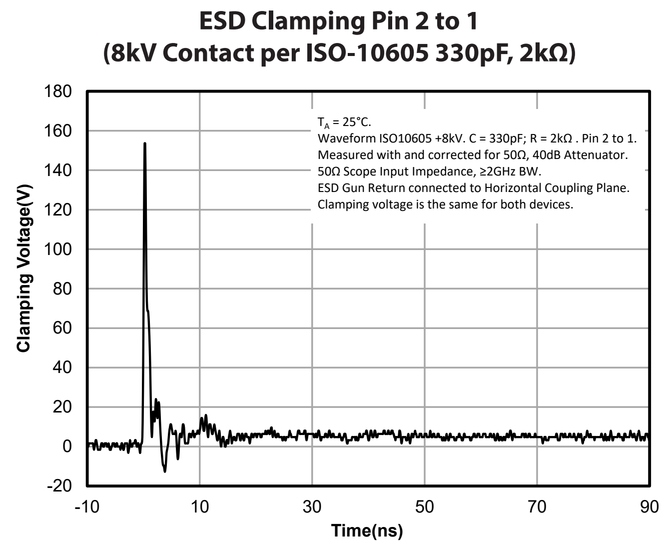


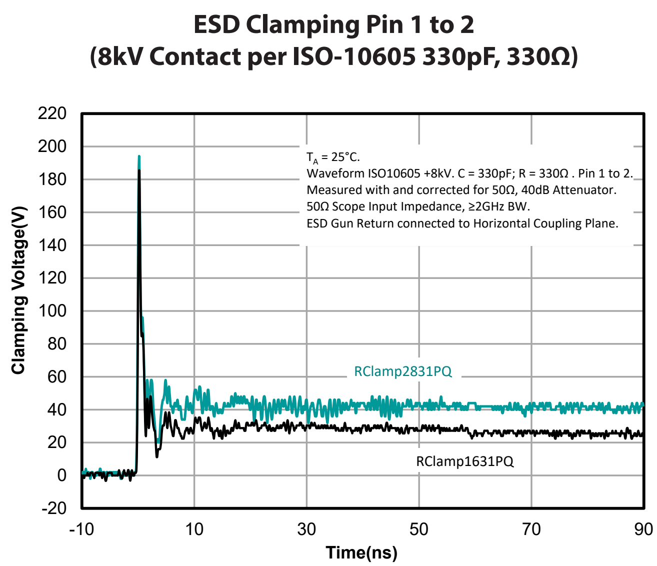
ESD Clamping Pin 2 to 1
(8kV Contact per ISO-10605 150pF, 2kΩ)

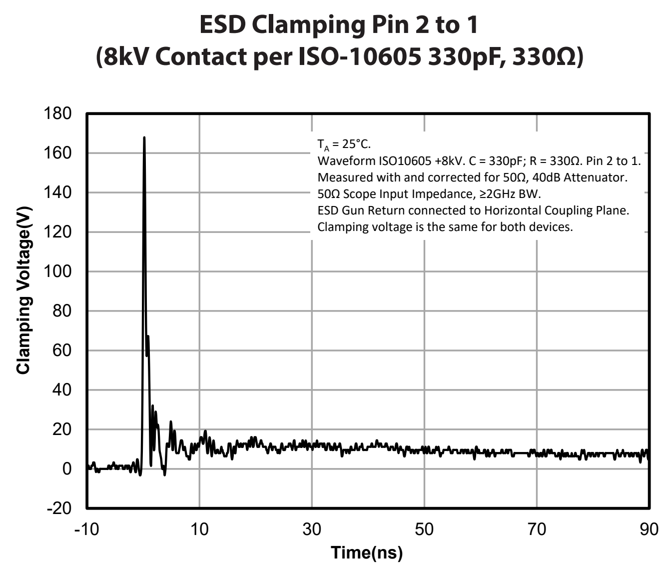


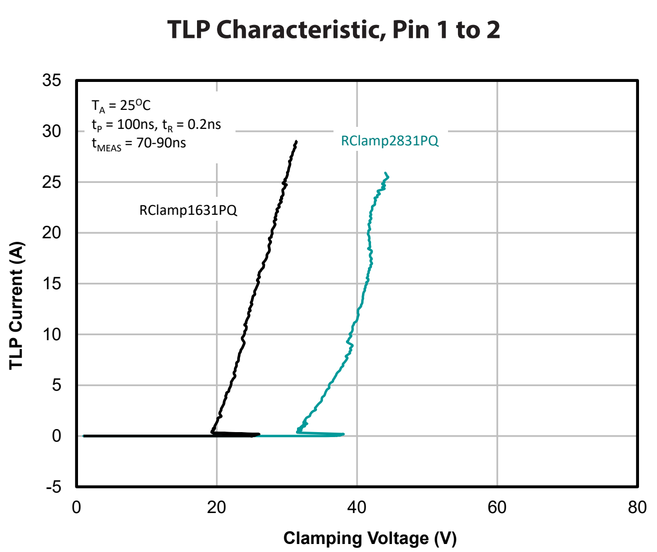
Typical Characteristics

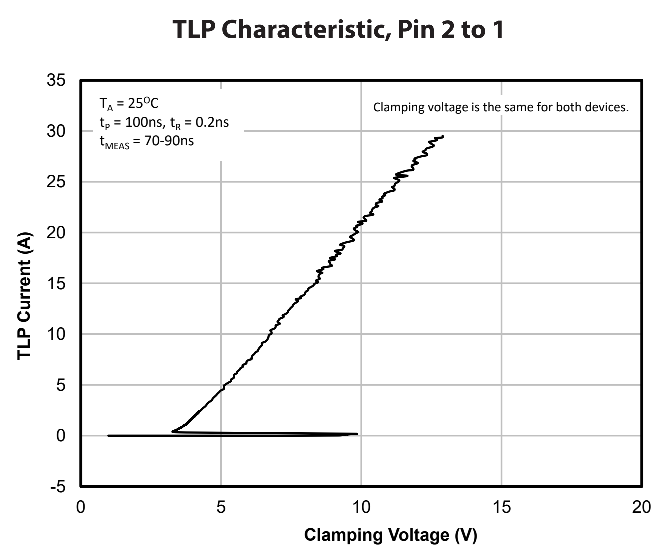






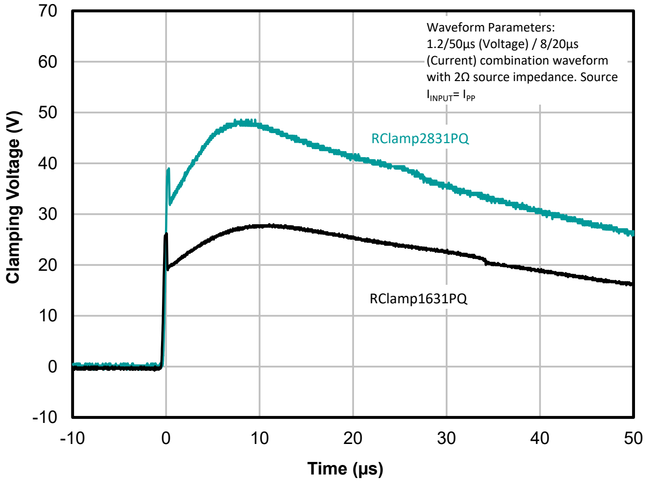




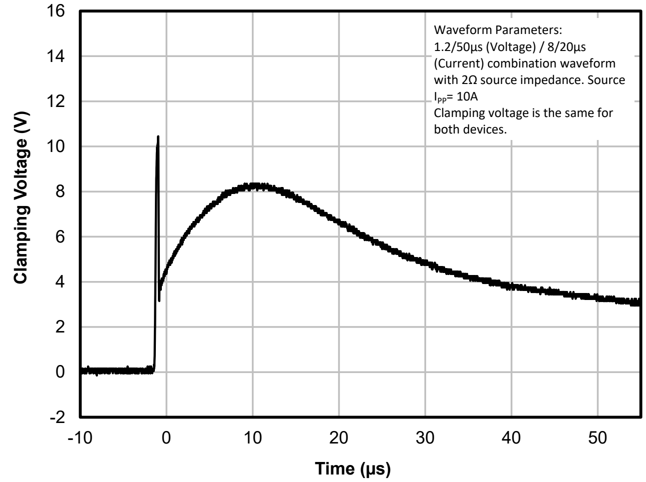


Typical Characteristics

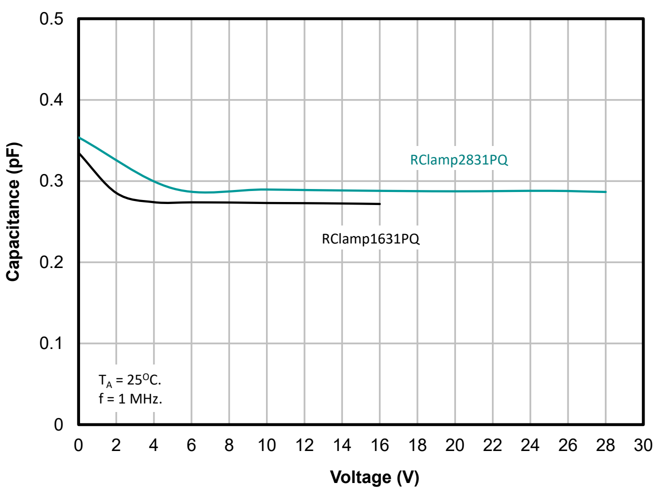
Clamping Characteristic, Pin 1 to 2 (1.2/50µs Voltage, 8/20µs Current Combination Waveform)



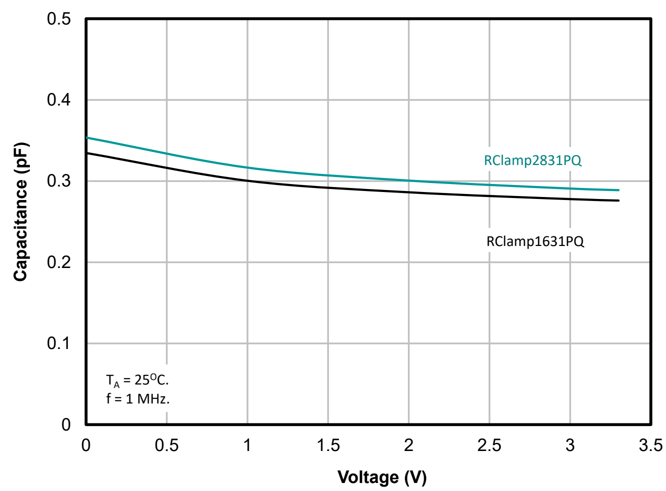
Clamping Characteristic, Pin 2 to 1 (1.2/50µs Voltage, 8/20µs Current Combination Waveform)



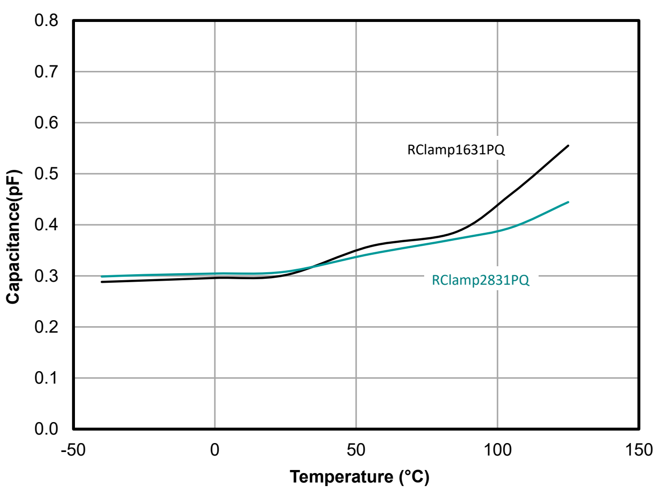
Capacitance vs. Reverse Voltage, Pin 1 to 2



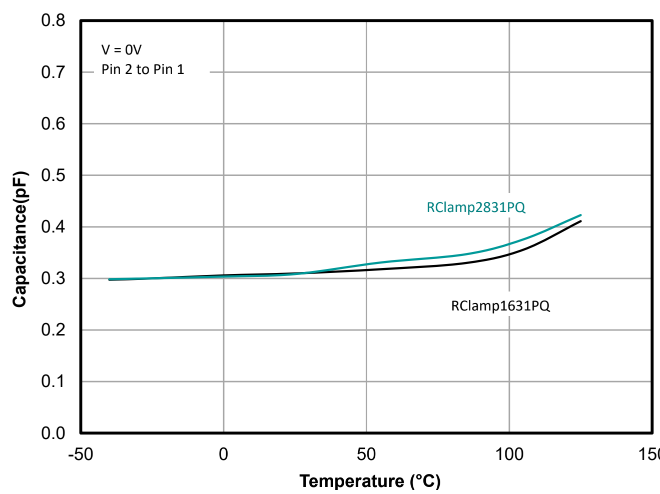
Capacitance vs. Forward Voltage, Pin 2 to 1



Capacitance vs. Temperature at V_{RWM}, Pin 1 to 2

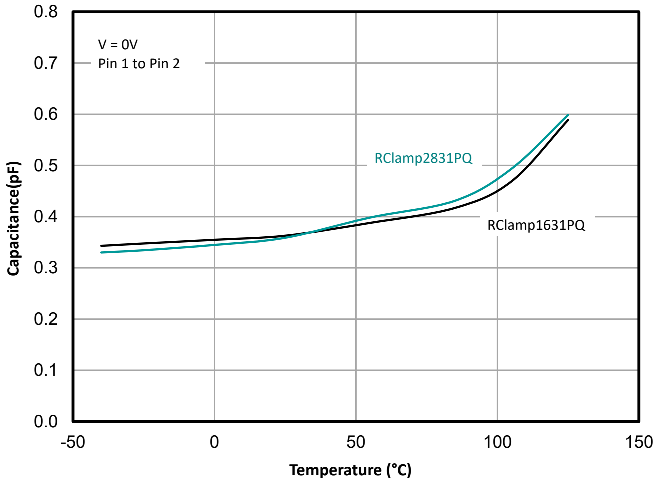


Capacitance vs. Temperature at 3.3V, Pin 2 to 1

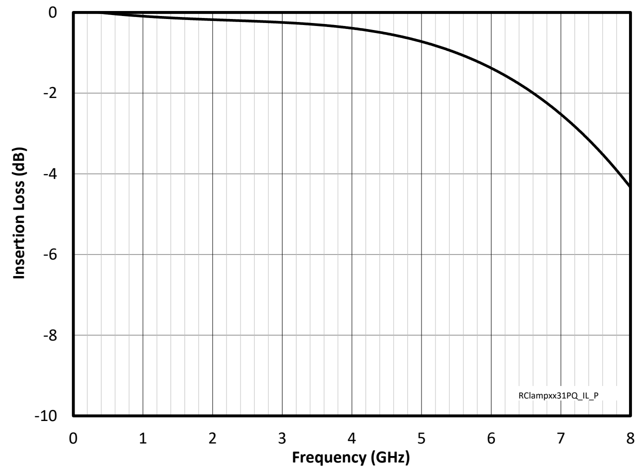


Typical Characteristics (Continued)

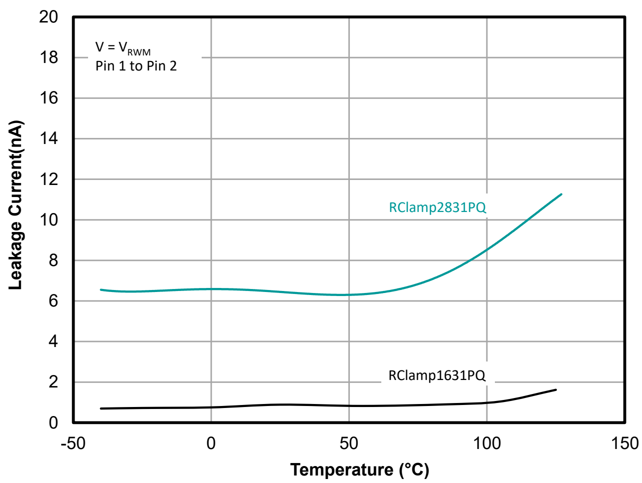
Capacitance vs. Temperature at 0V, Pin 1 to 2 or Pin 2 to 1



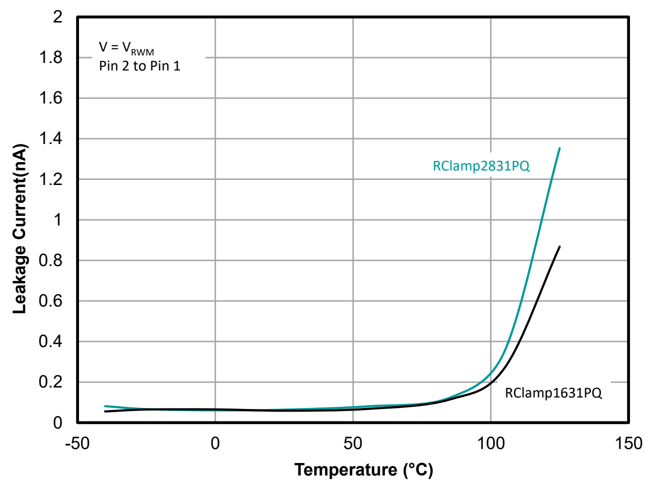
Insertion Loss (S21), Pin 1 to 2 or Pin 2 to 1



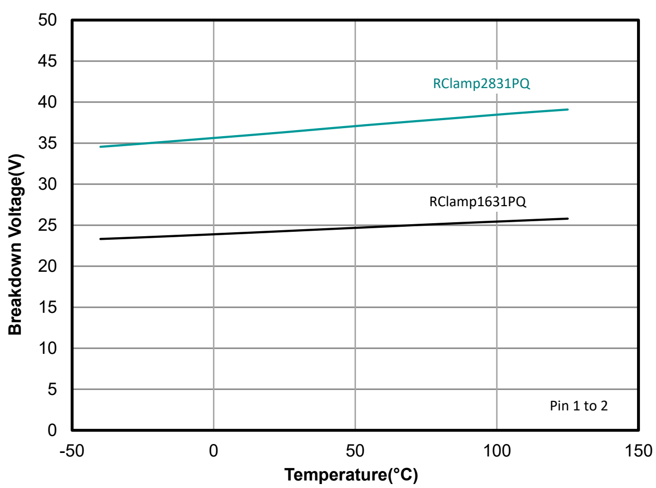
Leakage Current vs Temperature, Pin 1 to 2



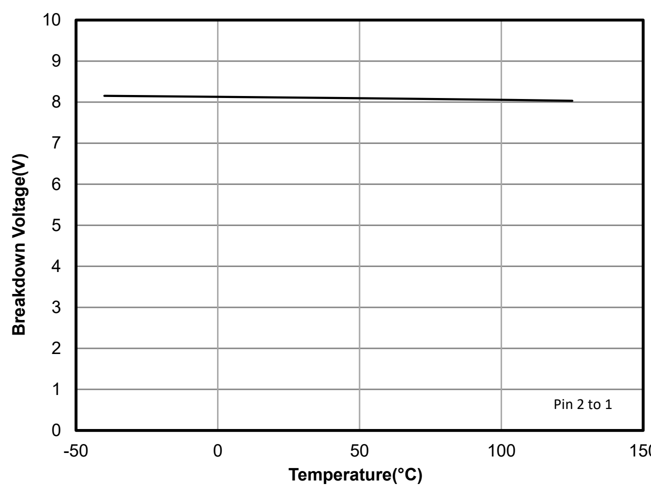
Leakage Current vs Temperature, Pin 2 to 1



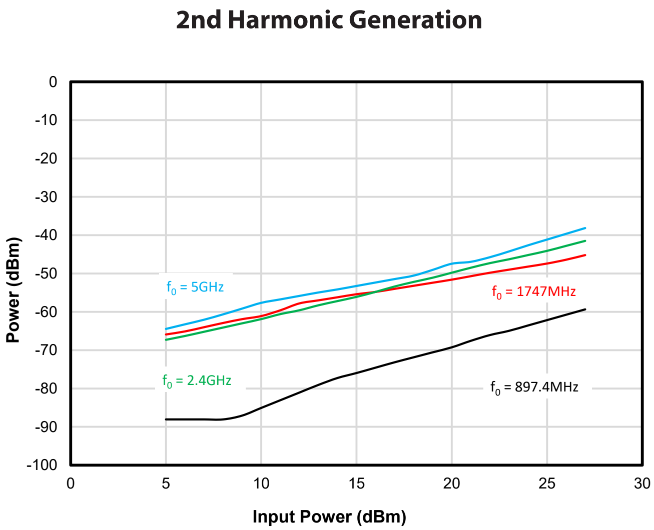
Breakdown Voltage vs Temperature, Pin 1 to 2

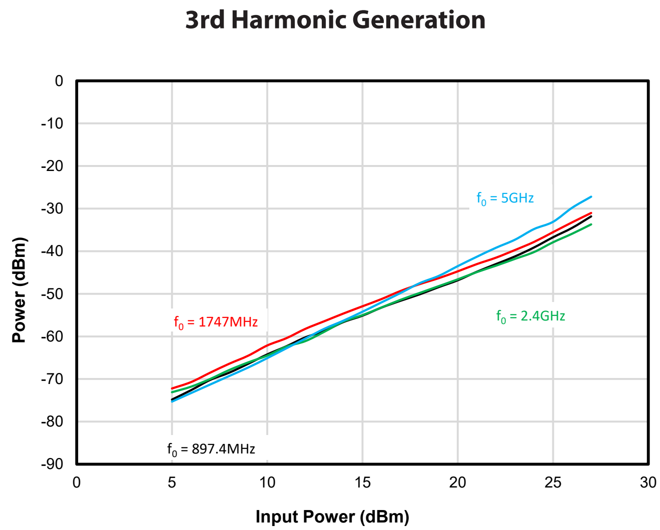


Breakdown Voltage vs Temperature, Pin 2 to 1



Typical Characteristics (Continued)





Applications Information

Automotive RF Antenna Protection

RF radio antennas such as DAB, XM, TV, and GPS in automotive applications are susceptible to damage from electrical over stress (EOS) and electrostatic discharge (ESD) events. Transient Voltage Suppressors (TVS) are the optimal protection solution for these lines as they have fast response times, low clamping voltage and no wear-out mechanism. RClamp1631PQ and RClamp2831PQ are designed to provide minimal capacitive loading and low-harmonic generation on RF lines. They incorporate low clamping voltage and asymmetric trigger-voltages providing protection for RF pins which pass both DC input voltages and AC output signal voltages.

Short-to-Battery Protection

RClamp1631PQ and RClamp2831PQ are intended for use in automotive systems of 12V and 24V respectively. They are able to protect against short-to-battery conditions without risk of latch-up. Asymmetric triggering allows for the lowest possible clamping in either polarity while presenting a high impedance at the working voltage under normal operating conditions.

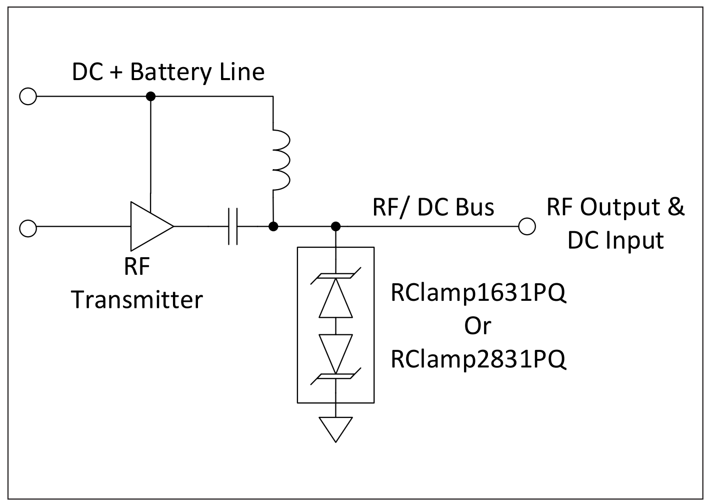
Low Harmonic Generation

Due to their non-linear nature, traditional TVS diodes used to protect RF lines can generate unwanted harmonics. RClamp1631PQ and RClamp2831PQ are designed to reduce both second and thirds order harmonic generation. Third order harmonics are reduced by the RClamp1631PQ and RClamp2831PQ's optimized capacitive linearity. Internal structures increase the device voltage in reverse polarity, providing a more balanced configuration and increasing the suppression of second order harmonics compared to a unidirectional TVS configuration.

Device Placement

The combined ESD, EOS and short-to-battery protection allow the RClamp1631PQ and RClamp2831PQ to be placed directly at the RF output and DC Input for an automotive RF transmitter. Low capacitive loading and minimized harmonics allow these devices to be used without signal degradation up to 7GHz on automotive antenna or Ethernet lines.

RF Transmitter TVS Placement



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

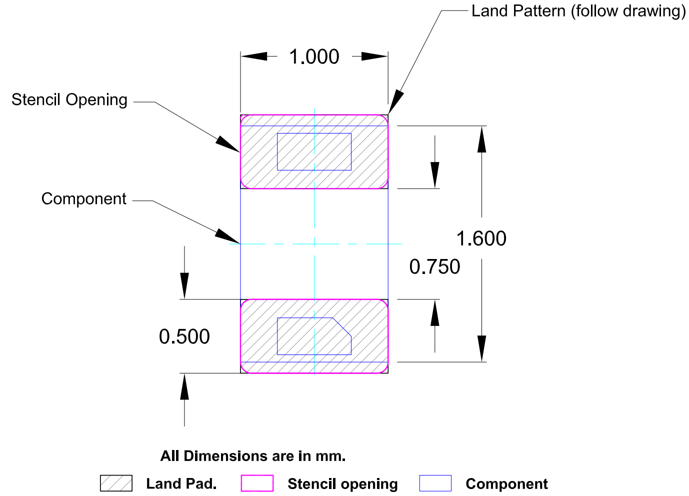
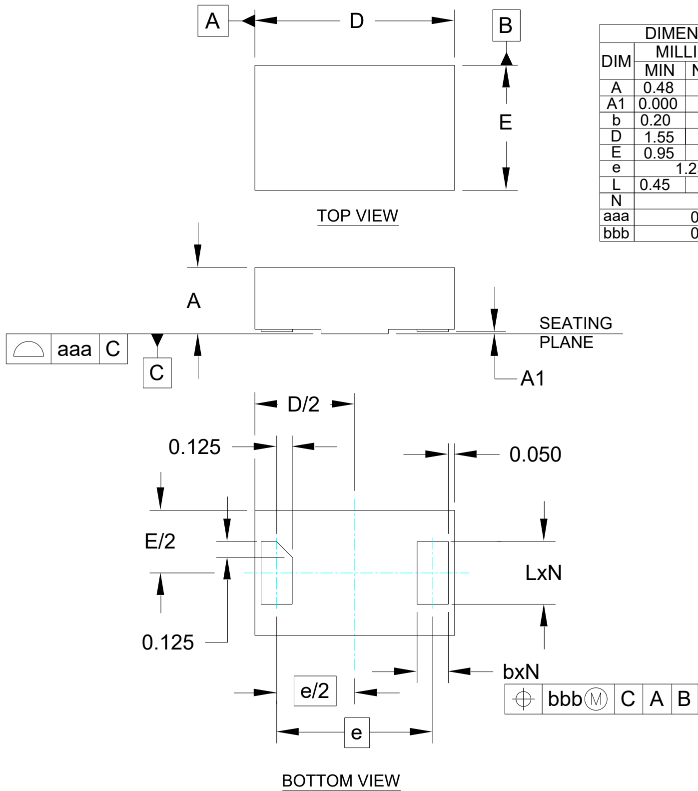


Table 2 - Recommended Assembly Guidelines	
Assembly Parameter	**Recommendation**
Solder Stencil Design	Laser Cut, Electro-Polished
Aperture Shape	Rectangular
Solder Stencil Thickness	0.100mm (0.004”)
Solder Paste Type	Type 4 size sphere or smaller
Solder Reflow Profile	Per JEDEC J-STD-020
PCB Solder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

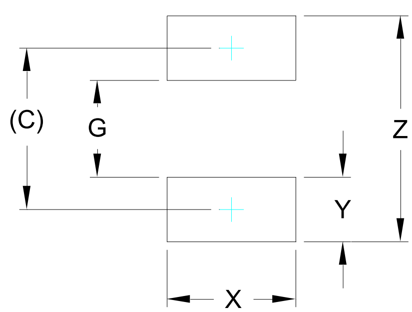
Outline Drawing - DFN 1.60 x 1.00 x 0.53mm 2-Lead



DIM	DIMENSIONS MILLIMETERS		
	MIN	NOM	MAX
A	0.48	0.53	0.58
A1	0.000	0.02	0.05
b	0.20	0.25	0.30
D	1.55	1.60	1.65
E	0.95	1.00	1.05
e	1.250 BSC		
L	0.45	0.50	0.55
N	2		
aaa	0.08		
bbb	0.10		

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

Land Pattern - DFN 1.60 x 1.00 x 0.53mm 2-Lead

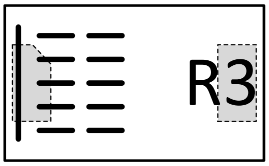


DIM	DIMENSIONS MILLIMETERS
C	(1.250)
G	0.750
X	1.000
Y	0.500
Z	1.750

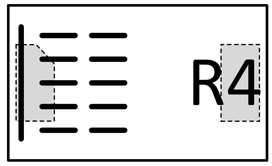
NOTES:

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

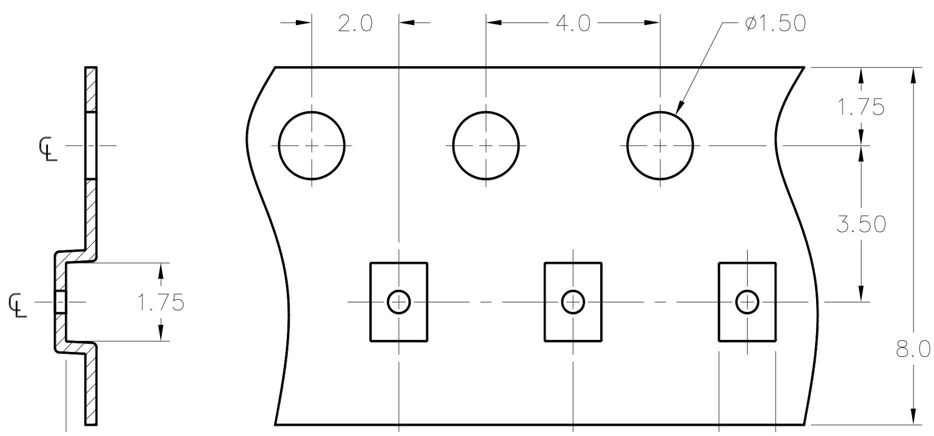


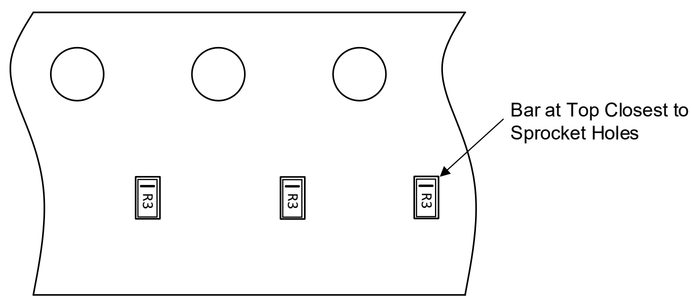
RClamp1631PQ



RClamp2831PQ

Tape and Reel Specification





Ordering Information

Part Number	Marking Code	Qty per Reel	Reel Size
RClamp1631PQTCT	R3	3,000	7″
RClamp2831PQTCT	R4	3,000	7″

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