

PROTECTION PRODUCTS
Absolute Maximum Rating

Rating	Symbol	Value	Units
DP, DM, USB ID (Pins 1, 2, 3)			
Peak Pulse Power (tp = 8/20μs)	P_{pk}	100	Watts
Peak Pulse Current (tp = 8/20μs)	I_{PP}	3	A
ESD per IEC 61000-4-2 (Air) ESD per IEC 61000-4-2 (Contact)	V_{ESD}	±15 ±8	kV
Operating Temperature	T_J	-55 to +125	°C
Storage Temperature	T_{STG}	-55 to +150	°C
VBus (Pin 6)			
Peak Pulse Power (tp = 8/20μs)	P_{pk}	200	Watts
Peak Pulse Current (tp = 8/20μs)	I_{PP}	5	A
ESD per IEC 61000-4-2 (Air) ESD per IEC 61000-4-2 (Contact)	V_{ESD}	±15 ±8	kV
Operating Temperature	T_J	-55 to +125	°C
Storage Temperature	T_{STG}	-55 to +150	°C

PROTECTION PRODUCTS
Electrical Characteristics (T = 25°C)

DM, DP, USB ID TVS (Pins 1, 2, 3)						
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Reverse Stand-Off Voltage	V_{RWM}	Pin 1, 2, or 3 to GND			5.5	V
Reverse Breakdown Voltage	V_{BR}	$I_t = 1\text{mA}$, Pin 1, 2, or 3 to GND	6.5	8	10	V
Reverse Leakage Current	I_R	$V_{RWM} = 5.5\text{V}$, Pin 1, 2, or 3 to GND		0.100	1	μA
Forward Voltage	V_F	$I_f = 15\text{mA}$ GND to Pin 1, 2, or 3	0.6		1.2	V
Clamping Voltage	V_C	$I_{pp} = 1\text{A}$, $t_p = 8/20\mu\text{s}$ Pin 1, 2, or 3 to GND			15	V
Clamping Voltage	V_C	$I_{pp} = 3\text{A}$, $t_p = 8/20\mu\text{s}$ Pin 1, 2, or 3 to GND			30	V
Junction Capacitance	C_j	$V_R = 0\text{V}$, $f = 1\text{MHz}$, Pin 1, 2, or 3 to GND		0.7	0.8	pF
		$V_R = 0\text{V}$, $f = 1\text{MHz}$, Between I/O pins			0.5	pF

PROTECTION PRODUCTS

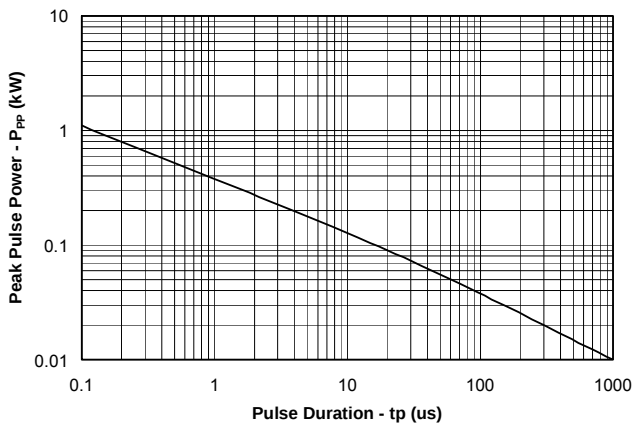
Electrical Characteristics (T = 25°C)

VBus TVS (Pin 6)						
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Reverse Stand-Off Voltage	V_{RWM}	Pin 6 to GND			12	V
Reverse Breakdown Voltage	V_{BR}	$I_t = 1mA$, Pin 6 to GND	15	16.5	18	V
Reverse Leakage Current	I_R	$V_{RWM} = 12V$ Pin 6 to GND		0.005	0.05	μA
Forward Voltage	V_F	$I_f = 10mA$ GND to Pin 6	0.6		1.0	V
Clamping Voltage	V_C	$I_{PP} = 1A$, $t_p = 8/20\mu s$ Pin 6 to Ground			20	V
Reverse Clamping Voltage	V_{FC}	$I_{PP} = 10A$, $t_p = 8/20\mu s$ Ground to Pin 6			3	V
Junction Capacitance	C_j	$V_R = 0V$, $f = 1MHz$ Pin 6 to GND			100	pF

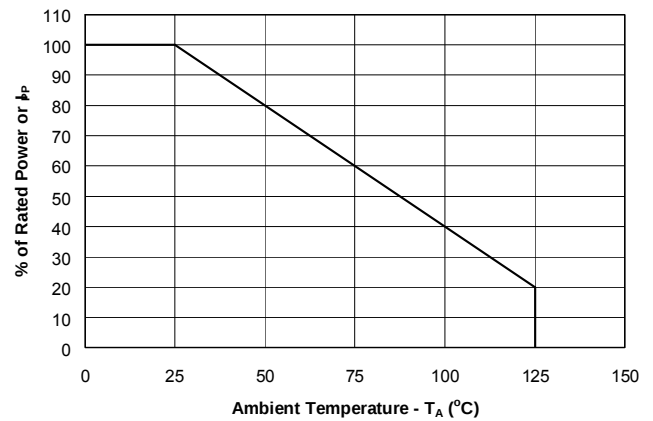
PROTECTION PRODUCTS

Typical Characteristics

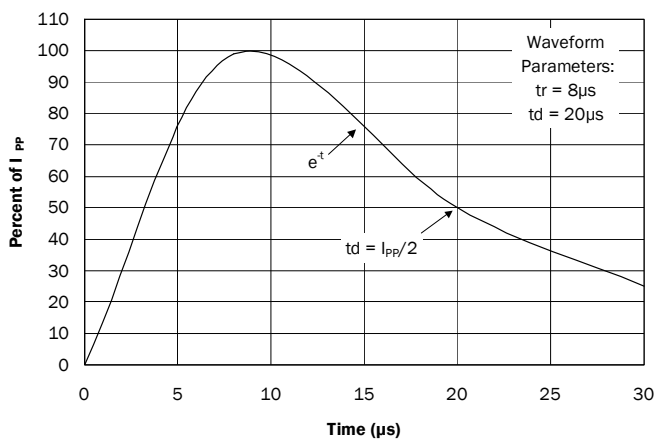
Non-Repetitive Peak Pulse Power vs. Pulse Time



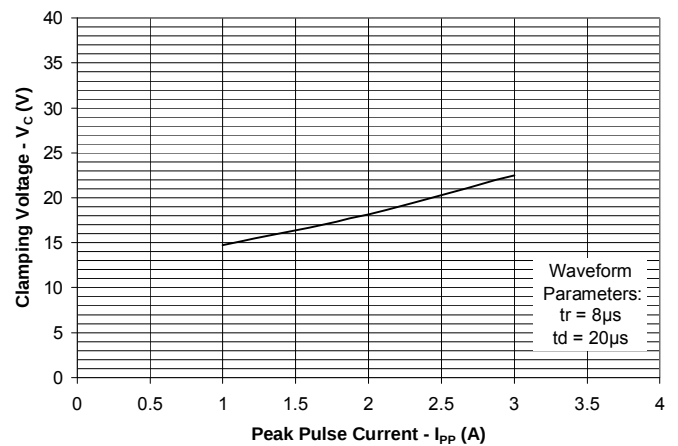
Power Derating Curve



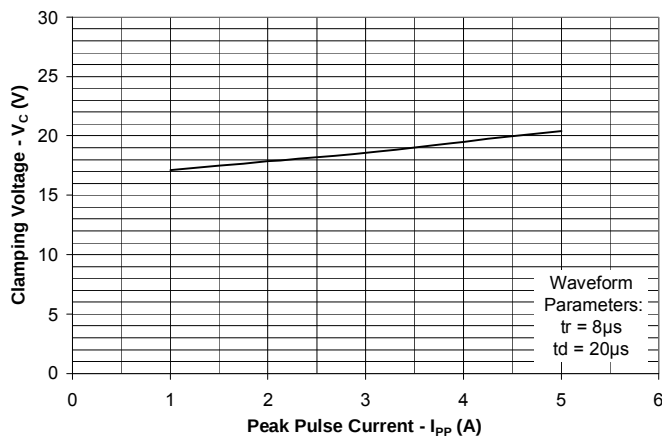
Pulse Waveform



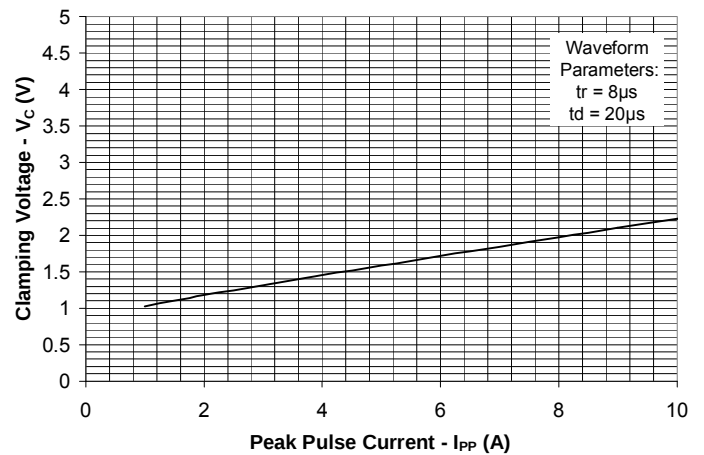
Clamping Voltage vs. Peak Pulse Current (Pin 1, 2, or 3 to GND)



Clamping Voltage vs. Peak Pulse Current (Pin 6 to GND)

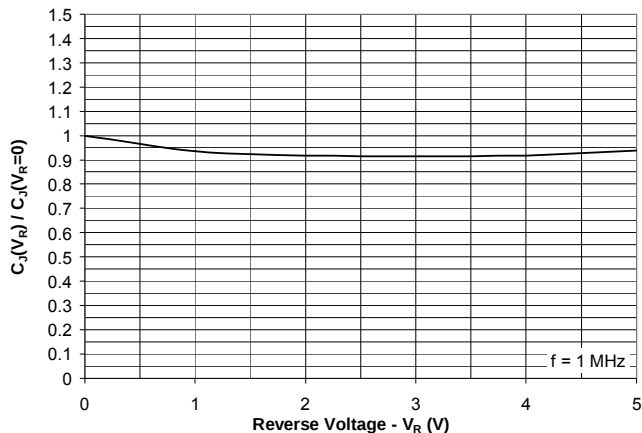


Reverse Clamping Voltage vs. Peak Pulse Current (Pin GND to Pin 6)

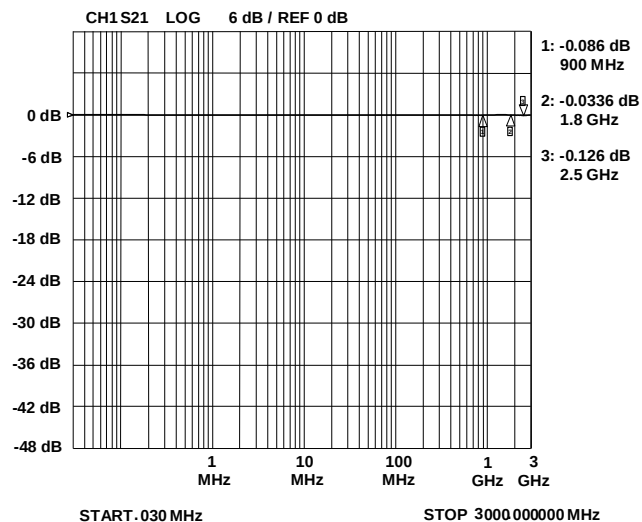


PROTECTION PRODUCTS
Typical Characteristics

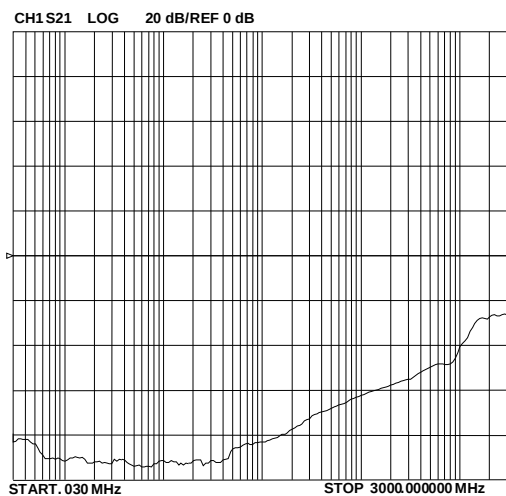
Normalized Capacitance vs. Reverse Voltage
(Pin 1, 2, or 3 to Gnd)



Insertion Loss S21 (Pin 1, 2, or 3 to Gnd)



Analog Crosstalk



PROTECTION PRODUCTS

Applications Information

Device Connection Options for Protecting One USB Port

USB Data and ID lines are connected at pins 1, 2, and 3. These inputs are referenced to an internal 5 volt TVS protection device. When the voltage on these lines exceed 5 volts, the TVS will conduct. Pin 6 is connected to the USB voltage bus (VBus). This device will conduct when the voltage on the bus exceeds 12 volts. The center tab is connected to ground. The path length should also be kept as short as possible to minimize parasitic inductance. For best results, multiple micro-vias are recommended to the ground plane.

Protecting USB Interfaces

The RClamp1654P is optimized for use on systems that utilize the USB interface for battery charging. Low capacitance protection is provided for the USB data (DM, DP) and USB ID pins. The maximum capacitance on these lines is <1pF for maximum signal integrity. All three lines are referenced to an internal 5 volt TVS device. A separate 12 volt TVS device is used for protection of the USB voltage bus. This allows battery charging without signal clipping. A typical example is shown in Figure 2.

Figure 1- Pin Configuration & Circuit Diagram

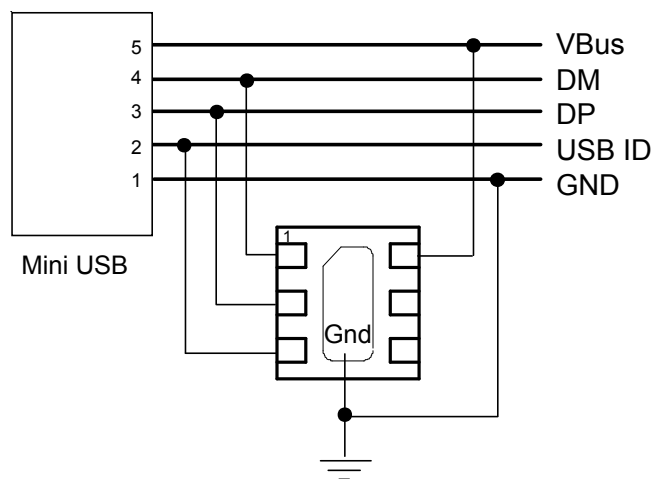
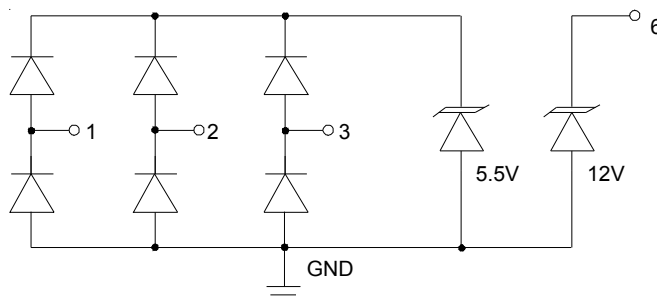
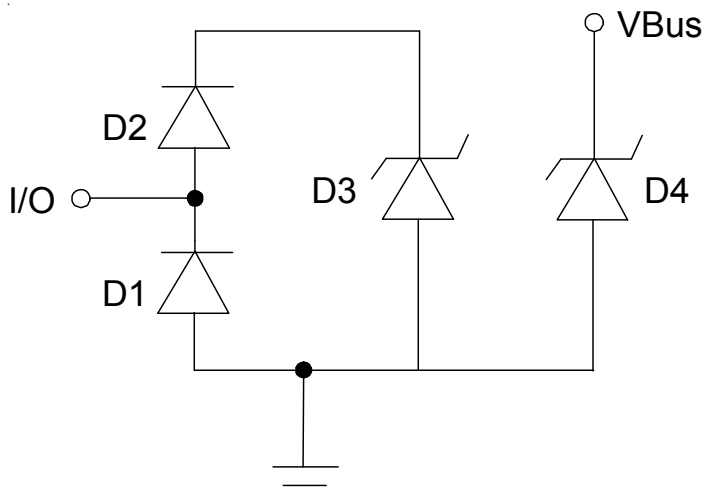
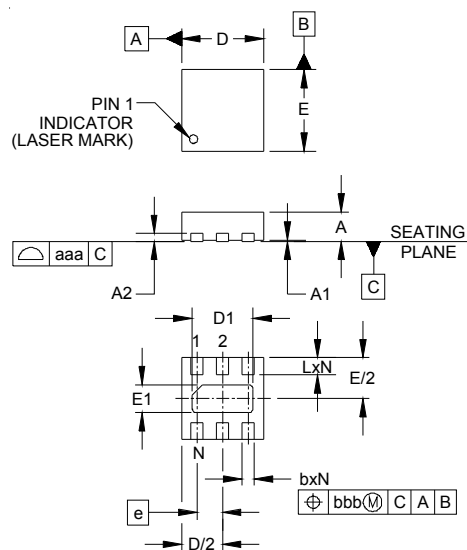


Figure 2 - USB Protection

PROTECTION PRODUCTS
Applications Information - Spice Model

RClamp1654P Spice Model

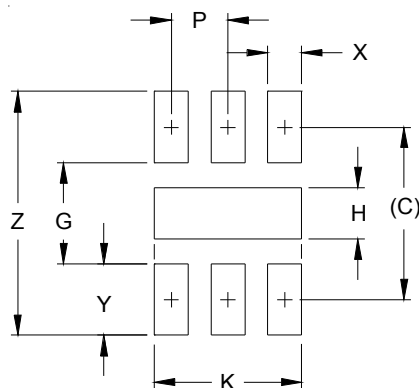
RClamp1654P Spice Parameters					
Parameter	Unit	D1	D2	D3	D4
IS	Amp	1E-20	1E-20	2E-12	1.48E-14
BV	Volt	100	100	9.36	16.2
VJ	Volt	0.7	0.7	0.6	0.7
RS	Ohm	0.458	1.0	2.6	0.927
IBV	Amp	1E-3	1E-3	1E-3	1E-3
CJO	Farad	0.3E-12	0.3E-12	56E-12	49E-12
TT	sec	2.541E-9	2.541E-9	2.541E-9	2.541E-9
M	--	0.01	0.01	0.23	0.272
N	--	1.1	1.1	1.1	1.1
EG	eV	1.11	1.11	1.11	1.11

PROTECTION PRODUCTS
Outline Drawing - SLP1616P6


DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	.020	.023	.026	0.50	0.58	0.65
A1	0.00	.001	.002	0.00	0.03	0.05
A2		(.005)			(0.13)	
b	.008	.010	.012	0.20	0.25	0.30
D	.059	.063	.067	1.50	1.60	1.70
D1	.041	.047	.051	1.05	1.20	1.30
E	.059	.063	.067	1.50	1.60	1.70
E1	.010	.016	.020	0.25	0.40	0.50
e		.020 BSC			0.50 BSC	
L	.010	.013	.016	0.25	0.33	0.40
N		6			6	
aaa		.003			0.08	
bbb		.004			0.10	

NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

Land Pattern - SLP1616P6


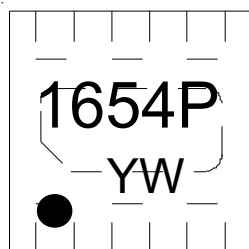
DIM	DIMENSIONS	
	INCHES	MILLIMETERS
C	.060	1.52
G	.035	0.89
H	.018	0.45
K	.051	1.30
P	.020	0.50
X	.012	0.30
Y	.025	0.63
Z	.085	2.15

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.
3. THERMAL VIAS IN THE LAND PATTERN OF THE EXPOSED PAD SHALL BE CONNECTED TO A SYSTEM GROUND PLANE. FAILURE TO DO SO MAY COMPROMISE THE THERMAL AND/OR FUNCTIONAL PERFORMANCE OF THE DEVICE.

PROTECTION PRODUCTS

Marking



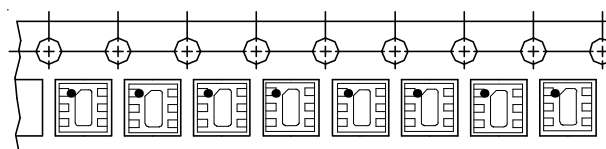
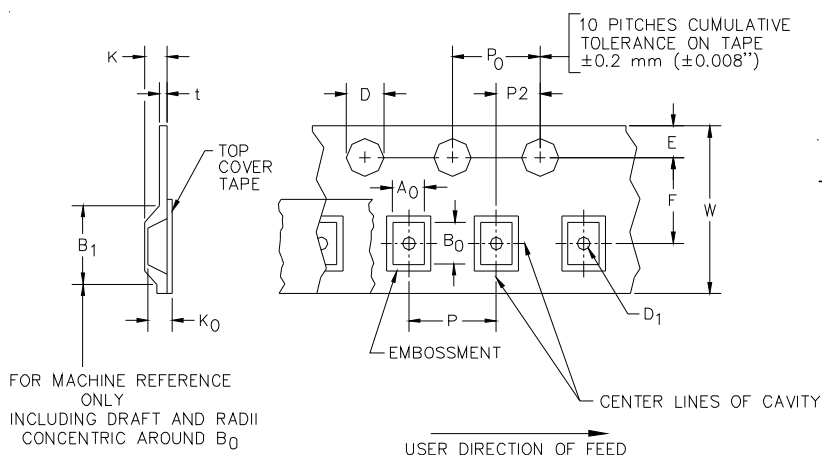
Ordering Information

Part Number	Lead Finish	Qty per Reel	Reel Size
RClamp1654P.TCT	Pb Free	3,000	7 Inch

RailClamp and RClamp are marks of Semtech Corporation

YW = Two character Date Code

Tape and Reel Specification



Device Orientation in Tape
Pin 1 in upper left towards sprocket holes

A0	B0	K0
1.78 +/-0.05 mm	1.78 +/-0.05 mm	0.69 +/-0.05 mm

Tape Width	B, (Max)	D	D1	E	F	K (MAX)	P	P0	P2	T(MAX)	W
8 mm	4.2 mm	1.5 + 0.1 mm - 0.0 mm)	0.5 mm ±0.05	1.750±10 mm	3.5±0.05 mm	2.4 mm	4.0±0.1 mm	4.0±0.1 mm	2.0±0.05 mm	0.4 mm	8.0 mm + 0.3 mm - 0.1 mm

Contact Information

Semtech Corporation
Protection Products Division
200 Flynn Rd., Camarillo, CA 93012
Phone: (805)498-2111 FAX (805)498-3804