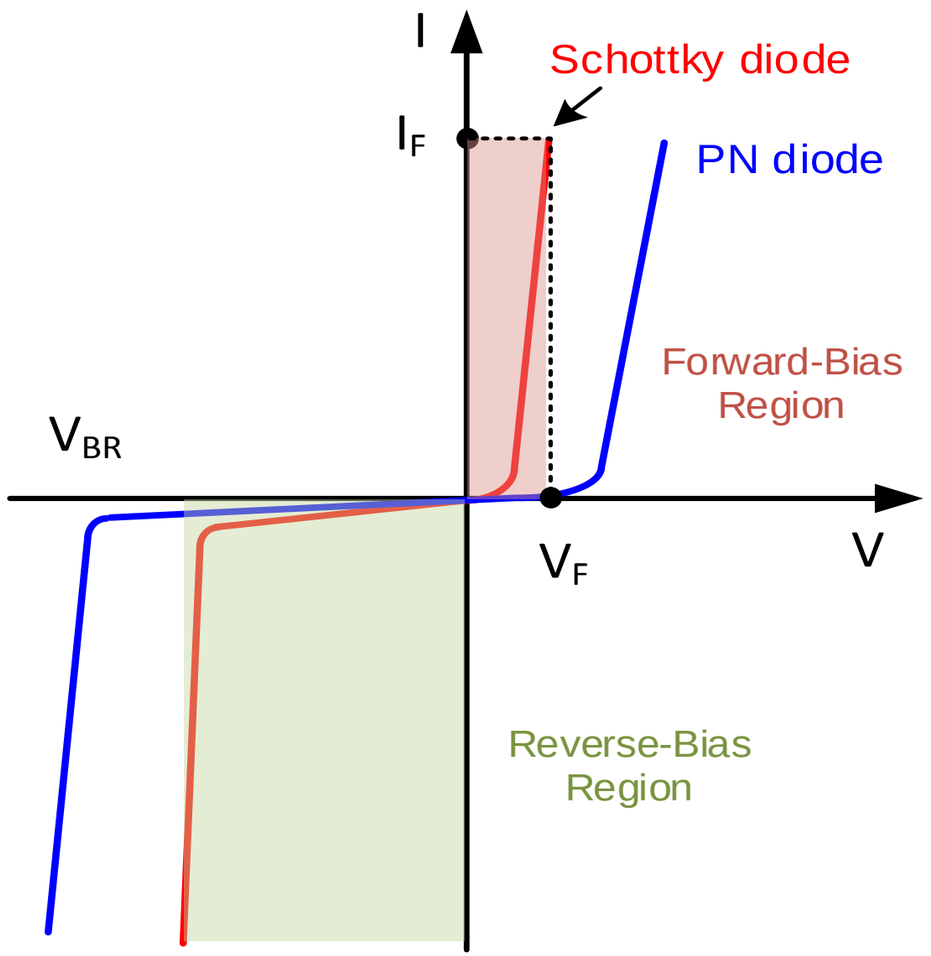
External EOS Protection Devices

TI Precision Labs – ADCs

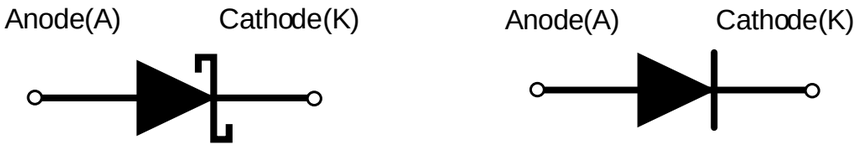
Presented by Alex Smith

Prepared by Dale Li

Schottky Diode vs PN Diode



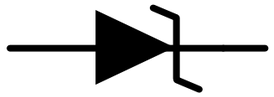
I-V Characteristic



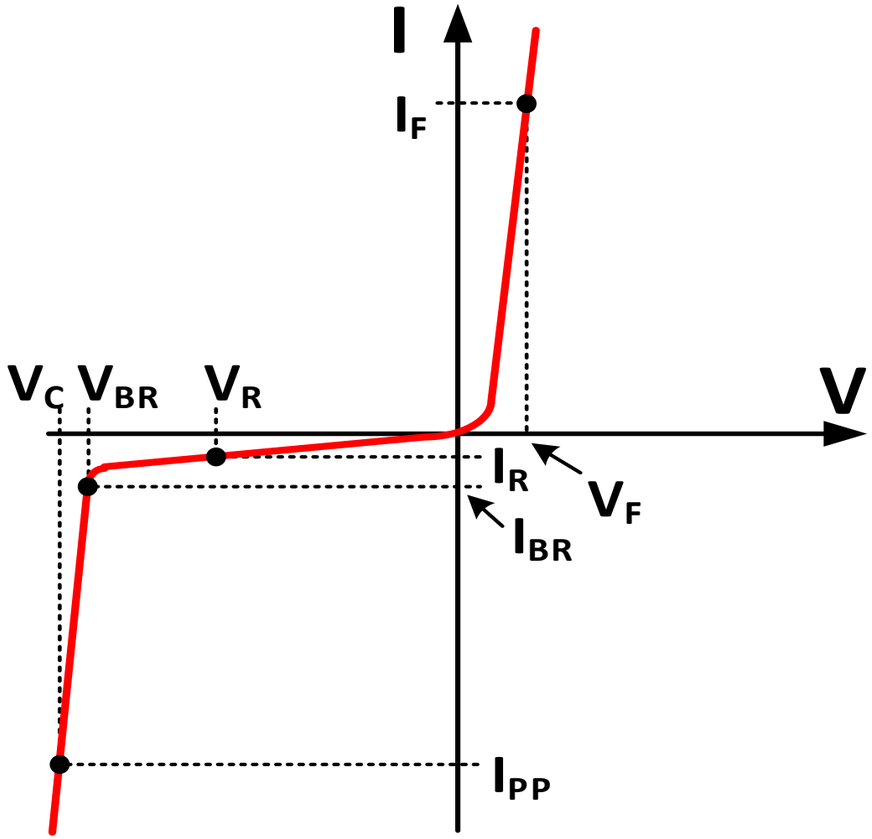
Characteristic	Schottky Diode	PN Junction Diode
Junction Type	Metal-semiconductor	Semiconductor-semiconductor
Forward Voltage	Small - typically 0.3V	Large - typically 0.7V
Capacitance and Variation	Lower	Higher
Reverse Leakage Current	Higher current but less temperature dependence	Lower current, but greater temperature dependence
Reserve Voltage	Lower	Higher
Switching speed and Recovery time	Faster because of majority carrier transport	Limited by the recombination time of injected minority carriers

Unidirectional TVS Diode
(Transient Voltage Suppressor)

Symbol	Parameter
V_{BR}	Breakdown voltage
V_R	Stand-off voltage
V_C	Clamping voltage
V_F	Forward voltage drop
I_{BR}	Breakdown Current @ V_{BR}
I_R	Reverse Leakage @ V_R
I_F	Forward Current @ V_F
I_{PP}	Peak Pulse current @ V_C

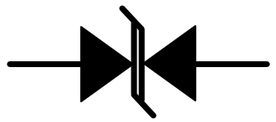


TVS_Uni

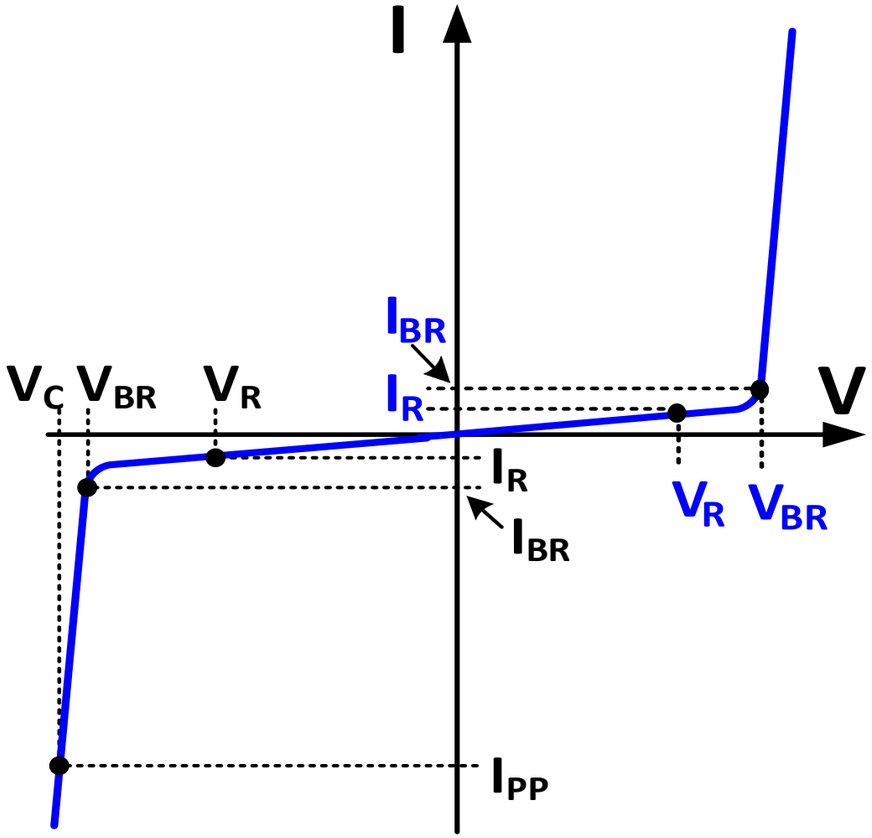


Bidirectional TVS Diode
(Transient Voltage Suppressor)

Symbol	Parameter
V_{BR}	Breakdown voltage
V_R	Stand-off voltage
V_C	Clamping voltage
V_F	Forward voltage drop
I_{BR}	Breakdown Current @ V_{BR}
I_R	Reverse Leakage @ V_R
I_F	Forward Current @ V_F
I_{PP}	Peak Pulse current @ V_C

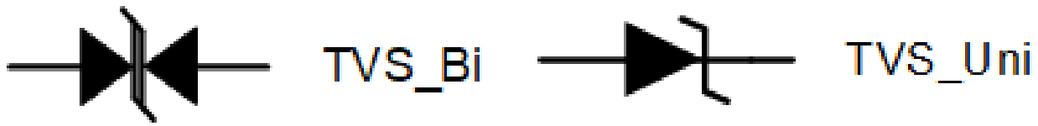


TVS_Bi

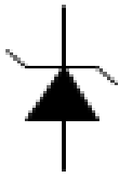


TVS vs. Zener

- TVS Diode
  - Solid state PN junction
  - Designed for operation in reverse-breakdown region only during over-voltage events
  - Junction area sized to conduct significant current and absorb significant power
  - Specifically designed for large transients such as ESD
  - Can react to overvoltage in pico-seconds

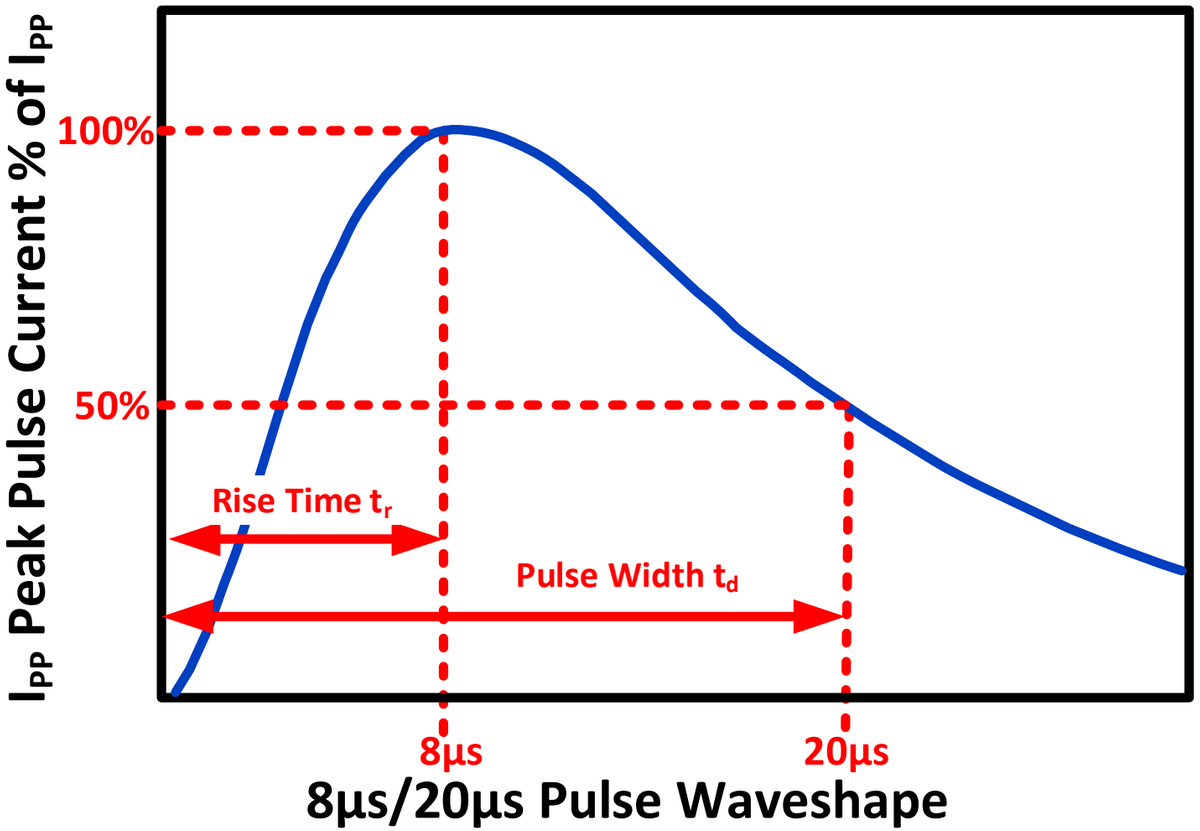


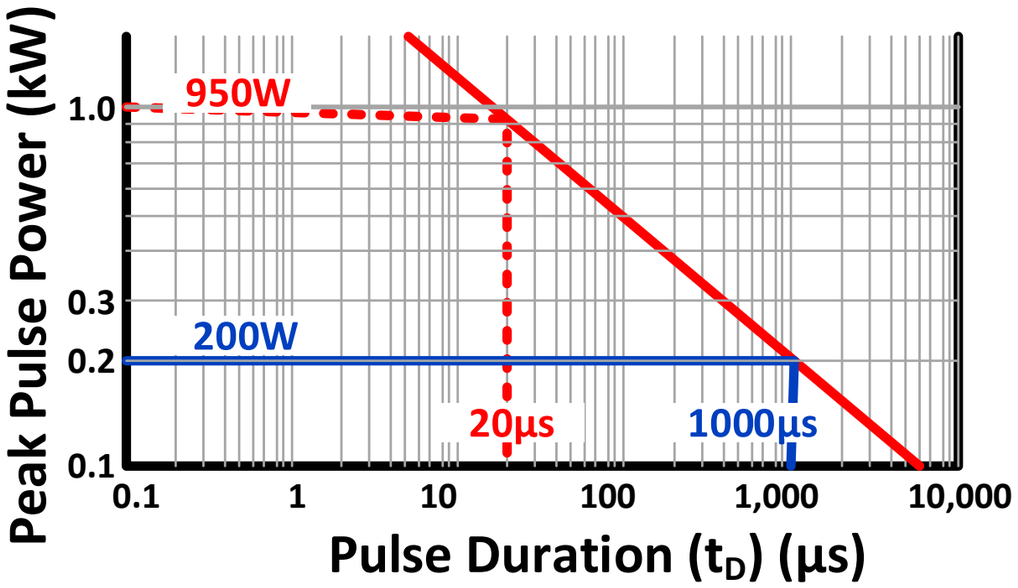
- Zener
  - Solid state PN junction
  - Designed for full-time operation in reverse-breakdown region
  - Ideal for voltage regulation
  - Slower reaction time
  - Lower current/power capability



Zener Diode

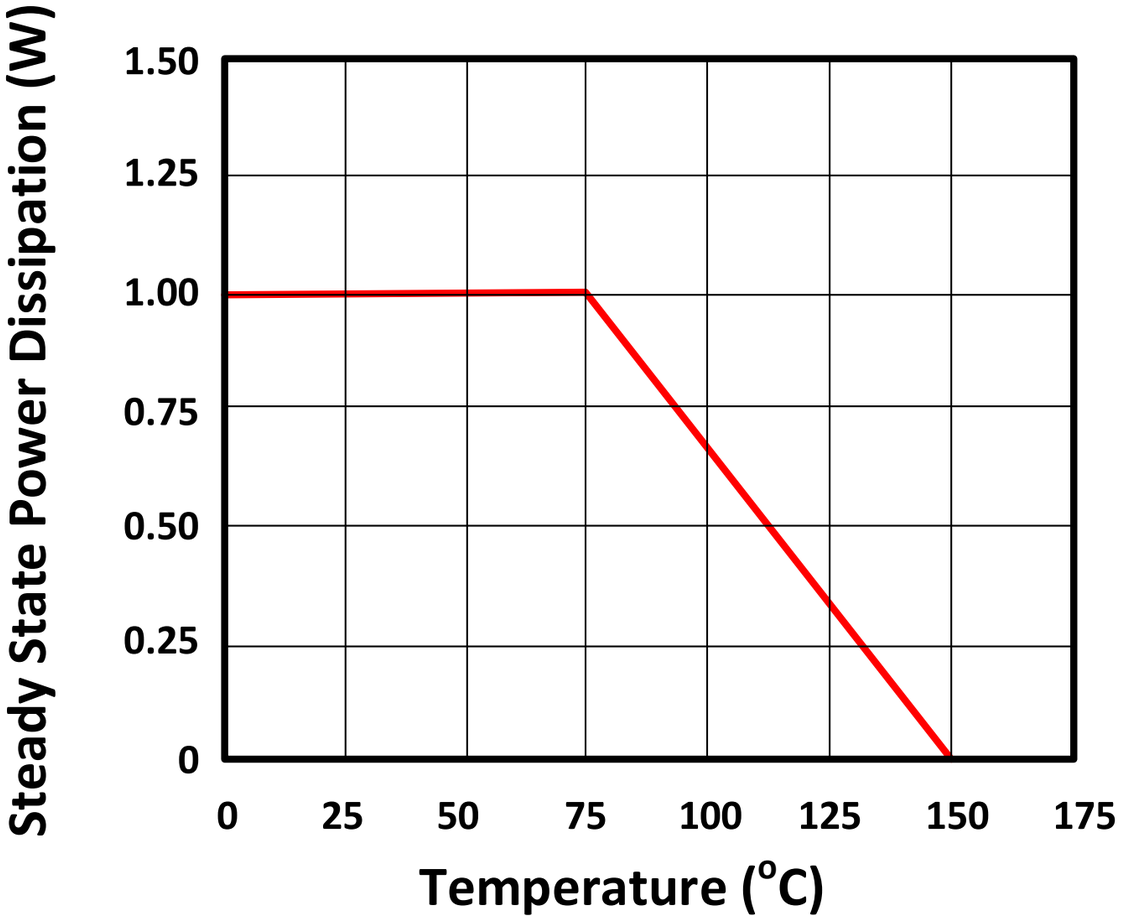
Current and Power Ratings on TVS diodes

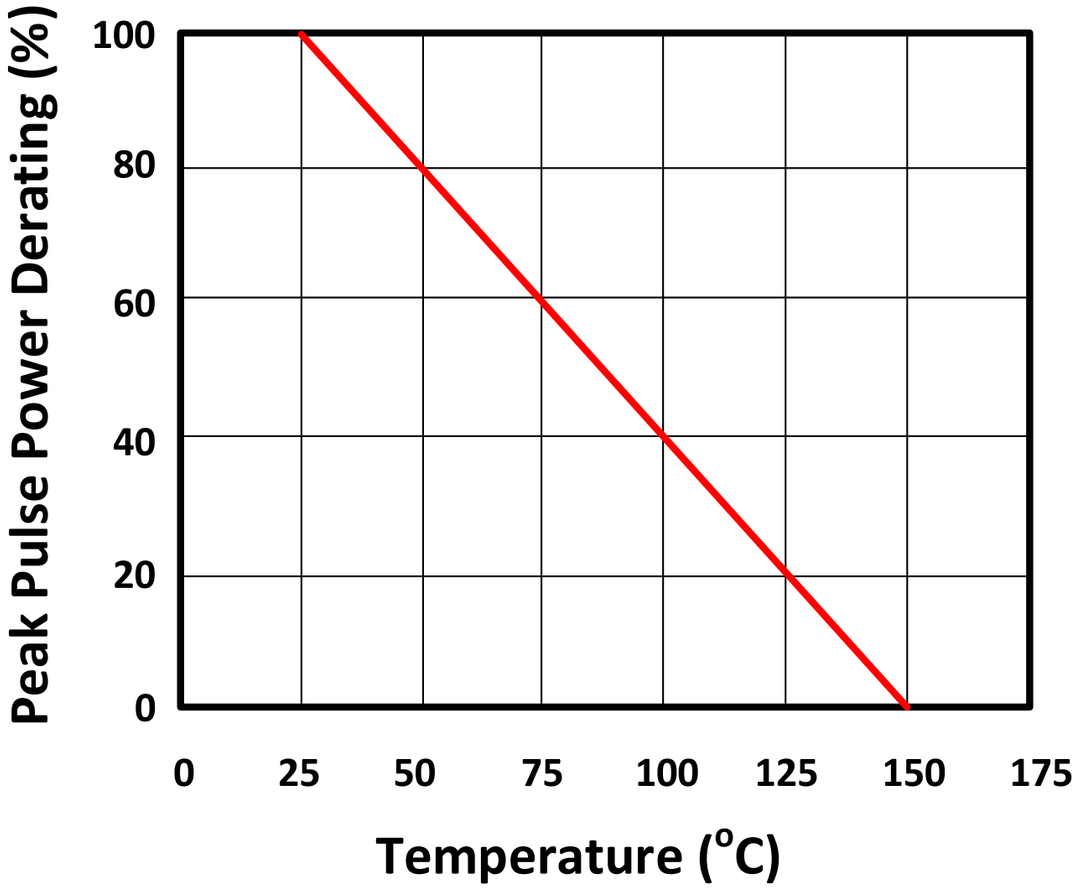




PART NUMBER	PULSE DURATION, t_D (µs)	PEAK PULSE POWER P_{PP} (W)		MAX. CLAMPING VOLTAGE V_C AT I_{PP} (V)	PEAK PULSE CURRENT I_{PP} (A)	
		+25°C	+85°C		+25°C	+85°C
SMF13CA	10/1000	200	120	21.5	9.3	5.6
	8/20	950	570	21.5	44.2	26.5

Current and Power Ratings on TVS diodes





Thanks for your time!
Please try the quiz.

Questions: External EOS Protection Devices

1. What are the main reasons to use a Schottky diode rather than a PN diode for input protection?
   a. Low forward voltage
   b. Fast switching
   c. High reverse breakdown
   d. Low leakage current
   e. Both a and b
   f. Both c and d

2. (T/F) In some cases a PN type diode may be used in place of a Schottky diode because of it's low leakage current.
   a. True
   b. False

Questions: External EOS Protection Devices

3. What are the main reasons to use a TVS diode rather than a Zener diode for input protection?
   a. Better accuracy
   b. Lower noise
   c. Larger power rating
   d. Faster switching time
   e. Both a and b
   f. Both c and d

4. (T/F) The peak power rating will be lower than the continuous power rating on a TVS diode.
   a. True
   b. False

Questions: External EOS Protection Devices

5. Which of the following is ***NOT*** true for a TVS diode with a peak pulse power rating of 200W for a 10/1000µs pulse?
   a. The rise time is 10µs, and the pulse width is 1000µs
   b. The amplitude of the current will drop to 50% at 1000µs
   c. The amplitude of the current will drop to 10% at 1000µs
   d. The power rating will be lower for higher temperature

6. If the normal linear input range of the ADC is ±10V, which parameter on the TVS diode should be set to 10V or greater?
   a. Breakdown voltage
   b. Stand-off voltage
   c. Clamping Voltage
   d. Breakdown Voltage

Thanks for your time!