
2nd Annual
BiTS CHINA 中国
September 13, 2016
Session 1

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Session 1

Yuanjun Shi

Session Chair

BiTS China

High Frequency & Burn-In

"Implementation Challenges of and ATE Test Cell for At-Speed Production Test of 32 Gbps Applications "

Jose Moreira - Advantest

"Addressing Challenges in High Temperature Burn-In"

Paolo Rodriguez - Analog Devices Philippines

"Derating Transient Voltage Suppressor Diodes for Burn-In Applications"

Gil Conanan - Analog Devices Philippines

"An Ignorable Testing Technology for High Speed/Frequency Device Testing"

Pang Cheng Chiu - Jthink Technology

Session 1
施元军
Session Chair

BiTS China

High Frequency & Burn-In

"32 Gbps速度应用在自动测试单元量产实施中的挑战 "
Jose Moreira – Advantest

"高温老化测试挑战的讨论"
Paolo Rodriguez - Analog Devices Philippines

"老化测试中瞬态电压抑制器的降额设计"
Gil Conanan - Analog Devices Philippines

"一个不容忽视的高速芯片测试方法"
Pang Cheng Chiu - Jthink Technology

Derating Transient Voltage Suppressor Diodes for Burn-in Applications

Gil Conanan & Rolando Reyes
Analog Devices Inc.

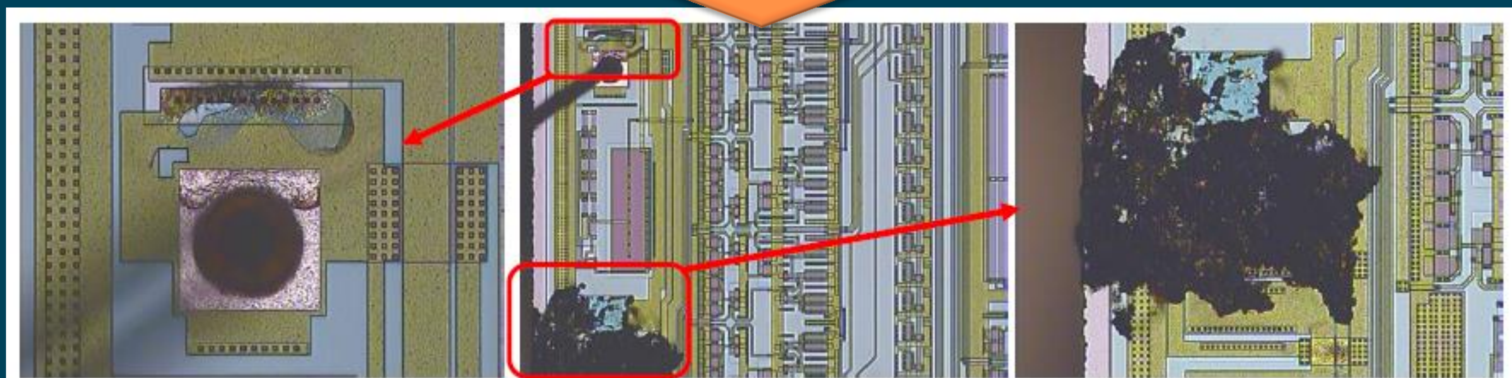
BiTS China Workshop
Suzhou
September 13, 2016

Outline

- Introduction
- Objective
- Methodology
- Results and Discussion
- Conclusion
- Recommendation

Introduction

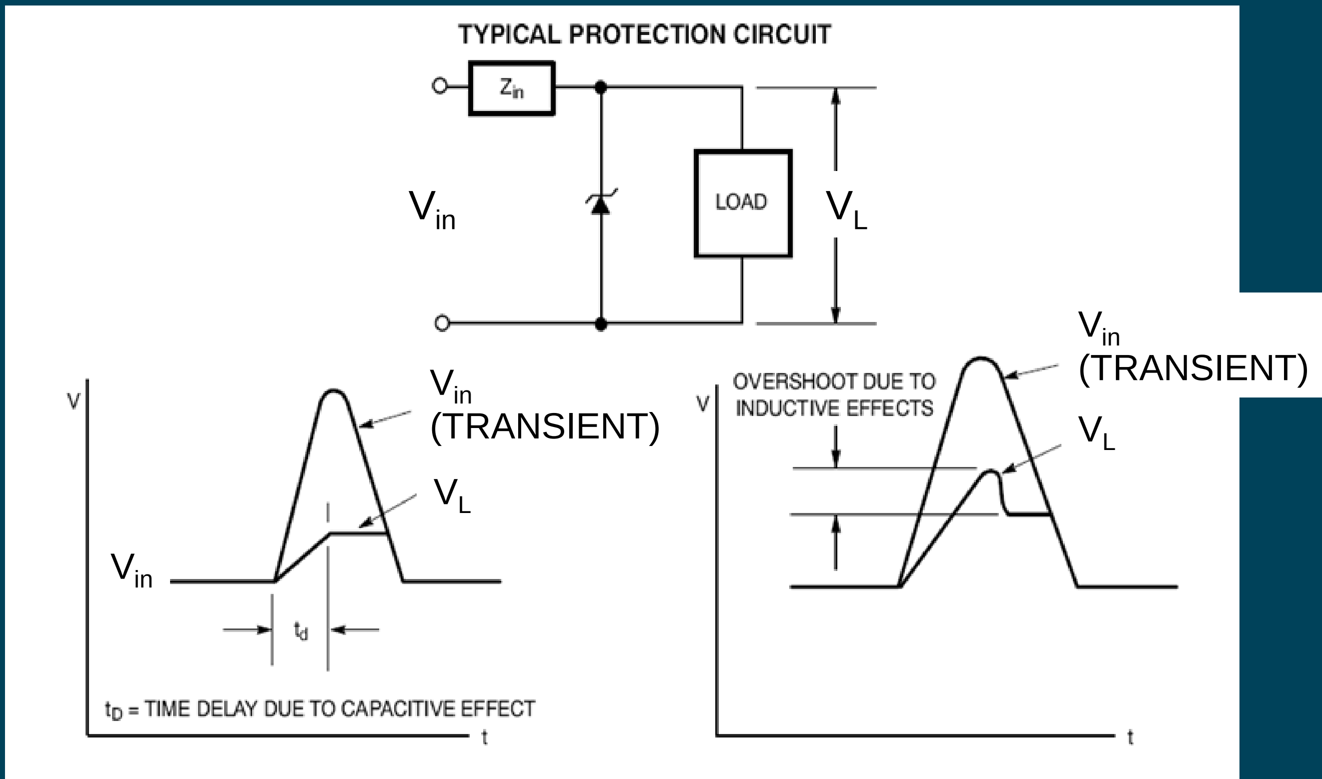
Clamp Voltage of Transient Voltage Suppressor (TVS) Diodes greater than the Absolute Maximum Voltage of Products



Possible Device Failures

Introduction

Overview of Transient Voltage Suppressor (TVS) Protection Circuit



Objective

The main objective is to propose deration guidelines on Clamp Voltage (Vc) parameter of common Transient Voltage Suppressor (TVS) diodes at 125^{o}C burn-in temperature.

Objective

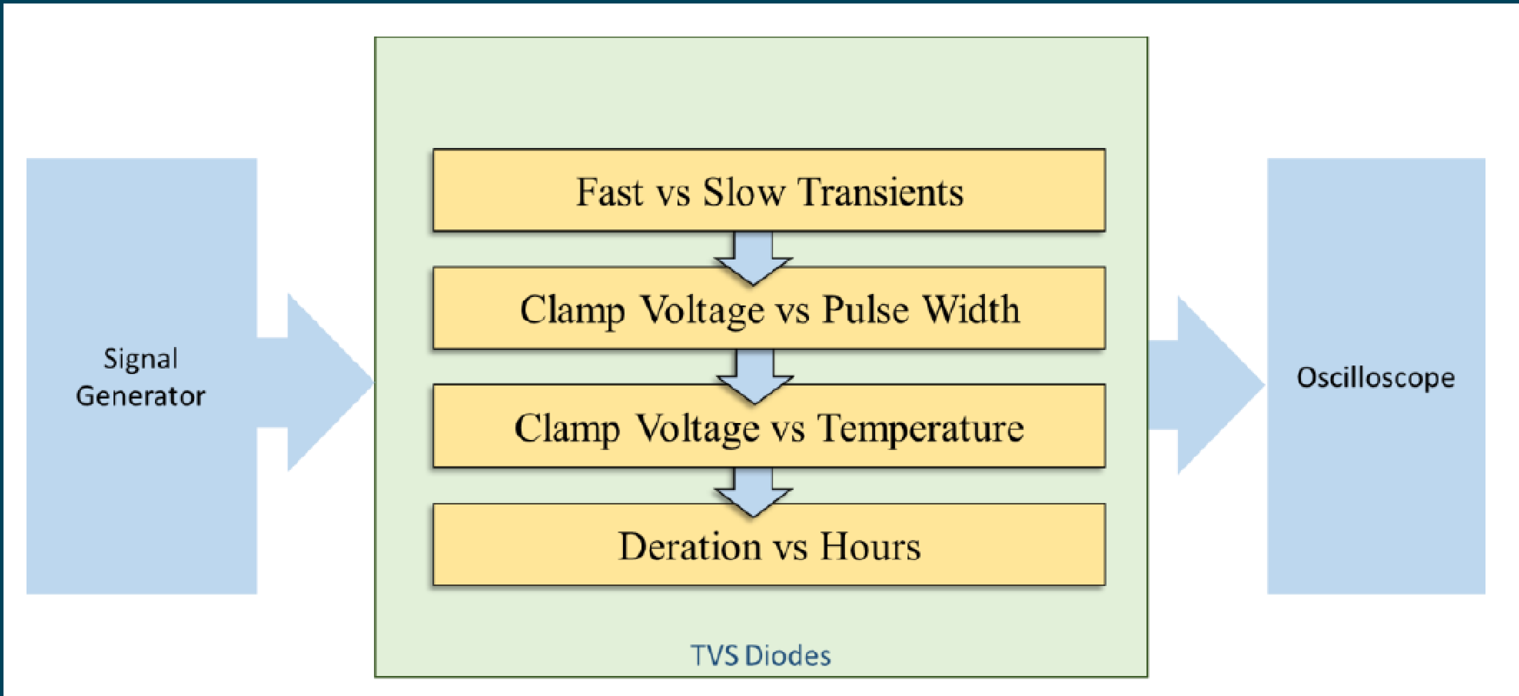
Specific objectives are:

1) Analyze behavior of fast and slow transient responses at 25^{o}C
2) Analyze clamp voltage response when varying input pulse width at 125^{o}C
3) Evaluate the behavior of clamp voltage at varying temperatures
4) Test a deration for stability and robustness

Scope and Limitation

1) Limited to capability of available instruments
2) Limited to low power Transient Voltage Suppressor (TVS) diodes namely P6KE6.5A, SR05, SR3.3, SR2.8 and SLVU2.8
3) Limited to 1.5V, 1.8V, 3.3V and 5.0V power supply set-up during burn-in

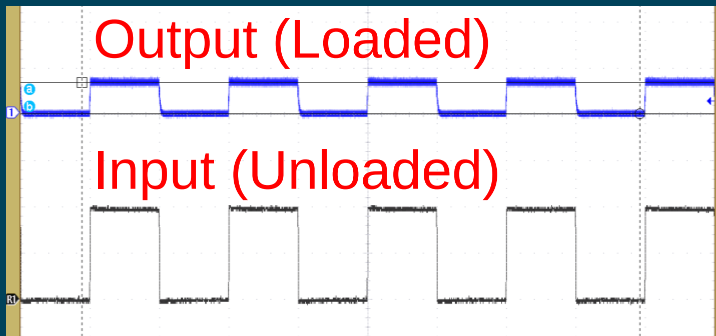
Methodology



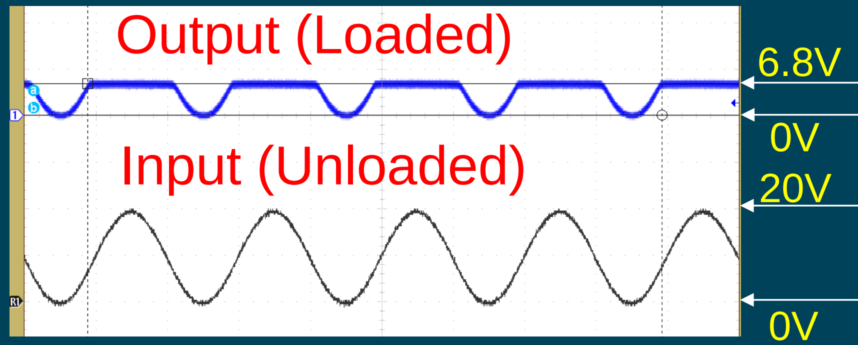
Conceptual Framework

Results and Discussion

Fast vs Slow Transients



Fast Transients



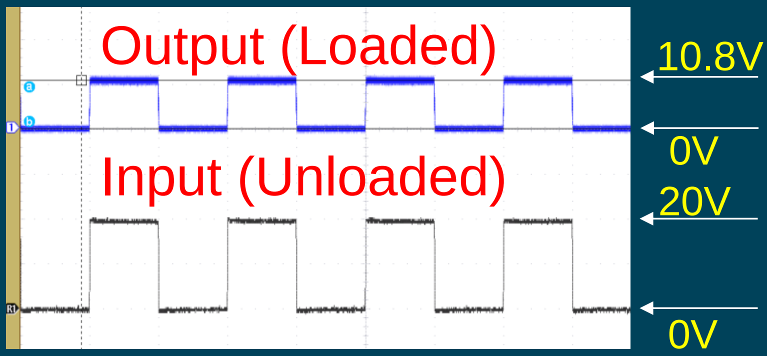
Slow Transients

P6KE6.8A

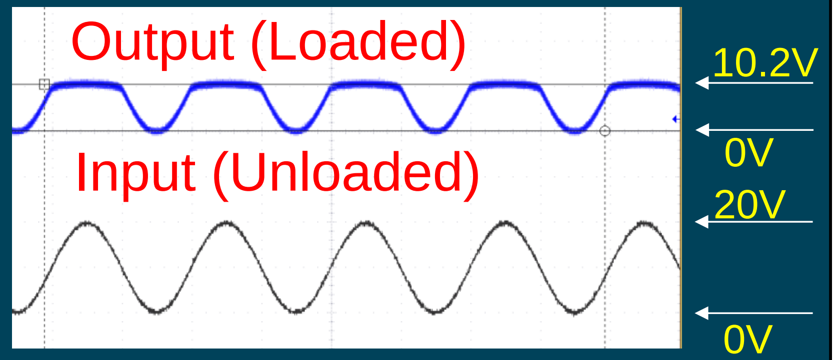
Input Signal Frequency = 50kHz

Results and Discussion

Fast vs Slow Transients



Fast Transients



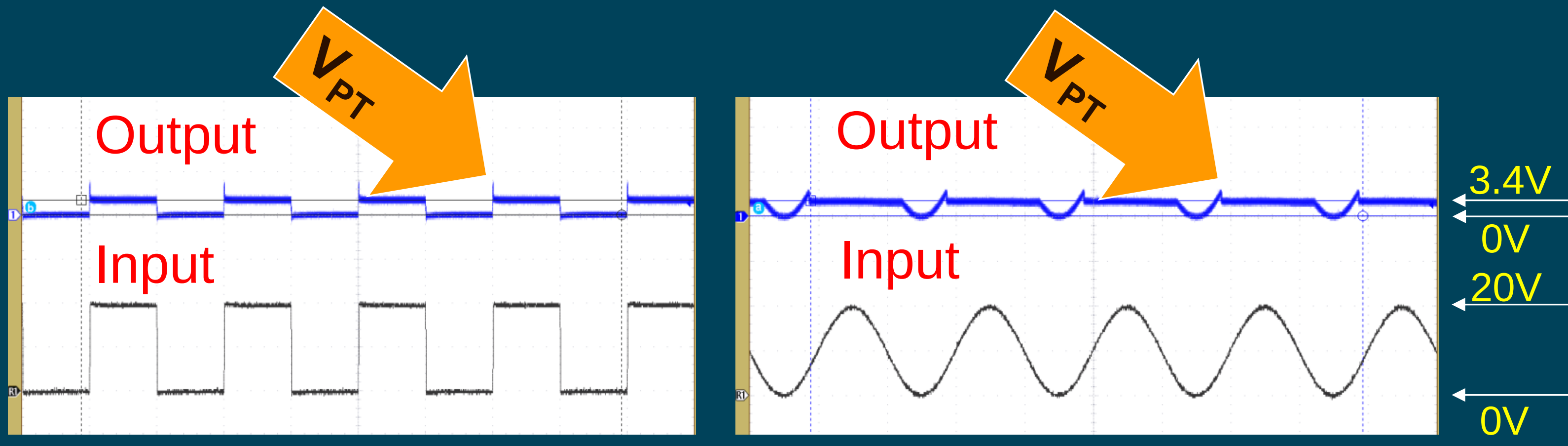
Slow Transients

SR05

Input Signal Frequency = 50kHz

Results and Discussion

Fast vs Slow Transients



Fast Transients

Slow Transients

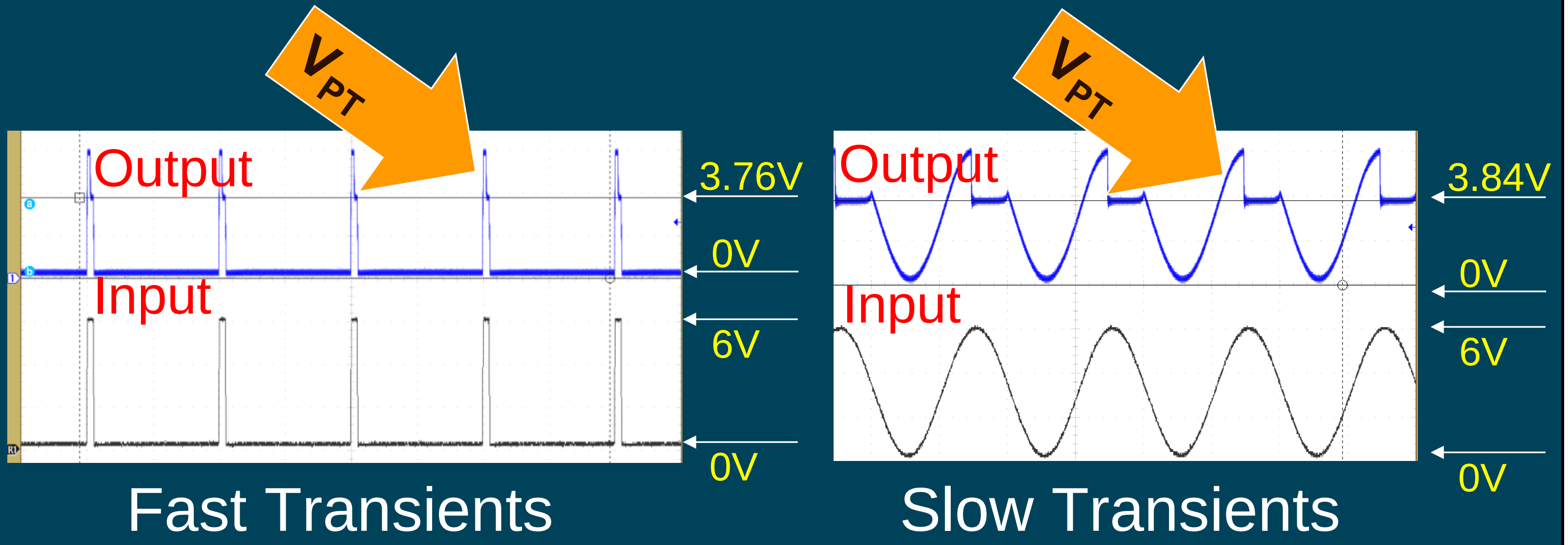
SR3.3

Input Signal Frequency = 50kHz

Punch-Through Voltage (V_{PT}) = 6V

Results and Discussion

Fast vs Slow Transients



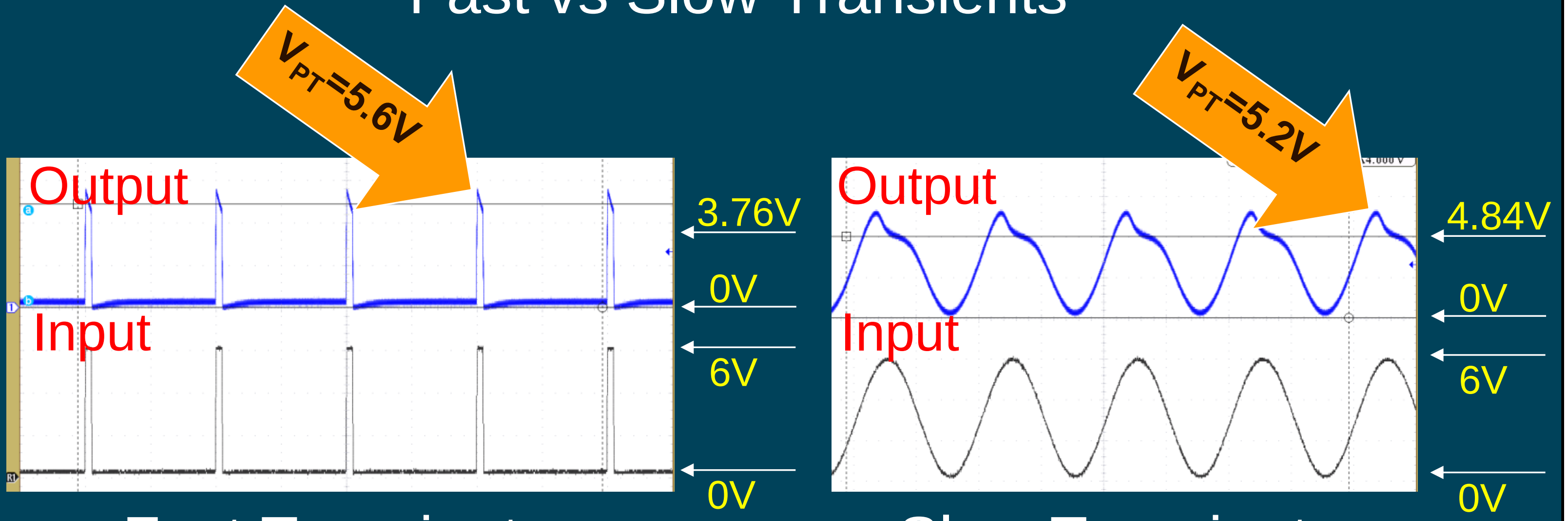
SR2.8

Input Signal Frequency = 50kHz

Punch-Through Voltage (V_{PT}) = 6V

Results and Discussion

Fast vs Slow Transients



Fast Transients

Slow Transients

SLVU2.8

Input Signal Frequency = 50kHz

Punch-Through Voltage (V_{PT}) = 5.2V (slow transient)

Punch-Through Voltage (V_{PT}) = 5.6V (fast transient)

Results and Discussion

Fast Transients @ 25°C

Fast Transients @25°C

TVS Diode	Rise Time	Fall Time	Pulse Wave	Clamp Voltage (measured)	Punch Through (measured)	Clamp Voltage (datasheet)	Punch Through (datasheet)
P6KE6.8A	55.0nS	51.6nS	20Vp, 10V offset, 50KHz 50% Duty Cycle	6.8V	n/a	$10.5V_{MAX}$	n/a
SR05	55.0nS	51.6nS	20Vp, 10V offset, 50KHz 50% Duty Cycle	10.8V	n/a	$20.0V_{MAX}$	n/a
SR3.3	55.0nS	51.6nS	20Vp, 10V offset, 50KHz 50% Duty Cycle	3.40V	6V	$15.0V_{MAX}$	$3.5V_{MIN}$
SR2.8	55.0nS	55.0nS	6Vp, 3V offset, 50KHz 10% Duty Cycle	3.76V	6V	$8.5V_{MAX}$	$3.0V_{MIN}$
SLVU2.8	55.0nS	55.0nS	6Vp, 3V offset, 50KHz 10% Duty Cycle	4.84V	5.6V	$15.0V_{MAX}$	$3.0V_{MIN}$

Results and Discussion

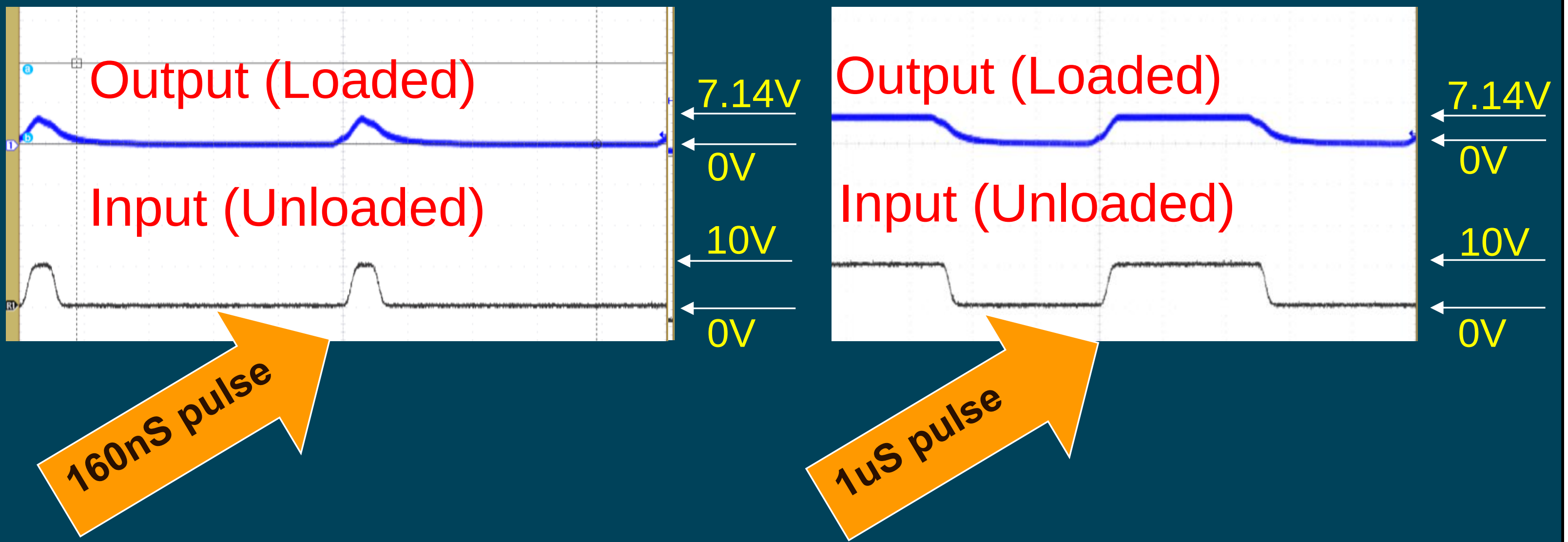
Slow Transients @ 25°C

Slow Transients @25°C

TVS Diode	Rise Time	Fall Time	Sine Wave	Clamp Voltage (measured)	Punch Through (measured)	Clamp Voltage (datasheet)	Punch Through (datasheet)
P6KE6.8A	6.72uS	6.72uS	20Vp, 10V offset, 50KHz,	6.8V	n/a	$10.5V_{MAX}$	n/a
SR05	6.72uS	6.72uS	20Vp, 10V offset, 50KHz	10.2V	n/a	$20.0V_{MAX}$	n/a
SR3.3	6.72uS	6.72uS	20Vp, 10V offset, 50KHz	3.40V	6.0V	$15.0V_{MAX}$	$3.5V_{MIN}$
SR2.8	6.46uS	6.46uS	6Vp, 3V offset, 50KHz	3.84V	6.0V	$8.5V_{MAX}$	$3.0V_{MIN}$
SLVU2.8	6.46uS	6.46uS	6Vp, 3V offset, 50KHz	4.00V	5.2V	$15.0V_{MAX}$	$3.0V_{MIN}$

Results and Discussion

Clamp Voltage vs Pulse Width



P6KE6.8A

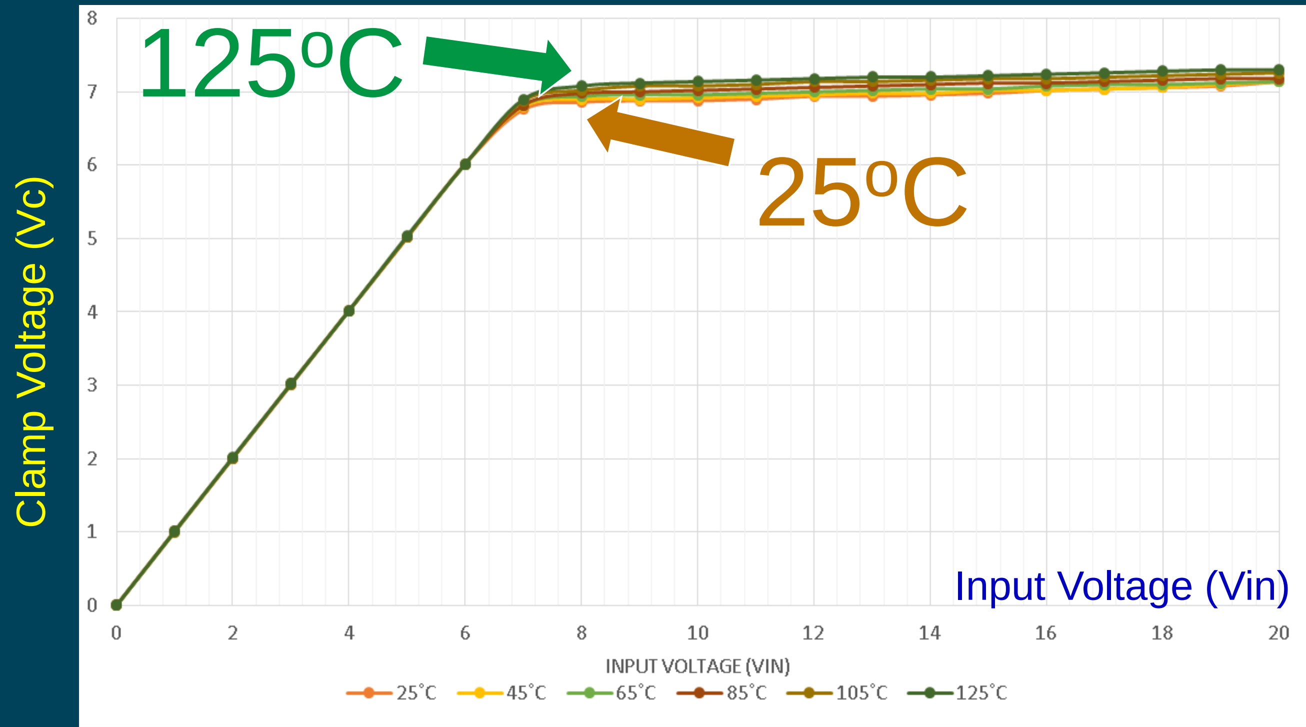
Results and Discussion

Clamp Voltage vs Pulse Width

Pulse Width	Start	Initial Voltage	First Clamp	Clamp Voltage	End of Capture	Clamp Voltage
P6KE6.8A	0ns	0V	160nS	7.14V	1uS	7.14V
SR05	0ns	0V	90nS	8.88V	1uS	8.88V
SR3.3	0ns	0V	80nS	3.80V	1uS	3.80V
SR2.8	0ns	0V	80nS	3.78V	1uS	3.78V
SLVU2.8	0ns	0V	80nS	4.16V	1uS	4.16V

Results and Discussion

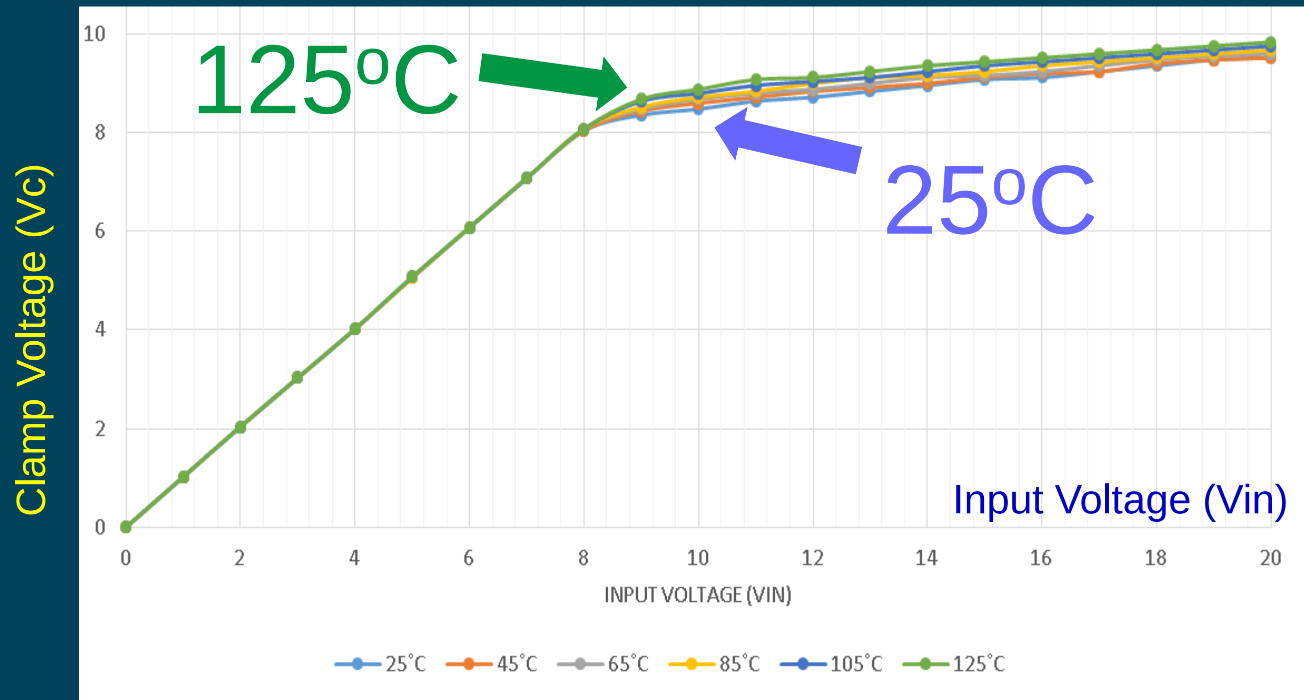
Clamp Voltage vs Temperature



P6KE6.8A

Results and Discussion

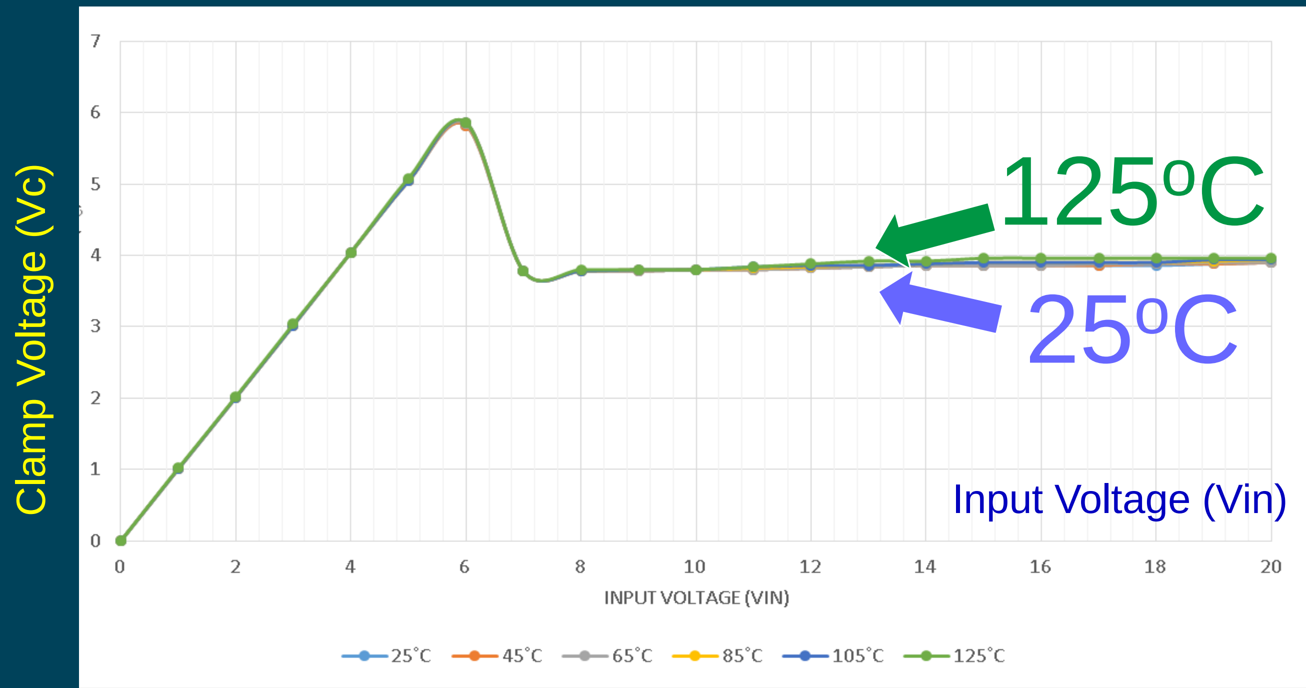
Clamp Voltage vs Temperature



SR05

Results and Discussion

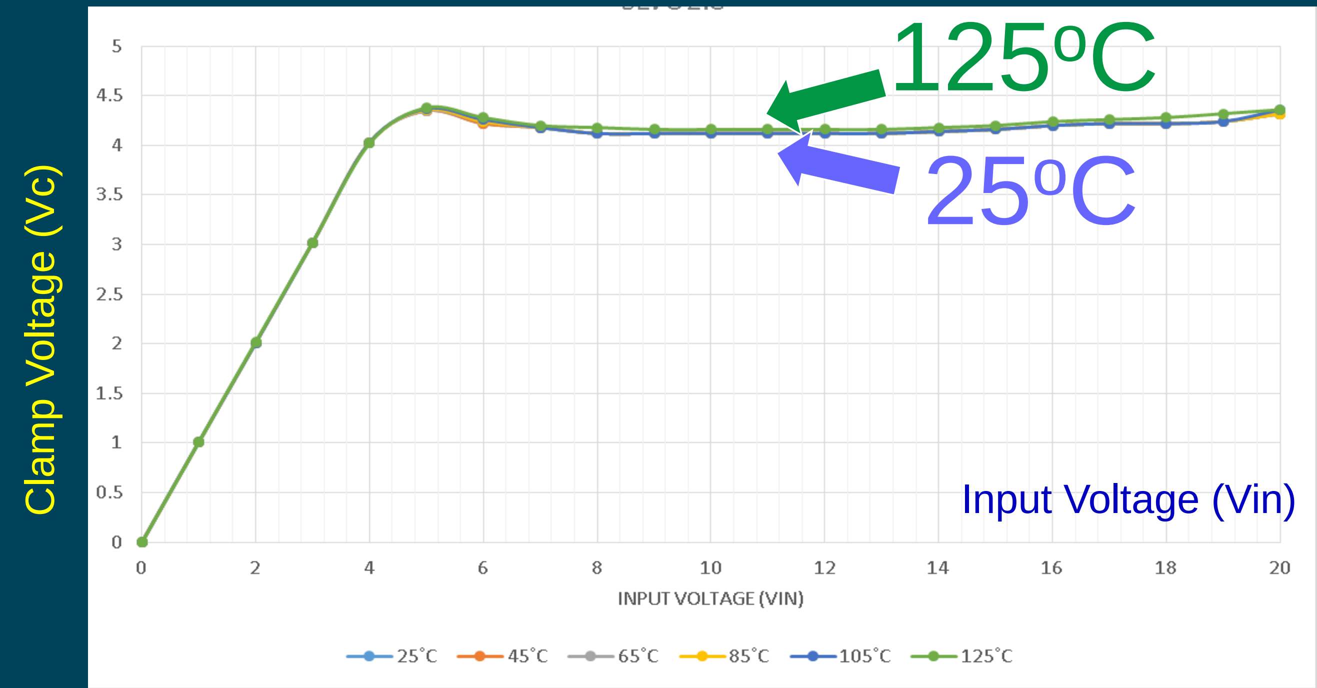
Clamp Voltage vs Temperature



SR3.3

Results and Discussion

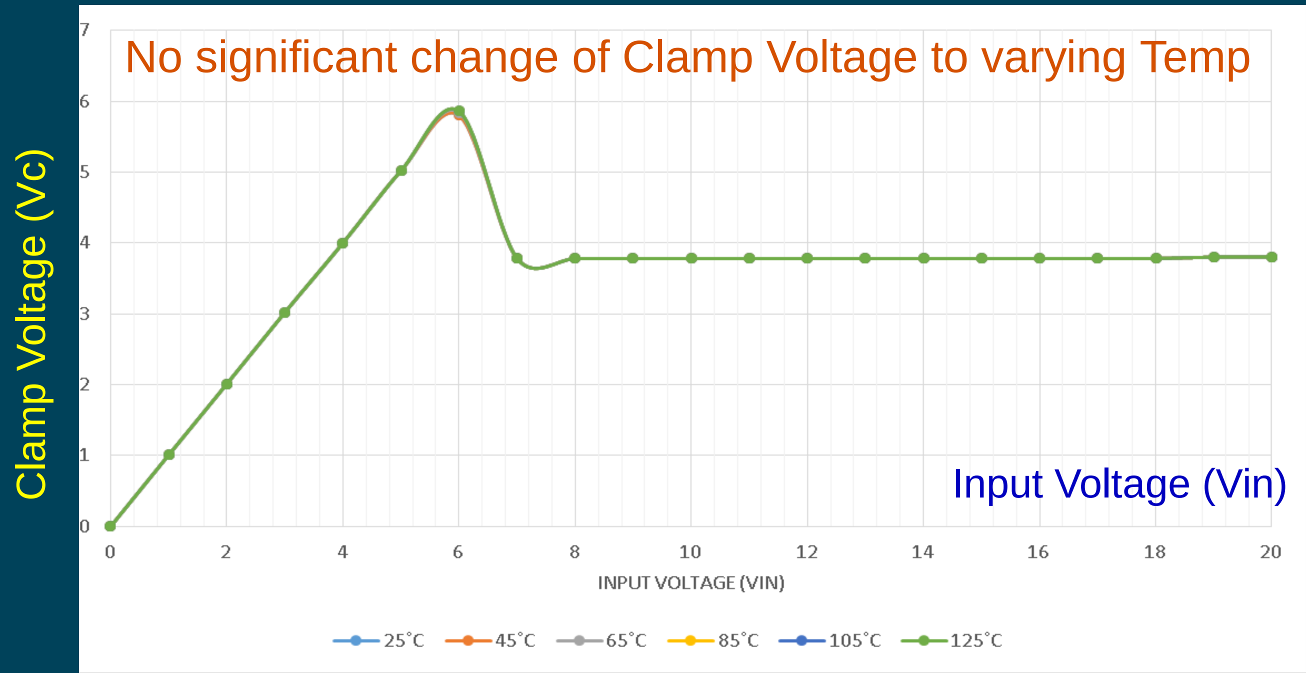
Clamp Voltage vs Temperature



SLVU2.8

Results and Discussion

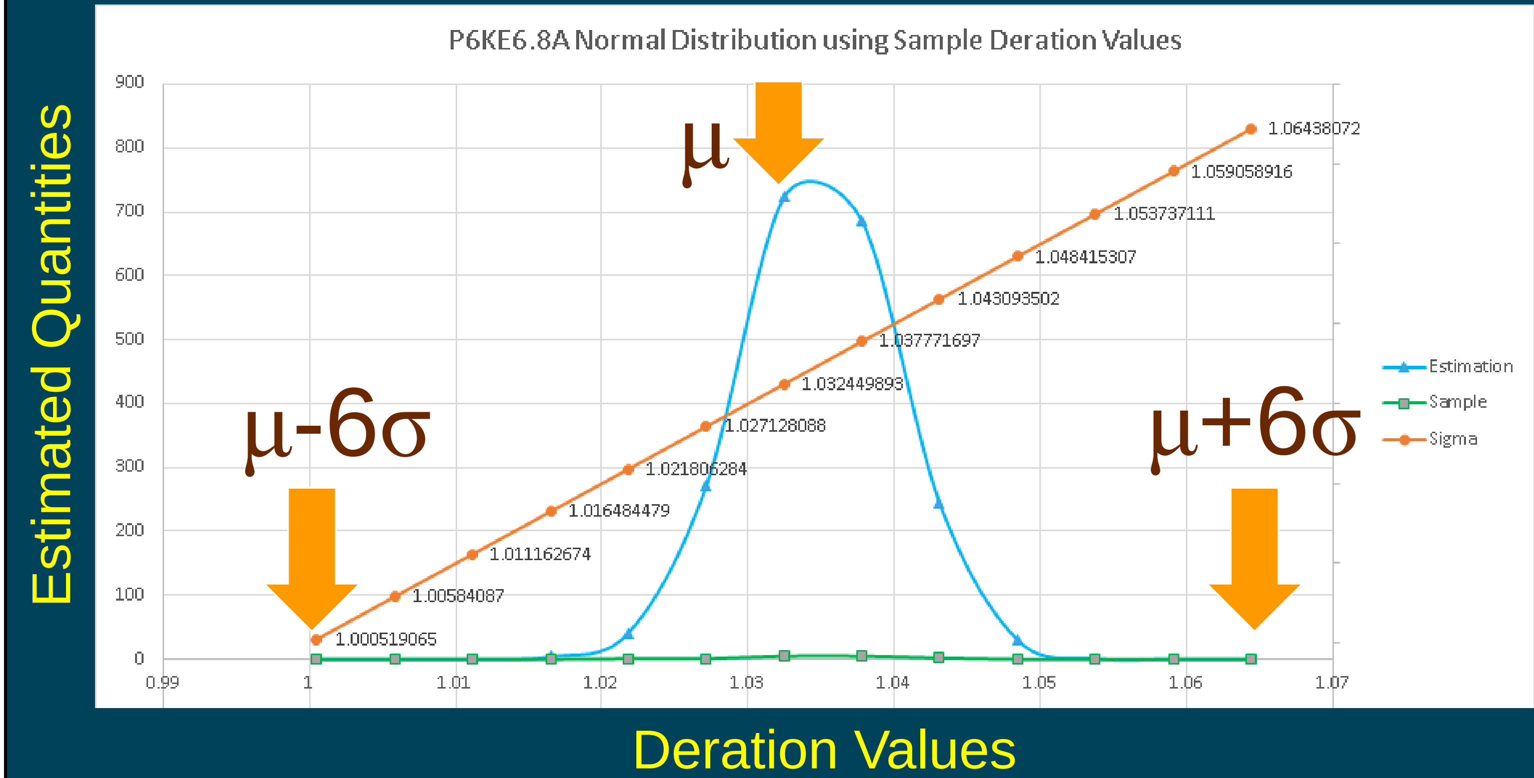
Clamp Voltage vs Temperature



SR2.8

Results and Discussion

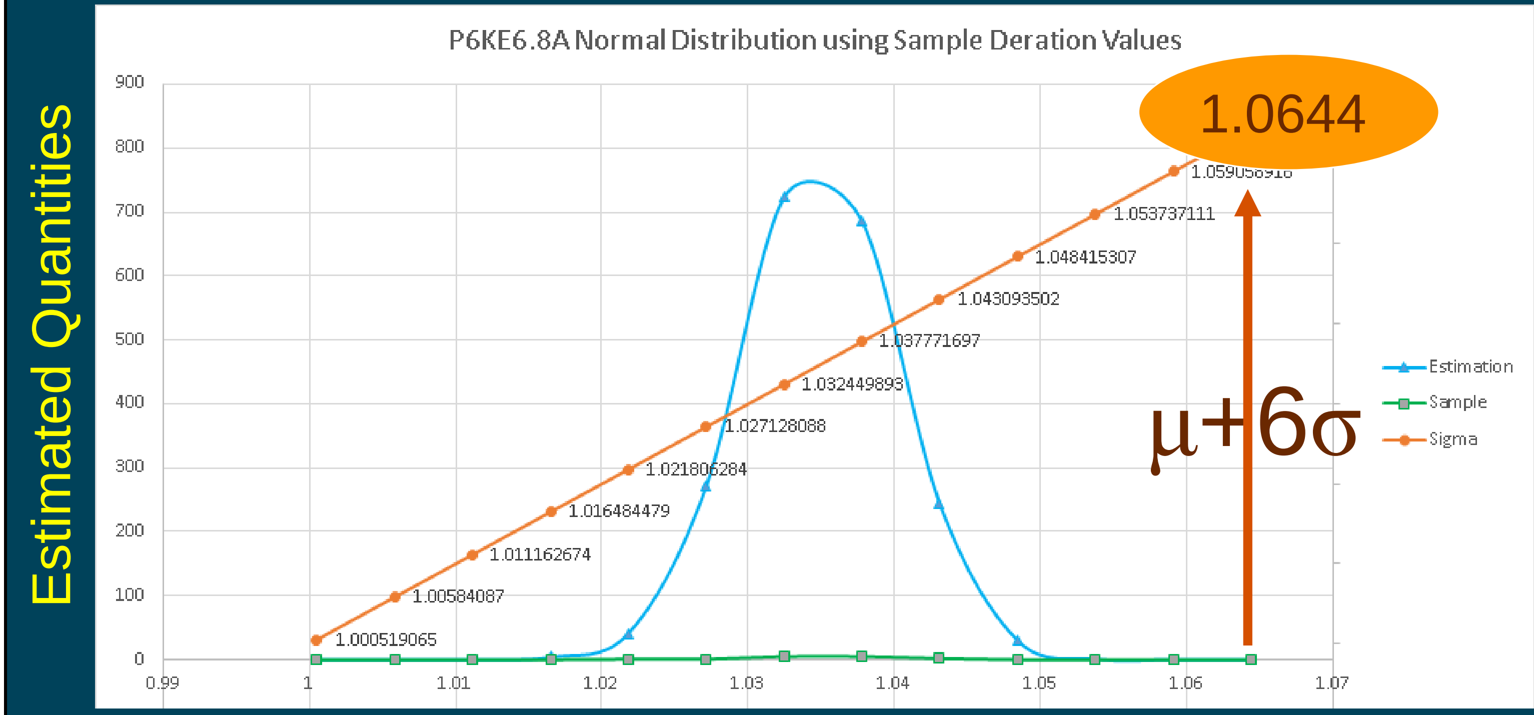
Clamp Voltage vs Temperature



Sample Statistical Analysis of Deration Values

Results and Discussion

Clamp Voltage vs Temperature



Sample Statistical Analysis of Deration Values

Results and Discussion

Clamp Voltage vs Temperature

TVS Diode	6Sigma Process	Proposed % Deration	Absolute Max Rating of Devices at 125°C
P6KE6.8A	106.44%	110%	
SR05	107.92%	110%	
SR3.3	107.29%	110%	>6V
SLVU2.8	102.88%	105%	>6V
SR2.8	n/a	No Deration	>6V

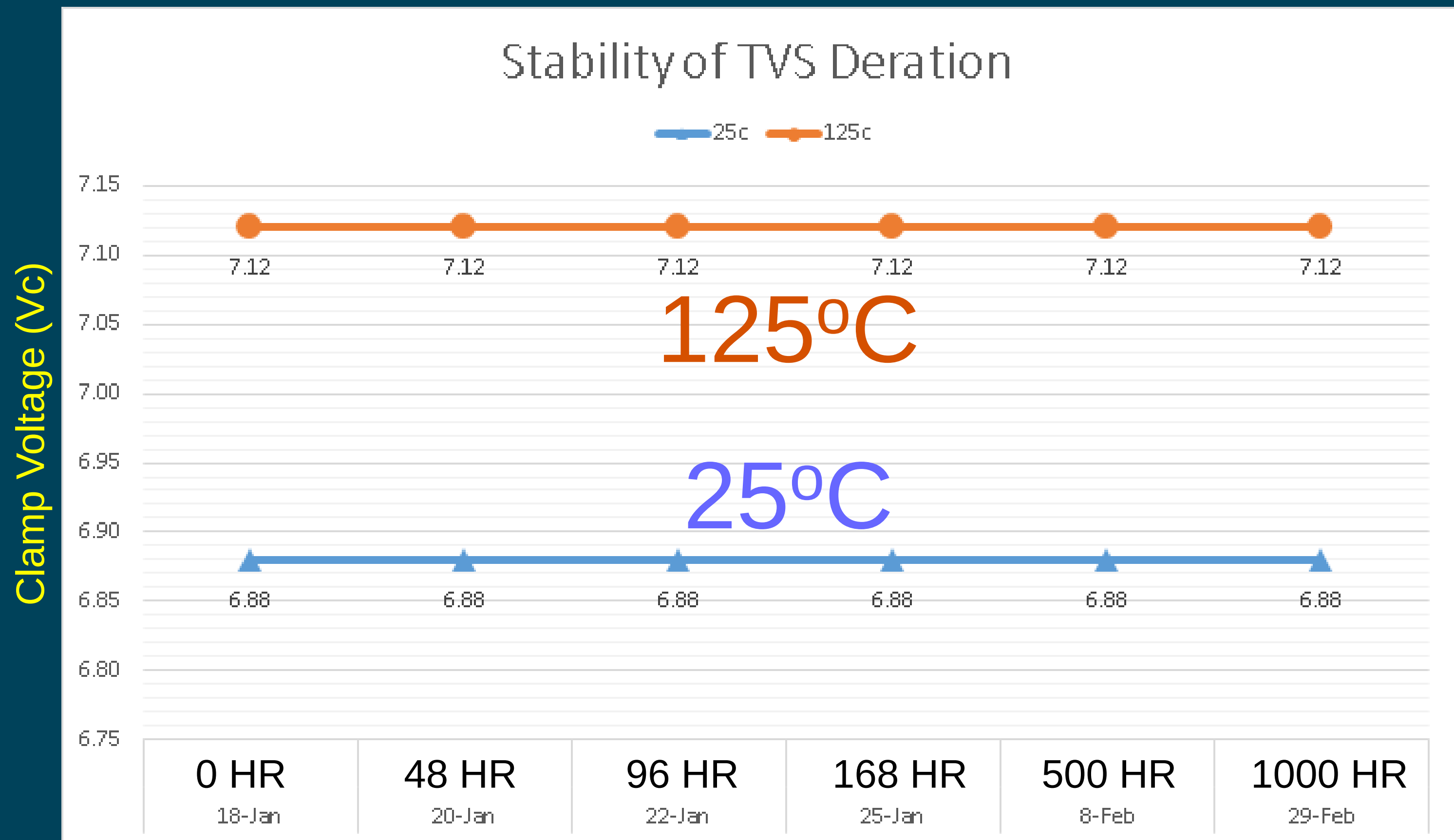
The proposed deration will ensure that the selected TVS diodes have clamp voltage rating below the absolute maximum voltage of load devices .

NOTE: Clamp voltage of TVS diodes should always be LESSER than absolute maximum voltage of load devices even during burn-in temperature.

Deration Values using 6 Sigma Process

Results and Discussion

Clamp Voltage vs Hours



Conclusion

- Clamp Voltage is increased at 125ºC degrading itself from protecting load devices
- For fast transitions and slow transitions, all TVS diodes will clamp the voltage at the specified rating in the datasheet.
- When changing the pulse width at 125ºC, TVS diodes will follow the same input signal until the clamping action takes place towards absolute maximum rating.
- Deration of TVS diodes is stable and robust

Conclusion

Proposed Percent Deration:

TVS Diode	6Sigma Process	Proposed % Deration	Absolute Max Rating of Devices at 125°C
P6KE6.8A	106.44%	110%	
SR05	107.92%	110%	
SR3.3	107.29%	110%	>6V
SLVU2.8	102.88%	105%	>6V
SR2.8	n/a	No Deration	>6V

Equation:
Clamp voltage @125°C = % Deration * (Rated Clamp Voltage @25°C)

NOTE: Clamp voltage of TVS diodes should always be LESSER than absolute maximum voltage of load devices even during burn-in temperature.

Recommendation

- High power, high voltage nanosecond pulse generator is recommended when acquiring derations for higher TVS ratings
- Avoid sinusoidal waveforms for higher TVS ratings due to regular application of peak voltages. TVS diodes are designed for non repetitive pulses
- Avoid persistent ringing as this will stress TVS diodes
- As input voltage is increased, apply single pulse single capture method

Acknowledgement

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