Tektronix

SiC and GaN Power Converter Analysis Kit

Instruction Guide





SIC AND GAN POWER CONVERTER ANALYSIS KIT

- 1. 5 Series MSO: (1 GHz) Oscilloscope
- 2. 5-PWR Software: Power analysis software
- **3. TIVH08:** (2.5 kV, 800 MHz) High voltage isolated differential probes
- 4. TIVH05 (Optional): (2.5 kV, 500 MHz) High voltage isolated differential probes
- 5. TIVM1 (Optional): (50 V, 1 GHz) High BW Isolated differential probes
- 6. **TPP1000 (Free):** (1 GHz) High BW passive probe. Comes standard with scope. One per channel.
- 7. MMCX Tip for TPP1000 (Optional): Passive probe MMCX Tip for high BW performance.
- 8. GaN Half-bridge Demo Board Guide: Instruction Guide for getting started.
- * All products come standard with their own accessories.

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SIC AND GAN POWER CONVERTER SWITCHING ANALYSIS

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Introduction

The SiC and GaN Switching Power Converter Analysis Kit is the ONLY solution in the market that can accurately characterize most of the critical parameters for optimizing Power Electronics topologies that use ultra-fast, power semiconductor switching technology such as SiC, GaN and even some silicon-based MOSFET and IGBTs.

Characterize:

- $V_{GS},\,V_{DS}$ and I_{D} measurements on high-side and low-side switches.
- Dead time optimization, including accurate turn-on, turn-off and gate-drive timing analysis.
- Switching and conduction loss measurements.
- Magnetic performance, losses and system efficiency.



GaN Half-bridge Evaluation Board Connections









- Two independent GaN-based half-bridge circuits.
- Choose between MMCX connectors (top half) or the Square pin connectors (bottom half) for your evaluation.
- DC Bus Voltage 50 V; Gate Voltage 5 V
- USB Powered *

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Selecting the Right Sensor Tip for TIVM

For this Demo, TIVM1 probe system is used to measure floating, high dv/dt Gate-Source (V_{GS}) signal:

- Maximum dv/dt: 5 V/1 nS = 5 V/ns
- Maximum differential voltage at the test points: 7 V_{pk-pk}
- Minimum differential loading (input impedance) that the circuit can tolerate : $1 \text{ K}\Omega$
- Required measurement sensitivity (V/div) <50 mV/div
- Sensor tip selected: IVTIP25X: ± 25 V; 1.25 k Ω // <1 pF; 25 mV/div

			ISOVU TIVH SERIES			
Sensor Tip Cable	Connection to DUT	Differential Voltage Range	ntial Voltage Offset Range Inpu		Most Sensitive V/div Setting	Attenuation
SMA Input	MMCX					
IVTIP1X	MMCX	± 1 V	±2 V	50 Ω // <1 pF	1 mV/div	1X
IVTIP5X (Standard)	MMCX	±5 V	± 10 V	250 Ω // <1 pF	5 mV/div	5X
IVTIP10X	MMCX	± 10 V	± 20 V	500 Ω // <1 pF	10 mV/div	10X
IVTIP25X (Standard)	MMCX	± 25 V	± 50 V	1.25 kΩ // <1 pF	25 mV/div	25X
IVTIP50X (Standard)	MMCX	± 50 V	± 100 V	2.5 kΩ // <1 pF	50 mV/div	50X

Note: Specifications are dependent on the probe tip cable.

Selecting the Right Sensor Tip for TIVH

For this Demo, TIVH probe system is used to measure floating, high dv/dt Drain-Source (V_{DS}) signal:

- Maximum dv/dt: 50 V/5ns = 10 V/ns
- Maximum differential voltage at the test points: 50 V_{pk-pk}
- Minimum differential loading (input impedance) that the circuit can tolerate: 10 kΩ
- Required measurement sensitivity (V/div): 10 V/div
- Sensor tip selected: MMCX50X: \pm 50 V; 10 M Ω // <3 pF; 50 mV/div

ISOVU TIVH SERIES											
Sensor Tip Cable	or Tip Cable Connection to Differential Voltage Offset Range Ir				Most Sensitive V/div Setting	Attenuation					
	Direct Connection into SMA Input of the Sensor Head										
SMA Input	MMCX	±1 V	± 25 V	1 MΩ // 20 pF		1X					
		Requires MMC	X Style female connecto	ors on the DUT							
MMCX10X	MMCX	± 10 V	± 250 V	10 MΩ // 6 pF	10mV	10X					
MMCX50X (Standard)	MMCX	± 50 V	± 250 V	10 MΩ // 3 pF	50mV	50X					
MMCX250X	MMCX	± 250 V	± 250 V	10 MΩ // 2 pF	250mV	250X					
		Requires 0.100"	Pitch (2.54 mm) Square	Pins on the DUT							
SQPIN100X	Square pin	± 100 V	± 600 V	10 MΩ // 3.5 pF	100mV	100X					
SQPIN500X (Standard)	Square pin	± 500 V	± 600 V	10 MΩ // 3.5 pF	500mV	500X					
		Requires 0.200"	Pitch (5.08 mm) Square	Pins on the DUT							
WSQPIN1000X	Square pin	± 1000 V	± 1000 V	40 MΩ // 3 pF	1.0V	1000X					
WSQPIN2500X	Square pin	± 2500 V	± 1000 V	40 MΩ // 3 pF	2.5V	2500X					

Note: Specifications are dependent on the probe tip cable

Make Connections – V_{DS} and V_{GS} Measurements



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Before Making Measurements

- Once all the connections are made, turn on the oscilloscope by pushing the power button in the lower left corner of the front panel.
- 2. Press 'Default Setup' button on the oscilloscope.
- Turn on Ch1, Ch2, Ch3, Ch4 on the oscilloscope by double-clicking on the respective channels' badges on the bottom ribbon.
- Before turning the GaN evaluation board ON or making any measurements, run following settings on all active channels. (Details on the following pages):
 - Self Calibration (IsoVu only)
 - Auto Zero (IsoVu only)
 - Deskew
 - Probe Compensation (passive probes only)





Self Calibration for IsoVu Probes

The SELF CAL sequence should always be run on an IsoVu probe after it is first powered on and has **warmed up for 20 minutes**.

- 1. Make sure there is no differential signal present at the sensor tip cable.
- 2. Press the SELF CAL button on the controller to adjust the operating point of the measurement system.
- The indicator blinks orange during the self calibration process; it turns solid green when the operation completes or solid red when the operation fails.
- Always run Self Calibration in following situations:
 - The measurement system is first attached to the oscilloscope.
 - Changes are made to the range (1X|2X), internal compensation or clamp (ON|OFF) setting.
 - The temperature in the sensor head changes more than 10°C.
 - The sensor tip cable is changed.

Tektronix	TIVM1 An IsoVu™ Product
● STATUS ● SELFCAL STATUS SELFCAL ● ON CLAMPING	• OVERANGE • 1X • 2X RANGE MENU

Auto Zero for IsoVu Probes

Run Autozero on start or when the displayed waveform is not centered correctly (for example, due to a small DC offset error).

- Make sure there is no differential signal present at the sensor tip cable.
- 2. Press the MENU button on the IsoVu controller to view the Probe Setup menu* on the oscilloscope.
- 3. Press the Autozero button in the Probe Setup menu of the oscilloscope.
- 4. Repeat this for all the connected IsoVu probes.

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	CHANN	IEL 3					?	
	VERTIC	AL SETTINGS					>	
	PROBES	SETUP						
C 3	Probe I Probe T Serial Version Attenu Propag	nformation Type: TIVH08 Number: M 1: 1.2 ation: 100X ation Delay	3L IKE01	in an air th	herekî:	(awar		dir.w
		AutoZero		Deres				ž
	Range	Mode Mani	al	Range	e o v			
	Clampi	ng ff						j) I
								22
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	OTHER		0.05			120.115	>	
Ch	1	Ch 2	Ch 3	-	Ch 4			
100 ලු 1 G) mV/div Hz	20 V/div 50 Ω 1 GHz	5 V/d 50 Ω 800 N	iv ЛНz ^в w	2 V/di 心 1 GHz	v		

Deskew All Probe Channels

Running Deskew is very important to get accurate delays between the signals. Double-tap the Ch1 badge and go to 'Other' Menu.

- 1. Set the Ch1 Deskew to 0 by pressing 'Set to 0' soft button.
- 2. To set other channels' Deskew, press the 'Multi Channel' soft button. This will open an Deskew setting popup.
- 3. Select 'From Source' as Ch1, 'To Source' as Ch2, and press the 'OK, Deskew' button.
- 4. This will deskew the second channel using the default propagation delay for each probe.
- 5. Repeat this step for all channels and deskew them with respect to Ch1.

File Edit Utility Help				
Waveform View		[- 0
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CHANNEL 3	⑦ DESKEW			()
VERTICAL SETTINGS	> From Source	Probe		Propagation
	> Ch 1 -	TPP1000		Delay. 5.5 fis
OTHER	To Source	Probe		Propagation Delay: 68.5 ns
Deskew	Ch 3 🔻	TIVH08L		
63.2 ns Set Multi- Channel	Channel 3's c	leskew value will be	set to: 63.2 ns	OK, Deskew
External Attenuation	t to	a a a a		
Ca Alternate Units	nity			
Off	N 2			
-80 ns -60 ns	-40 ns	e a co e e a co esta	10 ns	0 s
C 4				
Ch 1 Ch 2 Ch 3 Ch 4 1 V/div 1 A/div 10 V/div 10 V/div			5	
Φ 50 Ω DS 50 Ω DS Φ 1 GHz 1 GHz 800 MHz ^B _W 1 GHz			2	

Probe Compensation for Passive Probes

Probe compensation optimizes probes to a specific channel and stores the results to the oscilloscope.

IsoVu probes are compensated at the factory and do not need any additional compensation.

For all other passive probes, run the probe compensation under the Probe Setup menu by double-tapping the respective channel badges.

Follow the instructions under the 'Probe Compensation' popup.

CHANNEL 1	PROBE COMPENSATION	D						
VERTICAL SETTINGS	1 TPP1000 C031459 Probe Compensation optimizes this probe for this channe and stores the results in the oscilloscope.	el 🔜						
Probe Information Probe Type: TPP1000 Serial Number: C031459 Version: 1.1 Attenuation: 10X Propagation Delay: 5.3 ns Compensate Probe	Carefully hold the probe tip and ground to the oscilloscope's probe compensation pins at the lower right of the front panel. For best results, do not use any probe tip accessories. Note that the upper pin is Ground. Push "Compensate Probe" to start the compensation. Probe compensation will take less than five seconds to run. To delete the stored compensation values for this probe and channel combination, push "Restore Factory Defaults". Probe Compensation Status:							
	Restore Factory Defaults Compensate Prob	e						
OTHER								
Ch 1 Ch 2 Ch 3 Ch 4 1 V/div 1 A/div 10 V/div 10 V/div % 50 Ω DS 50 Ω 0S 1 GHz 1 GHz 1 GHz 1 GHz 1 GHz		5						

Powering on the GaN Half-bridge Evaluation Board

- Once all the pre-requisite settings are applied, connect the supplied dual-input USB cable to two of the oscilloscope USB ports *before* connecting the cable to the USB Power input on the demo board. Using any other cable can cause serious damage to the oscilloscope's USB port due to high inrush current on the board.
- 2. Now, connect the GaN Half-bridge **board power** (USB power) to the USB cable.
- 3. The green LED labeled 'USB PWR' on the board will turn on and remain steady when the USB cable is connected.
- 4. Turn **Switch S3**, next to the USB input, to the ON position to turn on the main board power.
- 5. Next, turn ON Switch S1 to power the upper half of the board with MMCX test points.
- 6. Now, you are ready to make the measurements.



GaN Half-bridge Evaluation Board



Test 1:

Gate-charge Characterization and Effective Dead Time Analysis

- Measuring high-side V_{GS} and low-side V_{GS} simultaneously
- Measuring high-side V_{DS} and low-side V_{DS} simultaneously

Gate-charge Characterization and Effective Dead Time Analysis

Getting the best performance out of a SiC- or GaNbased power converter topology requires optimizing dead time and gate charge characteristics. This requires accurate measurement of all high-side and low-side gate-source (V_{GS}) and drain-source (V_{DS}) voltages.

Measuring the signals on the low-side, ground referenced switch is possible with a passive probe setup, but ground return currents and the ground lead inductance of a traditional passive probe can degrade the measurement. The high-side, high frequency, floating measurements are almost impossible to measure using traditional differential measurement systems due to the presence of high common-mode voltage.

The following section will demonstrate how to make all gate-source (V_{GS}) and (V_{DS}) measurements accurately.

Floating Measurements – Very Difficult



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On-Screen Setup – All Measurements

- Start by pressing the 'Autoset' button on the front panel. This will adjust the screen to show all the waveforms simultaneously.
- 2. Press trigger badge and set the trigger on Ch2 (Vgs_High Side) rising edge and set trigger to 50%.
- 3. For the most accurate measurements, the probe's offset function should be used to center the signals on the display; for instance, the 0-50 V V_{DS} signals should be offset 25 V).
- 4. Enable cursors to analyze dead time and switch characteristics.



High-Side and Low-Side V_{GS} Measurements

- 1. Turn off Ch3 and Ch4 by double-tapping the respective channel badges and tapping the display button to OFF. This will give a clear view of gate-source (V_{GS}) signals on the low side and high side.
- 2. Set trigger on Ch2 and adjust the horizontal scale to 10 nS/div to fill the screen with the turn-on (rise) sequence on Ch2 (Vgs_hi).
- 3. Adjust the vertical scale on Ch2 and Ch1 to 1 V/div. Alternatively, use pinch and zoom to view the gate-charge response on the gate signals.
- 4. Miller plateau and dead time should be clearly visible for analysis. Use cursors for further evaluation.
- 5. Use the Measure button on the right soft panel to enable Rise Time, Fall Time, Slew rates and other critical measurements for each channel. Note that the rise time measurement might include the time to charge the Miller capacitance, depending on where the reference level is set.



High-Side and Low-Side V_{Ds} Measurements

- Turn on Ch3 (Vds_hi) and Ch4 (Vds_lo) and turn off Ch1(Vgs_lo) and Ch2(Vgs_hi) to get a clear view of drain-source (V_{DS}) signals on the high side and low side.
- 2. Set the trigger on Ch3 (Vds_hi) falling edge.
- 3. Adjust the horizontal scale to 200 ns/div to view the dead time between the (Ch3) Vds_hi falling edge and Ch4 (Vds_lo) rising edge.
- 4. Adjust the vertical scale on Ch3 and Ch4 to 10 V/div. Alternatively, use pinch and zoom to view the drainsource response on the full screen.
- 5. Dead time should be clearly visible. Use cursors to evaluate dead time and rise-fall time characteristics.
- 6. Use the Measure button on the right soft panel to enable Rise Time, Fall Time, Slew rates and other critical measurements for each channel.



Note: Turn on Ch2 (Vgs_hi) and Ch3 (Vds_hi) to view V_{GS} , Miller charge time and V_{DS} turn-on correlation (not demonstrated).



Test 2:

Fast-Switching Load Current or Drain Current Analysis

Measuring high di/dt switching, drain/load current using a shunt

Fast-Switching Load Current or Drain Current Analysis

Testing high di/dt load and drain current is critical for optimizing power converter performance. The most common methods of measuring these currents involves inserting either a wire loop for a current probe or a resistive current shunt at the test point.

The added inductance of a wire loop for a current probe can have a negative impact on the performance of the circuit. Using a low-inductance resistive current shunt can be a better choice in many applications.

The following section will demonstrate how to make fast-switching load current measurements on a floating shunt using the IsoVu probe.

NOTE: The GaN Evaluation board is not designed to carry any significant current, so use the following steps as representative test only.



Make Connections – Current Measurements Shunt vs. Loop



* The GaN Evaluation board is not designed to carry any significant current, so use the following steps as representative tests only. 22

Fast-Switching Load Current or Drain Current Analysis

- Make sure the Ch3 and Ch4 are deskewed using the steps noted in the <u>Deskew</u> section.
- Because Ch3 -TIVM1 (IsoVu) probe is testing current through a floating shunt, change the measurement unit to current: 'A'.
- Double-tap the Ch3 badge and under 'OTHER,' toggle the 'Alternate Units' switch On and set the Ratio to 1 A/V. (Current shunt value on the board is 1 Ω).
- To compare the traditional loop-based measurement with the shunt-based measurement, add current loop using a standard square pin lead on the 'Current probe' test-point of the lower GaN Half-bridge circuit.
- Use a high BW current probe (TCP0030A) to measure load current through the loop. Degauss the probe before making the measurement.



Measuring Fast-Switching Load Current

- Average current through the shunt in on-state is quite low (~50 mA). The parasitic elements on output circuit causes ringing as high as 4 A_{pk-pk}, which makes it difficult to measure the on-state current.
- To see the on-state current, switch to averaging mode by tapping the Acquisition badge and selecting Average from Acquisition mode.
- The vertical scale might have to be extended beyond the clipping range to view the average current.



Current Measurement – Shunt vs. Loop

- It can be clearly seen from the waveform that adding a loop adds quite a lot of ringing and settling time (~275 ns) vs. (~50 ns) on the shuntbased measurement.
- The effects of lower bandwidth on Hall effect-based current probe are also visible on the low frequency ringing on the loop-based (Ch4) waveform.
- Adding a loop can also affect the performance of gate drive, along with other timing characteristics and can be seen in V_{GS} and V_{DS} measurements.



Test 3:

Testing Switching/Conduction Losses and Magnetic Properties

(This test does not use the GaN Evaluation Board)

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Switching/Conduction Loss and Magnetic Measurements

Getting the best efficiency and power density out of any power converter requires accurate measurements of switching, conduction and magnetic losses.

To measure switching and conduction losses, measure the drainsource voltage (V_{DS}) and drain current (I_D) across the power switch using appropriate probes, as shown in the connection diagram on the next page. For magnetic properties, measure voltage (V_L) across the coil and current (I_L) through the coil.

The following section uses the built-in demo to demonstrate the capabilities of the 5 PWR software for switching and conduction losses.

Use your own DUT to test any of the demonstrated parameters.



Make Connections – Switching/Conduction/Magnetic



Power Measurements Demo

- No connections are required to enable the 5-PWR scope demo.
- Tap 'Utility \rightarrow Demo' on the top ribbon.
- Tap 'Power Measurements' under the Demo popup.
- Select between the available choices.
- The following pages show the screenshots and capabilities of these functions:
 - Switching/Conduction Loss
 - Magnetic Measurements

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Sum	The Switching conduction re all made with instrument se automatically shows the vol turn-off. sedures Notice the me the display. The measurer at the top of current signa	g Loss measuren egion power an the press of a l tup for repeata calculated and ltage-vscurrent easurement resu nent results and the display. If th ls, the measurer	nents are a col d energy loss n button, and th ble results. The displayed. The t characteristic ults are shown d measuremen ne oscilloscope ments and stat	lection of turn-on, t neasurements. Thes e Power Autoset as e instantaneous poo e trajectory plot at t s of the switching d in the results badge t statistics are show were connected to istics would be accu	turn-off, and e measurements are sures consistent wer loss waveform is the top of the display levice turn-on and e at the right side of n in the results table live voltage and mulating.
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Switching/Conduction Losses Demo

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Power 1	SL: Turn ON Energy SL: Turn ON Loss SL: Turn OFF Energy SL: Turn OFF Loss SL: Conduction Energy SL: Conduction Loss SL: Total Energy SL: Total Loss	Switching Loss	Ch 1, Ch 2, None	82.558 μJ 11.928 mW 197.82 μJ 28.579 mW 803.63 nJ 116.09 μW 281.18 μJ 40.623 mW	81.835 μJ 11.601 mW 194.19 μJ 27.965 mW 785.64 ηJ 114.19 μW 277.46 μJ 39.967 mW	83.403 μJ 12.154 mW 201.06 μJ 29.409 mW 824.8 nJ 118.2 μW 285.04 μJ 41.648 mW	582.25 nJ 167.01 µW 2.4195 µJ 470.83 µW 11.878 nJ 1.4459 µW 2.5623 µJ 590.7 µW	11 11 11 11 11 11 11 11 11		82.558 μJ 11.928 mW 197.82 μJ 28.579 mW 803.63 nJ 116.09 μW 281.18 μJ 40.623 mW	81.835 μJ 11.601 mW 194.19 μJ 27.965 mW 785.64 ηJ 114.19 μW 277.46 μJ 39.967 mW	83.403 μJ 12.154 mW 201.06 μJ 29.409 mW 824.8 nJ 118.2 μW 285.04 μJ 41.648 mW	582.25 nJ 167.01 µW 2.4195 µJ 470.83 µW 11.878 nJ 1.4459 µW 2.5623 µJ 590.7 µW	11 11 11 11 11 11 11 11 11		Table Power 1 Switching Ton: 11 Toff: 28 Cond: 1 Total: 4	1 2 Loss' 1.93 mW 3.58 mW 16.1 μW 0.62 mW
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3															30 V 20 V 10 V -20 V -20 V -20 V -20 MV -200 MV 150 MV 50 MV 0 V -50 MV	**	
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Magnetic Measurements Demo

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Power 1	Inductance	Inductance	Ref 1, Ref 2	3.4213 mH	3.4213 mH	3.4213 mH	0 H	1		3.4213 mH	3.4213 mH	3.4213 mH	0 H	A second for the second
Power 2	Magnetic Loss	Magnetic Loss	Ref 1, Ref 2	8.8442 mW	8.8442 mW	8.8442 mW	0 W	1		8.8442 mW	8.8442 mW	8.8442 mW	0 W	wie asure Search
Power 3	MP: Peak Flux Density MP: Retentive Flux Density MP: Coercive Field Strength MP: Maximum Field Strength MP: Nipple Current MP: Delta B MP: Delta H MP: Permeability	Magnetic Property	Ref 1, Ref 2	238.3 μT -61.394 μT 7.1328 mAT/m 98.75 mAT/m 196.32 mA 465.91 μT 194.24 mAT/m 2.5268 kH/m	238.24 μT -61.394 μT 7.1328 mAT/m 98.75 mAT/m 196.27 mA 465.91 μT 194.24 mAT/m 2.5268 kH/m	238.37 μT -61.394 μT 7.1328 mAT/m 98.75 mAT/m 196.38 mA 465.91 μT 194.24 mAT/m 2.5268 kH/m	90.523 nT 0 T 0 AT/m 0 AT/m 82.864 μA 0 T 0 AT/m 0 H/m	2 1 1 2 1 1 1 1		238.3 μT -61.394 μT 7.1328 mAT/m 98.75 mAT/m 196.32 mA 465.91 μT 194.24 mAT/m 2.5268 kH/m	238.24 μT -61.394 μT 7.1328 mAT/m 98.75 mAT/m 196.27 mA 465.91 μT 194.24 mAT/m 2.5268 kH/m	238.37 μT -61.394 μT 7.1328 mAT/m 98.75 mAT/m 196.38 mA 465.91 μT 194.24 mAT/m 2.5268 kH/m	90.523 0 T 0 AT/m 0 AT/m 82.864 0 T 0 AT/m 0 H/m	Results Plot Power 1 Intuctance' µ': 3.421 mH Power 2 Intuctance' Magnetic Loss' Washing µ': 8.844 mW
Plot 1 - BH	l Curve (Ref 1, Ref 2, Power 3)				200 μ	Waveform V	ew						- 1.92 - 1.44 V 960 mV	Power 3 R1 / R2 Magnetic Property Break: 238.3 μT Br: -61.39 μT Hc: 7.133 mAT/m Max: 98.75 mAT/m Mare: 19.63 mA ΔB: 465.9 μT ΔH: 144.2 mAT/m
					100 μ	T							480 mV -480 mV -960 mV -1.44 V -1.92 V	Perm:2.527 kH/m
	150 mAT/m			α α α α α α α α α α α α α α	-100	R2	-1.2 ms	-800 µs	-400 μ5	0'5 400 μ	s 800 us	1.2 ms 1.6 ms	- 88 mA 66 mA - 44 mA - 22 mA 	
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Power Measurements Software Help

For detailed setup steps and a full description of 5-PWR software features, please refer to the onscreen help by tapping the Help button.



Specifications

IsoVu Technology Specifications

	ISOVU TIVM SERIES	ISOVU TIVH SERIES
Bandwidth	Up to 1 GHz	Up to 800 MHz
Rise Time	Down to 350 ps	Down to 450 ps
Differential Voltage Range	±5 mV up to ±50 V	±5 mV up to ±2.5 kV
Common Mode Voltage Range	60 kV	60 kV
Common Mode Rejection Ratio	DC – 1 MHz: 160 dB (100 Million to 1) 1 MHz – 100 MHz: 120 dB (1 Million to 1) 1 GHz: 80 dB (10,000 to 1)	DC – 1 MHz: 160 dB (100 Million to 1) 1 MHz – 100 MHz: 120 dB (1 Million to 1) 800 MHz: 80 dB (10,000 to 1)
Input Impedance	Up to 2.5 kΩ < 1 pF	Up to 40 MΩ As low as 2 pF
Fiber Cable Length	3 meters or 10 meters	3 meters or 10 meters
Power Over Fiber	Powered over the fiber connection – no batteries required	Powered over the fiber connection – no batteries required
Input Offset	Up to ± 100 V	Up to ± 1000 V
Input Coupling	DC	DC or AC
Note: Specifications are dependent on the probe tip cable.		

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