PWS4205, PWS4305, PWS4323, PWS4602, and PWS4721
Linear DC Power Supplies
Specifications and Performance Verification

Technical Reference

077-0480-00

Tektronix

PWS4205, PWS4305, PWS4323, PWS4602, and PWS4721 Linear DC Power Supplies Specifications and Performance Verification

Technical Reference

Warning

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries before performing service.

www.tektronix.com

077-0480-00

Tektronix

Contacting Tektronix

Tektronix, Inc.
14150 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Use proper voltage setting. Before applying power, ensure that the line selector is in the proper position for the source being used.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Power disconnect. The power switch disconnects the product from the power source. See instructions for the location. Do not block the power switch; it must remain accessible to the user at all times.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Use proper fuse. Use only the fuse type and rating specified for this product.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

Provide proper ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Terms in This Manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

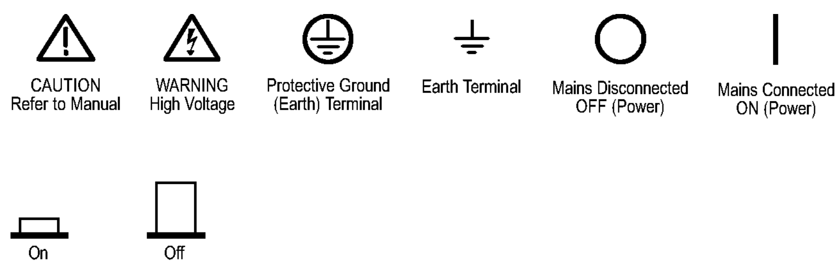
CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and Terms on the Product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbol(s) may appear on the product:



Specifications

This section contains specifications for the PWS4000 series instruments. All specifications are guaranteed unless noted as "typical." Typical specifications are provided for your convenience but are not guaranteed. Specifications that are marked with the ✓ symbol are checked in *Performance Verification*.

Table 1: Specifications

Parameter	PWS4205	PWS4305	PWS4323	PWS4602	PWS4721
Constant voltage operation, nominal	The unit may be set to a constant voltage over a range of currents				
Voltage range This is the range over which the output voltage is adjustable	0 to 20 V	0 to 30 V	0 to 32 V	0 to 60 V	0 to 72 V
Remote sense voltage range	The total voltage from the – terminal to the + terminal may not exceed the rated FS voltage + 0.2 V, allowing a minimum of 0.1 V/line for remote sense. The voltage each terminal of the remote sense function is allowed to vary from the respective output terminal is 0 V to 1 V.				
Voltage resolution, nominal					
Front panel:	1 mV	1 mV	1 mV	1 mV	1 mV
Programming:	0.1 mV	0.1 mV	0.1 mV	0.5 mV	0.1 mV
✓ Voltage setting accuracy with remote sense At 25 °C ±5 °C	±(0.03% of settling + 3 mV)	±(0.03% of settling + 3 mV)	±(0.03% of settling + 3 mV)	±(0.03% of settling + 6 mV)	±(0.03% of settling + 6 mV)
✓ Voltage setting accuracy without remote sense At 25 °C ±5 °C	±(0.05% of settling + 10 mV)	±(0.05% of settling + 10 mV)	±(0.05% of settling + 10 mV)	±(0.05% of settling + 20 mV)	±(0.05% of settling + 20 mV)
Current limit, nominal	Defined by the constant current setting. The changeover is automatic.				
Voltage temperature coefficient, typical	±(0.02% + 3 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% + 3 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% + 3 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% + 6 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% + 5 mV) per °C outside the 25 °C ±5 °C standard range
Constant current operation, nominal	The unit may be set to a constant current over a range of voltages.				
Current range This is the range over which the output current is adjustable	0 A to 5 A	0 A to 5 A	0 A to 3 A	0 A to 2.5 A	0 A to 1.2 A

Table 1: Specifications (cont.)

Parameter	PWS4205	PWS4305	PWS4323	PWS4602	PWS4721
Current resolution, nominal Front panel: Programming:	 0.1 mA 0.1 mA	 0.1 mA 0.1 mA	 0.1 mA 0.1 mA	 0.1 mA 0.1 mA	 0.1 mA 0.05 mA
✓ Current setting accuracy At 25 °C ±5 °C	±(0.05% + 2 mA)	±(0.05% + 2.5 mA)	±(0.05% + 2 mA)	±(0.05% + 1.5 mA)	±(0.05% + 1 mA)
Voltage limit, nominal	0 to 20 V	0 to 30 V	0 to 32 V	0 to 60 V	0 to 72 V
	Also see the Over Voltage Limit characteristics. (See page 3.)				
Current temperature coefficient, typical	±(0.05% + 2 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 2 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 2 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 1 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 0.5 mA) per °C outside the 25 °C ±5 °C standard range
Meter, nominal	Internal measurement capability. Voltage and current are measured internally.				
Current readback resolution, nominal	0.1 mA				
✓ Current readback accuracy At 25 °C ±5 °C	±(0.05% of reading + 2 mA)	±(0.05% of reading + 2.5 mA)	±(0.05% of reading + 2 mA)	±(0.05% of reading + 1.5 mA)	±(0.05% of reading + 1 mA)
Current readback temperature coefficient, typical	±(0.05% + 2 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 2 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 2 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 1 mA) per °C outside the 25 °C ±5 °C standard range	±(0.05% + 0.5 mA) per °C outside the 25 °C ±5 °C standard range
✓ Voltage readback accuracy At 25 °C ±5 °C	±(0.02% of reading + 3 mV)	±(0.02% of reading + 2.5 mV)	±(0.02% of reading + 3 mV)	±(0.02% of reading + 6 mV)	±(0.02% of reading + 5 mV)
Voltage readback resolution, nominal	1 mV				
Voltage readback temperature coefficient, typical	±(0.02% of reading + 3 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% of reading + 2 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% of reading + 3 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% of reading + 6 mV) per °C outside the 25 °C ±5 °C standard range	±(0.02% of reading + 5 mV) per °C outside the 25 °C ±5 °C standard range
Maximum input VA_{RMS}, typical	350 VA	500 VA	350 VA	500 VA	350 VA
✓ Line regulation – voltage	Change over the full rated input voltage: ±(0.01% + 1 mV)	Change over the full rated input voltage: ±(0.01% + 1 mV)	Change over the full rated input voltage: ±(0.01% + 1 mV)	Change over the full rated input voltage: ±(0.01% + 2 mV)	Change over the full rated input voltage: ±(0.01% + 1 mV)

Table 1: Specifications (cont.)

Parameter	PWS4205	PWS4305	PWS4323	PWS4602	PWS4721
✓ Line regulation – current	Change over full rated input voltage: ±(0.05% + 0.1 mA)	Change over full rated input voltage: ±(0.05% + 0.1 mA)	Change over full rated input voltage: ±(0.05% + 0.1 mA)	Change over full rated input voltage: ±(0.05% + 0.05 mA)	Change over full rated input voltage: ±(0.05% + 0.1 mA)
✓ Load regulation – voltage	Change from 0 to 100% of full scale current; ±(0.01% + 2 mV)				
✓ Load regulation – current	Change from 10 to 90% of full scale voltage; ±(0.05% + 0.1 mA)	Change from 10 to 90% of full scale voltage; ±(0.05% + 1.5 mA)	Change from 10 to 90% of full scale voltage; ±(0.05% + 0.1 mA)	Change from 10 to 90% of full scale voltage; ±(0.05% + 0.5 mA)	Change from 10 to 90% of full scale voltage; ±(0.05% + 0.5 mA)
✓ Voltage ripple, 20 MHz bandwidth	< 3 mV_{RMS} and 20 mV_{p-p}, guaranteed < 1.5 mV_{RMS} and 12 mV_{p-p}, typical				
✓ Voltage ripple, 7 MHz bandwidth	< 1 mV_{RMS} and 3 mV_{p-p}	< 1 mV_{RMS} and 4 mV_{p-p}	< 1 mV_{RMS} and 4 mV_{p-p}	< 1 mV_{RMS} and 5 mV_{p-p}	< 1 mV_{RMS} and 3 mV_{p-p}
✓ Current ripple, 20 MHz bandwidth	< 3 mA_{RMS}	< 4 mA_{RMS}	< 3 mA_{RMS}	< 3 mA_{RMS}	< 3 mA_{RMS}
Voltage transient response settling time, load change	<400 µs to within 75 mV following a change from 0.1 A to 1 A.				
Voltage transient response settling time, setting change, rising	<35 ms from beginning of excursion to within 75 mV of terminal value following a change from 1 V to 11 V into a 1 A load.				
Voltage transient response settling time, setting change, falling	<35 ms from beginning of excursion to within 75 mV of terminal value following a change from 11 V to 1 V into a 1 A load.				
Isolation voltage	The output can be floated up to 100 V (DC + pk AC (where the AC component cannot exceed 3 V_{p-p} max and 60 Hz max)) between the Earth Ground terminal and any of the following terminals: Positive Output (+), front or rear panel Negative Output (-), front or rear panel Remote Sense (+ or -). Must maintain correct voltage relative to the related output. All other rear panel terminals are grounded.				
✓ Over Voltage Protection setting accuracy	0.5% of setting + 0.5 V				
Over Voltage Protection “ON” voltage, typical	< 1 V				

Table 1: Specifications (cont.)

Parameter	PWS4205	PWS4305	PWS4323	PWS4602	PWS4721
Over Voltage Protection "ON" holding current, typical	>250 mA A minimum amount of current is required for operation.				
Over Voltage Protection adjustment range, typical	1 V ≤ OVP Setting ≤ FS Output Voltage It may be possible to set very low voltages for the OVP output but behavior may be unexpected.				
Over Voltage Protection response time, typical	<10 ms from voltage sensed in excess of OVP setting to output begins to fall.				
Over Voltage Protection setting resolution	1 mV				
Setup memory, nominal	40 setup locations				
Software voltage limit	The maximum settable voltage (MAX VOLT) menu entry, when set below the hardware maximum voltage limit, disallows adjusting the instrument to voltages more than the MAX VOLT limit.				

Table 2: USB characteristics

Parameter	All models
USB device	USB 2.0 Full Speed device. 12 Mb/sec maximum. Supports USB-TMC communications with Tektronix extensions to support TEK-USB-488 GPIB to USB adapter.
Command processing time, typical	Commands will be processed and committed to hardware within 400 ms.
GPIB interface	GPIB access using a TEK-USB-488 accessory through USB port.

Table 3: Terminal strip characteristics

Parameter	All models
CONTROL IN and OUT	Port Modes available: Trigger RI/DFI Digital I/O Negative (-) terminals are referenced to chassis ground.
Digital OUT	DFI or Digital OUT
Open circuit voltage, typical	5 V ±10%
Short circuit current, typical	0.5 mA ±20%
Breakdown voltage, typical	The output may be driven to 5 V. The Maximum current must not be exceeded.
Maximum current, typical	The output will sink up to 1 mA The Output Breakdown Voltage must not be exceeded.
Digital IN	Trigger, RI or Digital IN
Open circuit voltage, typical	5 V ±10%
Short circuit current, typical	0.5 mA ±20%
Maximum voltage, typical	5.5 VDC
V_{IH}, typical	2.4 V (V_{IH}) Voltage at which the sense is assured to be high.
V_{IL}, typical	0.8 V (V_{IL}) Voltage at which the sense is assured to be low.

Table 4: Mains power characteristics

Parameter	All models
Voltage	Two ranges. Bottom-panel switch selectable. 110 V: 110 VAC to 120 VAC (±10%) 220 V: 220 VAC to 240 VAC (±10%)
Frequency	50/60 Hz
Fuse rating, nominal	110 VAC setting: 5.0 A TH 250 V 220 VAC setting: 2.5 A TH 250 V

Table 5: Mechanical characteristics

Parameter	PWS4205	PWS4305	PWS4323	PWS4602	PWS4721
Weight, nominal Includes boots, handles, and shorting adapters	16.0 lbs (7.3 kg)	16.0 lbs (7.3 kg)	16.0 lbs (7.3 kg)	15.3 lbs (7.0 kg)	16.0 lbs (7.3 kg)
Dimensions, nominal	With boots and handle: Height: 105 mm (4.15 in) Width: 242 mm (9.52 in) Depth: 384 mm (15.12 in) Without boots and handle: Height: 91 mm (3.57 in) Width: 217 mm (8.55 in) Depth: 362 mm (14.24 in)				
Cooling method, nominal	Fan				
Required cooling clearance	Rear of instrument must be separated by at least 5 cm (2 in) from any airflow restrictions to assure adequate cooling. Bottom of instrument must have 1 cm (0.4 in) from any airflow restrictions. The protective boot maintains the proper bottom clearance. For rackmount configuration, follow the clearance requirements provided with the rackmount installation instructions.				
Construction materials, nominal	Chassis – Aluminum Front Panel Plastics – PC/ABS blend				

Table 6: Environment performance

Parameter	All models
Temperature	Operating: +0 °C to +40 °C Nonoperating: -20 °C to 70 °C
Humidity	Operating: 5% to 95% relative humidity (% RH) at up to 40 °C, noncondensing Nonoperating: 5% to 95% relative humidity (RH) at up to +40 °C, 5% to 60% RH above +40 °C up to +70 C, noncondensing
Altitude	Operating: 100% capability up to 2,000 meters Nonoperating: Up to 4,000 meters

Table 7: Keypad special operations

Operation	Key press
Display the instrument firmware version.	Shift + 8
Display the internal temperature of the instrument.	Shift + . + 1
Perform a factory reset. All setups and lists are erased.	Shift + . + 2
Activate the factory service port. The factory service port provides no user functions.	Shift + . + 3
Unlock the keypad.	If the password used to lock the keypad is forgotten, enter the four numerical digits of the instrument name to unlock the keypad. Cycling the instrument power also unlocks the keypad.

Performance Verification

This section contains performance verification procedures for the specifications marked with the ✓ symbol. Additional test equipment is required to complete the verification procedures. (See Table 21 on page 20.)

These procedures cover the PWS4205, PWS4305, PWS4323, PWS4602, and PWS4721 models. Ignore checks that do not apply to the specific model you are testing.

Print the test record on the following pages, and use it to record the performance test results for your power supply.

NOTE. *Completion of the performance verification procedure does not update the stored time and date of the latest successful adjustment. The date and time are updated only when the factory adjustment procedures are successfully completed.*

The performance verification procedures verify the performance of your instrument. They do not adjust your instrument. If your instrument fails any of the performance verification tests, you should contact Tektronix service.

⚠ ***WARNING.*** *Observe all safety precautions listed in this manual before using this product and any associated instrumentation. Although some instruments and accessories are used with nonhazardous voltages, there are situations where hazardous conditions may be present. This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Before using the product, carefully read and follow all installation, operation, and maintenance information. Refer to this manual for complete product specifications. Before performing any maintenance, disconnect the line cord and all test cables. Operators of this instrument must be protected from electric shock at all times. The responsible body must make sure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit can operate at or above 1000 volts, no conductive part of the circuit may be exposed.*

⚠ ***WARNING.*** *Do not loosen any screw on this product. There are no user serviceable components inside.*

⚠ ***CAUTION.*** *Use properly rated load wires. All load wires must be heavy enough not to overheat when carrying the maximum short-circuit output current of the power supply. If there is more than one load, then any pair of load wires must be capable of safely carrying the full-rated short-circuit output current of the power supply.*

Test Record

Model	Serial	Procedure performed by	Date

Test	Passed	Failed
Self test		
DC voltage accuracy with remote sense		
DC voltage accuracy without remote sense		
DC voltage readback accuracy		
DC voltage line regulation		
DC voltage load regulation		
DC voltage detection		
DC current accuracy		
DC current readback accuracy		
DC current line regulation		
DC current load regulation		
Voltage noise at 7 MHz		
Voltage noise at 20 MHz		
Current noise at 20 MHz		

Table 8: DC voltage accuracy with remote sense

Instrument	DUT voltage	Test current	Min	Measured	Max
0% Test Voltage					
PWS4205	0 V	2.5 A	-0.0030 V	__________	0.0030 V
PWS4305	0 V	2.5 A	-0.0030 V	__________	0.0030 V
PWS4323	0 V	1.5 A	-0.0030 V	__________	0.0030 V
PWS4602	0 V	1.25 A	-0.0060 V	__________	0.0060 V
PWS4721	0 V	0.63 A	-0.0060 V	__________	0.0060 V
25% Test Voltage					
PWS4205	5 V	2.5 A	4.9955 V	__________	5.0045 V
PWS4305	7.5 V	2.5 A	7.49475 V	__________	7.50525 V
PWS4323	8 V	1.5 A	7.9946 V	__________	8.0054 V
PWS4602	15 V	1.25 A	14.9895 V	__________	15.0105 V
PWS4721	18 V	0.63 A	17.9886 V	__________	18.0114 V
50% Test Voltage					
PWS4205	10 V	2.5 A	9.9940 V	__________	10.0060 V
PWS4305	15 V	2.5 A	14.9925 V	__________	15.0075 V
PWS4323	16 V	1.5 A	15.9922 V	__________	16.0078 V
PWS4602	30 V	1.25 A	29.9850 V	__________	30.0150 V
PWS4721	36 V	0.63 A	35.9832 V	__________	36.0168 V
75% Test Voltage					
PWS4205	15 V	2.5 A	14.9925 V	__________	15.00750 V
PWS4305	22.5 V	2.5 A	22.49025 V	__________	22.50975 V
PWS4323	24 V	1.5 A	23.9898 V	__________	24.0102 V
PWS4602	45 V	1.25 A	44.9805 V	__________	45.0195 V
PWS4721	54 V	0.63 A	53.9778 V	__________	54.0222 V
100% Test Voltage					
PWS4205	20 V	2.5 A	19.9910 V	__________	20.0090 V
PWS4305	30 V	2.5 A	29.9880 V	__________	30.0120 V
PWS4323	32 V	1.5 A	31.9874 V	__________	32.0126 V
PWS4602	60 V	1.25 A	59.9760 V	__________	60.0240 V
PWS4721	72 V	0.63 A	71.9724 V	__________	72.0276 V

Table 9: DC voltage accuracy without remote sense

Instrument	DUT voltage	Test current	Min	Measured	Max
0% Test Voltage					
PWS4205	0 V	2.5 A	-0.0100 V	__________	0.0100 V
PWS4305	0 V	2.5 A	-0.0100 V	__________	0.0100 V
PWS4323	0 V	1.5 A	-0.0100 V	__________	0.0100 V
PWS4602	0 V	1.25 A	-0.0200 V	__________	0.0200 V
PWS 4721	0 V	0.63 A	-0.0200 V	__________	0.0200 V
25% Test Voltage					
PWS4205	5 V	2.5 A	4.9875 V	__________	5.0125 V
PWS4305	7.5 V	2.5 A	7.4863 V	__________	7.5138 V
PWS4323	8 V	1.5 A	7.9860 V	__________	8.0140 V
PWS4602	15 V	1.25 A	14.9725 V	__________	15.0275 V
PWS4721	18 V	0.63 A	17.9710 V	__________	18.0290 V
50% Test Voltage					
PWS4205	10 V	2.5 A	9.9850 V	__________	10.0150 V
PWS4305	15 V	2.5 A	14.9825 V	__________	15.0175 V
PWS4323	16 V	1.5 A	15.9820 V	__________	16.0180 V
PWS4602	30 V	1.25 A	29.9650 V	__________	30.0350 V
PWS4721	36 V	0.63 A	35.9620 V	__________	36.0380 V
75% Test Voltage					
PWS4205	15 V	2.5 A	14.9825 V	__________	15.0175 V
PWS4305	22.5 V	2.5 A	22.4788 V	__________	22.5213 V
PWS4323	24 V	1.5 A	23.9780 V	__________	24.0250 V
PWS4602	45 V	1.25 A	44.9575 V	__________	45.0425 V
PWS4721	54 V	0.63 A	53.9530 V	__________	54.0470 V
100% Test Voltage					
PWS4205	20 V	2.5 A	19.9800 V	__________	20.0200 V
PWS4305	30 V	2.5 A	29.9750 V	__________	30.0250 V
PWS4323	32 V	1.5 A	31.9740 V	__________	32.0260 V
PWS4602	60 V	1.25 A	59.9500 V	__________	60.0500 V
PWS4721	72 V	0.63 A	71.9440 V	__________	72.0560 V

Table 10: DC voltage readback accuracy

Instrument	DUT voltage	Test current	Measured voltage	Voltage readout	Absolute difference	Maximum difference
0% Test Voltage						
PWS4205	0 V	2.5 A	________	________	________	0.0030 V
PWS4305	0 V	2.5 A	________	________	________	0.0025 V
PWS4323	0 V	1.5 A	________	________	________	0.0030 V
PWS4602	0 V	1.25 A	________	________	________	0.0060 V
PWS4721	0 V	0.63 A	________	________	________	0.0050 V
25% Test Voltage						
PWS4205	5 V	2.5 A	________	________	________	0.0040 V
PWS4305	7.5 V	2.5 A	________	________	________	0.0040 V
PWS4323	8 V	1.5 A	________	________	________	0.0046 V
PWS4602	15 V	1.25 A	________	________	________	0.0090 V
PWS4721	18 V	0.63 A	________	________	________	0.0086 V
50% Test Voltage						
PWS4205	10 V	2.5 A	________	________	________	0.0050 V
PWS4305	15 V	2.5 A	________	________	________	0.0050 V
PWS4323	16 V	1.5 A	________	________	________	0.0062 V
PWS4602	30 V	1.25 A	________	________	________	0.0120 V
PWS4721	36 V	0.63 A	________	________	________	0.0122 V
75% Test Voltage						
PWS4205	15 V	2.5 A	________	________	________	0.0060 V
PWS4305	22.5 V	2.5 A	________	________	________	0.0070 V
PWS4323	24 V	1.5 A	________	________	________	0.0078 V
PWS4602	45 V	1.25 A	________	________	________	0.0150 V
PWS4721	54 V	0.63 A	________	________	________	0.0158 V
100% Test Voltage						
PWS4205	20 V	2.5 A	________	________	________	0.0070 V
PWS4305	30 V	2.5 A	________	________	________	0.0085 V
PWS4323	32 V	1.5 A	________	________	________	0.0094 V
PWS4602	60 V	1.25 A	________	________	________	0.0180 V
PWS4721	72 V	0.63 A	________	________	________	0.0194 V

Table 11: DC voltage line regulation

Instrument	Min line	Max line	Nom line	Nom – Min	Max – Nom	Largest	Max value
PWS4205	________	________	________	________	________	________	0.0080 V
PWS4305	________	________	________	________	________	________	0.0100 V
PWS4323	________	________	________	________	________	________	0.0104 V
PWS4602	________	________	________	________	________	________	0.0160 V
PWS4721	________	________	________	________	________	________	0.0184 V

Table 12: DC voltage load regulation

Instrument	Min load	Ref load	Max load	Ref – Min	Max – Ref	(Max – Ref) / 0.98	Largest	Max value
PWS4205	______	______	______	_______	_______	_______	______	0.00800 V
PWS4305	______	______	______	_______	_______	_______	______	0.01000 V
PWS4323	______	______	______	_______	_______	_______	______	0.01040 V
PWS4602	______	______	______	_______	_______	_______	______	0.01600 V
PWS4721	______	______	______	_______	_______	_______	______	0.01840 V

Table 13: DC overvoltage detection

Instrument	Min trigger voltage	Measured trigger voltage	Max trigger voltage
PWS4205	4.75 V	_________	5.525 V
PWS4305	4.75 V	_________	5.525 V
PWS4323	4.75 V	_________	5.525 V
PWS4602	4.75 V	_________	5.525 V
PWS4721	4.75 V	_________	5.525 V

Table 14: DC current accuracy

Instrument	Test voltage	DUT current	Min	Measured current	Max
0% Test Current					
PWS4205	10 V	0.0 A	-0.002 A	__________	0.002 A
PWS4305	15 V	0.0 A	-0.0026 A	__________	0.0026 A
PWS4323	16 V	0.0 A	-0.002 A	__________	0.002 A
PWS4602	30 V	0.0 A	-0.0015 A	__________	0.0015 A
PWS4721	36 V	0.0 A	-0.001 A	__________	0.001 A
25% Test Current					
PWS4205	10 V	1.25 A	1.247375 A	__________	1.252625 A
PWS4305	15 V	1.25 A	1.246875 A	__________	1.253125 A
PWS4323	16 V	0.75 A	0.747625 A	__________	0.752375 A
PWS4602	30 V	0.625 A	0.6231875 A	__________	0.6268125 A
PWS4721	36 V	0.3 A	0.29885 A	__________	0.30115 A
50% Test Current					
PWS4205	10 V	2.5 A	2.49675 A	__________	2.50325 A
PWS4305	15 V	2.5 A	2.49625 A	__________	2.50375 A
PWS4323	16 V	1.5 A	1.49725 A	__________	1.50275 A
PWS4602	30 V	1.25 A	1.247875 A	__________	1.252125 A
PWS4721	36 V	0.6 A	0.5987 A	__________	0.6013 A
75% Test Current					
PWS4205	10 V	3.75 A	3.746125 A	__________	3.753875 A
PWS4305	15 V	3.75 A	3.745625 A	__________	3.754375 A
PWS4323	16 V	2.25 A	2.246875 A	__________	2.253125 A
PWS4602	30 V	1.875 A	1.8725625 A	__________	1.8774375 A
PWS4721	36 V	0.9 A	0.898553 A	__________	0.90145 A
100% Test Current					
PWS4205	10 V	5 A	4.9955 A	__________	5.0045 A
PWS4305	15 V	5 A	4.995 A	__________	5.005 A
PWS4323	16 V	3 A	2.9965 A	__________	3.0035 A
PWS4602	30 V	2.5 A	2.49725 A	__________	2.50275 A
PWS4721	36 V	1.2 A	1.1984 A	__________	1.2016 A

Table 15: DC current readback accuracy

Instrument	Test current	Measured current	Current readout	Absolute difference	Maximum difference
0% Test Current					
PWS4205	0 A	________	________	________	0.0020 A
PWS4305	0 A	________	________	________	0.0025 A
PWS4323	0 A	________	________	________	0.0020 A
PWS4602	0 A	________	________	________	0.0015 A
PWS4721	0 A	________	________	________	0.0010 A
25% Test Current					
PWS4205	1.2500 A	________	________	________	0.0026 A
PWS4305	1.2500 A	________	________	________	0.0031 A
PWS4323	0.7500 A	________	________	________	0.0024 A
PWS4602	0.6250 A	________	________	________	0.0018 A
PWS4721	0.3000 A	________	________	________	0.0012 A
50% Test Current					
PWS4205	2.500 A	________	________	________	0.0033 A
PWS4305	2.500 A	________	________	________	0.0038 A
PWS4323	1.500 A	________	________	________	0.0028 A
PWS4602	1.2500 A	________	________	________	0.0021 A
PWS4721	0.6000 A	________	________	________	0.0013 A
75% Test Current					
PWS4205	3.7500 A	________	________	________	0.0039 A
PWS4305	3.7500 A	________	________	________	0.0044 A
PWS4323	2.2500 A	________	________	________	0.0031 A
PWS4602	1.8750 A	________	________	________	0.0024 A
PWS4721	0.9000 A	________	________	________	0.0015 A
100% Test Current					
PWS4205	5.0000 A	________	________	________	0.0045 A
PWS4305	5.0000 A	________	________	________	0.0050 A
PWS4323	3.0000 A	________	________	________	0.0035 A
PWS4602	2.5000 A	________	________	________	0.0028 A
PWS4721	1.2000 A	________	________	________	0.0016 A

Table 16: DC current line regulation

Instrument	Test voltage	Min line	Max line	Nom line	Nom – Min	Max – Nom	Largest	Max value
PWS4205	10 V	______	______	______	______	______	______	0.0052 A
PWS4305	15 V	______	______	______	______	______	______	0.0052 A
PWS4323	16 V	______	______	______	______	______	______	0.0032 A
PWS4602	30 V	______	______	______	______	______	______	0.0026 A
PWS4721	36 V	______	______	______	______	______	______	0.0014 A

Table 17: DC current load regulation

Instrument	Meas @ min volts	Meas @ ref volts	Meas @ max volts	Ref - Min	Max - Ref	Largest	Maximum difference
PWS4205	_________	_________	_________	_________	_________	_________	0.0021 A
PWS4305	_________	_________	_________	_________	_________	_________	0.0035 A
PWS4323	_________	_________	_________	_________	_________	_________	0.0013 A
PWS4602	_________	_________	_________	_________	_________	_________	0.0015 A
PWS4721	_________	_________	_________	_________	_________	_________	0.00098 A

Table 18: Voltage noise at 7 MHz

Instrument	Voltage test load R [1]	Measured rms	Maximum rms	Measured pk - pk	Maximum pk - pk
PWS4205	5 Ω	________	1 mV	________	3 mV
PWS4305	10 Ω	________	1 mV	________	4 mV
PWS4323	12 Ω	________	1 mV	________	4 mV
PWS4602	40 Ω	________	1 mV	________	5 mV
PWS4721	65 Ω	________	1 mV	________	3 mV

1 Load R must be rated at 100 W minimum.

Table 19: Voltage noise at 20 MHz

Instrument	Voltage test load R [1]	Measured rms	Maximum rms	Measured pk - pk	Maximum pk - pk
PWS4205	5 Ω	________	3 mV	________	20 mV
PWS4305	10 Ω	________	4 mV	________	20 mV
PWS4323	12 Ω	________	3 mV	________	20 mV
PWS4602	40 Ω	________	3 mV	________	20 mV
PWS4721	65 Ω	________	3 mV	________	20 mV

1 Load R must be rated at 100 W minimum.

Table 20: Current noise at 20 MHz

Instrument	Current test load R [1]	Measured rms	Maximum rms
PWS4205	1 Ω	________	3 mV
PWS4305	1 Ω	________	4 mV
PWS4323	1 Ω	________	3 mV
PWS4602	1 Ω	________	3 mV
PWS4721	1 Ω	________	3 mV

1 Load R must be rated at 100 W minimum.

Performance Verification Procedures

Performance Verification Conditions

The following conditions must be met before performing these procedures:

1. The Device Under Test (DUT) and all test equipment must have been operating continuously for 20 minutes in an environment that meets the operating range specifications for temperature and humidity.

   Test setup changes affecting the remote sense require an additional 20 minute warm-up period.

2. The procedures are intended to be used in sequence. If it is necessary to partially test the DUT using an individual test, a 20 minute warm-up period is required for the individual test.

3. You must connect the DUT and the test equipment to the same AC power circuit. Connect the DUT and test instruments into a common power strip if you are unsure of the AC power circuit distribution. Connecting the DUT and test instruments into separate AC power circuits can result in offset voltages between the equipment, which can invalidate this performance verification procedure.

4. The AC Power Source for the DUT must match the Voltage Selector switch setting located on the bottom of the DUT.

DUT voltage selector switch	AC source voltage
110	115 V
220	230 V

⚠ ***WARNING.*** *Some procedures use hazardous voltages. To prevent electrical shock, always power off instruments before touching exposed circuitry. Read and follow the precautions in the General Safety Summary.*

Equipment Required

These procedures use external equipment to directly check warranted characteristics. The following table lists the required equipment.

Table 21: Test equipment

Item	Minimum requirements	Example
1. Connectors	Connectors for hook up wire assemblies and test resistors, item numbers 5, 6, 9, 10, and 11. ■ (Qty. 6) #10 fork lugs similar to Tyco part number 52951 ■ (Qty, 14) Stackable, gold plated, banana plugs/jacks similar to Pomona model 4897-0. Used for lower current connections, and connection to the load resistors (items 10 and 11) used for noise testing. ■ (Qty. 4) Sheathed Banana Jacks similar to Pomona model 4834 to put connectors on the Resistors (item 9).	
2. AC power source	Variable AC output from 90 to 265 VAC with at least 750 VA capacity	Kikusui PCR2000M
3. Electronic load	Variable DC Load capable of 6 ADC and 75 VDC	B&K Precision 8510
4. DC voltmeter	Voltage measurement at 12 mV through 72 V to better than 100 ppm accuracy with the ability to multiply the result by a scalar.	Tektronix DMM4040
5. High current hook up wire (High current connections are indicated with bold lines in the setup illustrations)	18 AWG (minimum) hookup wire assemblies. To perform all tests, the following wire assemblies need to be created: ■ #10 fork lug to #10 fork lug, Qty 2, (included in Guildline 92301 if used) ■ Stackable Banana to #10 fork lug, Qty 2 Wire lengths are not critical.	
6. Low current hook up wire (Low current connections are indicated with light lines in the setup illustrations)	22 AWG (minimum) hookup wires To perform all tests, the following wire assemblies need to be created: ■ Banana plug to Banana plug, Qty 2 ■ Bare Wire to stackable Banana, Qty 2 ■ Bare Wire to Banana, Qty 2 Wire lengths are not critical.	
7. 50 mΩ precision shunt resistor	0.050 Ω ±100 ppm at 25 W ±4 ppm/°C temperature coefficient	Guildline 9230A-50
8. Current sense resistor cabling	Kelvin 4 terminal measuring cables for shunt resistor to voltmeter	Guildline 92301 cable set

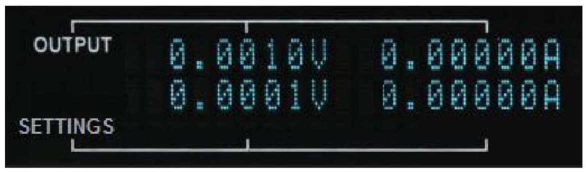
Table 21: Test equipment (cont.)

Item		Minimum requirements	Example
9.	50 mΩ resistor for Remote Sense testing (2 required) One of these 50 mΩ resistors may be substituted with item 7.	0.050 Ω, 5 W. To perform the tests as illustrated, both leads of each resistor require a Banana Jack connector (e.g. Pomona model 4834).	OHMITE 15FR050E
10.	Load resistor for Voltage Noise testing	Loading resistors for high current in voltage mode, and high voltage in current mode All resistors should be rated for at least 100 W. Ohms tolerance within 5%. Resistor composition is not critical. To perform the tests as illustrated, both leads of the load resistor require a Banana plug/jack (or equivalent) to connect to the power supply.	
	PWS4205	5 Ω	HL10006E5R000JJ
	PWS4305	10 Ω	HL10006E10R00JJ
	PWS4323	12 Ω	HL10006E12R00JJ
	PWS4602	40 Ω	HL10006E40R00JJ
	PWS4721	65 Ω	HL10006E65R00JJ
11.	Load Resistor for Current Noise testing	1 Ω, 100 W, 5% To perform the tests as illustrated, both leads of the load resistor require a Banana plug/jack (or equivalent) to connect to the power supply.	Vishay/Dale HL10006Z1R000JJ
12.	Oscilloscope	20 MHz bandwidth limited oscilloscope at 1 mV/division	Tektronix DPO3012
13.	Oscilloscope probe	Low capacitance 1 MΩ/10 MΩ 1X/10X 6 MHz/200 MHz probe	Tektronix P2220, 1X probe
14.	Oscilloscope probe	Low capacitance 10 MΩ 500 MHz probe	Tektronix P6139A, 10X probe
15.	Coaxial cable	50 Ω BNC, male-to-male	Tektronix part number: 012-0482-00
16.	BNC adapter	BNC female to banana breakout	Pomona Electronics 3073

Self Test

This procedure uses internal routines to verify that the DUT functions and passes its internal self tests. No test equipment or hookups are required.

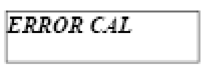
1. Disconnect all cables from the DUT outputs.
2. Power on the DUT. The front-panel display will light up briefly while the DUT performs its power-on self test. All the display annunciators will light up at once.
3. Review the display with all the annunciators. Visually check if there are any strokes lost on any annunciator.



0480-005

4. If the EEPROM is damaged or the latest operation data in the EEPROM is missing, the display appears as follows:

5. If the calibration data in the EEPROM is missing, the display appears as follows:



6. If the latest operating state of the power supply in the EEPROM is missing, the display appears as follows:

7. If there is no response when you power on the DUT, verify that there is AC power to the power supply, verify the power-line voltage settings, and verify that the correct power-line fuse is installed. If you need more help, contact Tektronix.
8. Power off the DUT.

Check DC Voltage Accuracy with Remote Sense

Equipment Required	
(Item 2) AC Power Source	(Item 5) High current hook up wire (bold line connections)
(Item 3) Electronic Load	(Item 6) Low current hook up wire (fine line connections)
(Item 4) DC Voltmeter	(Item 9) 0.050 Ω, 5 W Resistor (Qty 2)

1. Power off the DUT.
2. Remove the shorting clip (that connects the Output Sense to the Output Drive connections) from the Remote Sense connector on the rear panel.
3. Set up the equipment as shown. (See Figure 1.)

NOTE. *To assure accurate measurements, it is important that a significant amount of current does not flow through the sense leads. For this reason, we recommend that the wiring of the remote sense and the voltmeter be away from the high current connections between the electronic load and the DUT.*

A solution is a pair fork lugs with all three wires crimped in. Another alternative is a fork lug between the DUT and the load, and separate connections (probably also fork lugs) holding the wiring for one or both of the voltmeter and remote sense. A third alternative is to stack banana jacks at the voltmeter, with the remote sense toward the voltmeter, and the two high current connections on the outside.

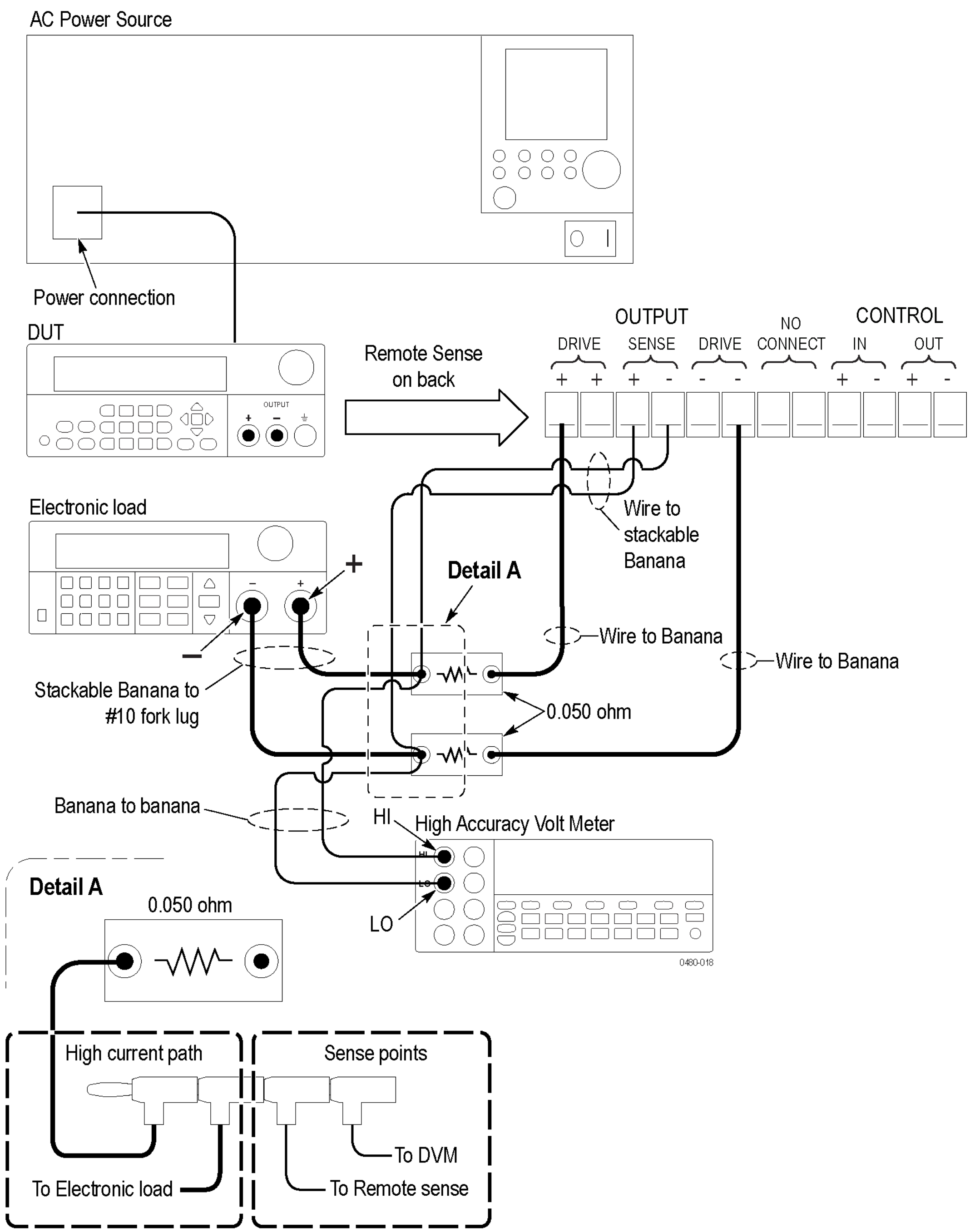


Figure 1: DC voltage accuracy with remote sense test setup

4. Power on the DUT.

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

---

5. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Verify that the Analyze mX+b function is disabled, assuring that volts are being read.
6. Set the electronic load as follows:
   a. Set to Constant Current.
   b. Set the to draw a constant current at the test current specified for the DUT in the table for checking DC Voltage Accuracy With Remote Sense. (See Table 8 on page 11.)
7. Set the DUT to the full scale (FS) output current.
8. Set the DUT to 0% of the FS output voltage (0 V).
9. Turn the DUT output on.
10. Enter the voltmeter reading into the table for checking DC voltage accuracy with remote sense. (See Table 8 on page 11.)
11. Increase the DUT output voltage by 25% of the FS output voltage.
12. Repeat steps 10 and 11 until you complete testing at 100% of the FS.
13. Power off the DUT.
14. Disconnect the hook up wires from the Remote Sense connector and reinstall the shorting clip between the Output Sense and Output Drive connectors.

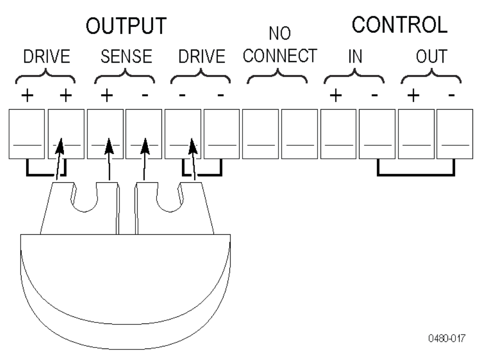


Figure 2: Installing shorting clip on Remote Sense connector

15. Power on the DUT.

Check DC Voltage Setting Accuracy Without Remote Sense and Voltage Readback Accuracy

Equipment Required	
(Item 2) AC Power Source	(Item 5) High current hook up wire (bold line connections)
(Item 3) Electronic Load	(Item 6) Low current hook up wire (fine line connections)
(Item 4) DC Voltmeter	

1. Set up the equipment as shown. (See Figure 3.)

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

NOTE. *To assure accurate measurements, the voltmeter must connect as close as possible to the front panel of the DUT. A solution is to use fork lugs between the electronic load and the DUT, and banana plugs between the DUT and voltmeter. An alternative solution is to use fork lugs for both connections at the DUT.*

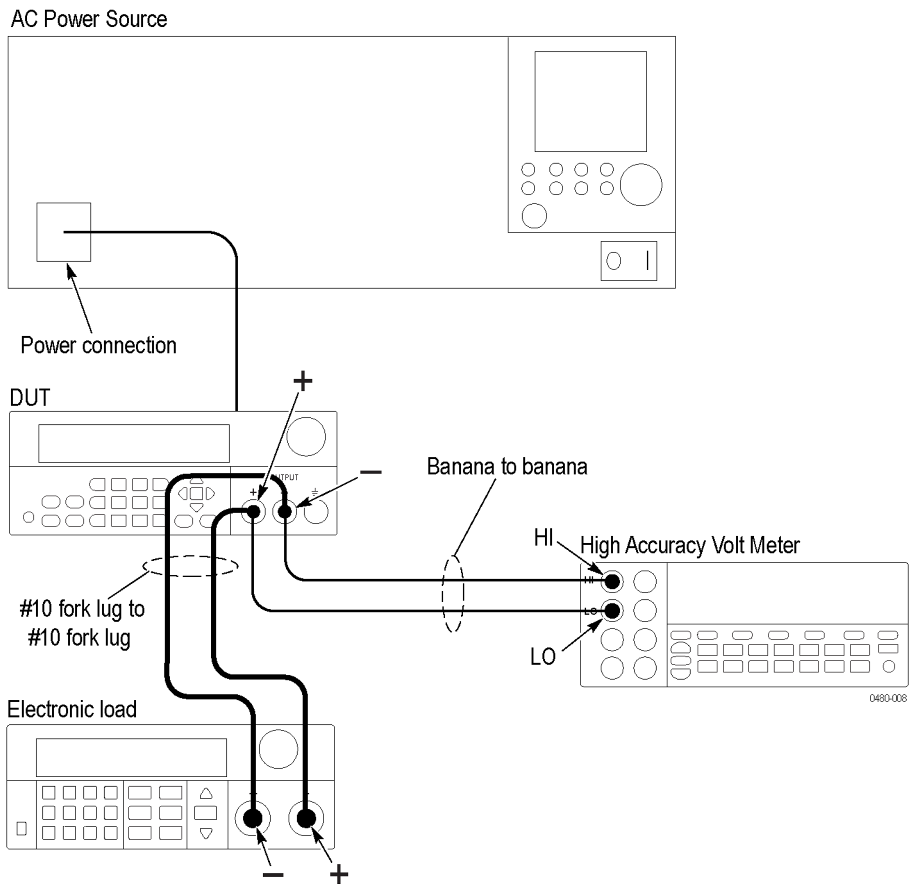


Figure 3: Voltage accuracy, regulation, and protection test setup

2. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Verify that the Analyze mX+b function is disabled, assuring that volts are being read.
3. Set the electronic load as follows:
   a. Set to Constant Current.
   b. Set to draw a constant current at the test current specified for the DUT in the table for checking DC Voltage Accuracy without Remote Sense. (See Table 9 on page 12.)
4. Set the DUT to the full scale (FS) output current.
5. Set the DUT to 0% of the FS output voltage (0 V).
6. Turn the DUT output on.

7. Enter the voltmeter reading into the table for checking DC voltage accuracy without remote sense. (See Table 9 on page 12.)
8. Enter the voltmeter reading into the table for checking DC voltage readback accuracy. (See Table 10 on page 13.)
9. Enter the DUT Readback Voltage into the table for DC voltage readback accuracy. (See Table 10 on page 13.)
10. Calculate the difference of the two measurements taken in steps 8 and 9 and enter the absolute value into the difference column of the table. (See Table 10 on page 13.)
11. Increase the DUT output voltage by 25% of the FS output voltage.
12. Repeat steps 7 through 11 until you complete testing at 100% of FS.

Check DC Voltage Line Regulation

This check procedure uses the same test setup as the previous procedure. (See Figure 3 on page 27.)

1. Change the AC Power Source output to the minimum voltage specified in the following table.

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

DUT voltage selector switch	AC Power Source voltage
110	98 V
220	196 V

2. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Verify that the Analyze mX+b function is disabled, assuring that volts are being read.
3. Set the electronic load as follows:
   a. Set to Constant Current.
   b. Set to draw the specified test current.

Instrument	Test current
PWS4205	2.5 A
PWS4305	2.5 A
PWS4323	1.5 A
PWS4602	1.25 A
PWS4721	0.63 A

4. Set the DUT to 100% of the full scale (FS) output current.
5. Set the DUT to 100% of the FS output voltage.
6. Turn the DUT output on.
7. Enter the voltmeter reading into the table for checking DC Voltage Line Regulation under the min column for your product. (See Table 11 on page 14.)

8. Change the AC Power Source output to the maximum voltage specified in the following table.

DUT voltage selector switch	AC Power Source voltage
110	132 V
220	264 V

9. Enter the voltmeter reading into table for checking DC Voltage Line Regulation under the Max column for your product. (See Table 11 on page 14.)

10. Change the AC Power Source output to match the Voltage Selector switch setting of the DUT.

DUT voltage selector switch	AC Power Source voltage
110	115 V
220	230 V

11. Enter the voltmeter reading into table for checking DC Voltage Line Regulation under the Nom column for your product. (See Table 11 on page 14.)

12. Calculate the two values: Nom – Min and Max – Nom. Enter the values into the appropriate columns. (See Table 11 on page 14.)

13. Enter the largest of the two values calculated in step 12 into the Largest column. (See Table 11 on page 14.)

Check DC Voltage Load Regulation

This check procedure uses the same test setup as the previous procedure. (See Figure 3 on page 27.)

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

1. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Verify that the Analyze mX+b function is disabled, assuring that volts are being read.
2. Set the electronic load as follows:
   a. Set to Constant Current.
   b. Set to draw 0 Amps.
3. Set the DUT to 100% of the full scale (FS) output current.
4. Set the DUT to 100% of the FS output voltage.
5. Turn the DUT output on.
6. Enter the voltmeter reading into the table for checking DC Voltage Load Regulation under the minimum load column for your product. (See Table 12 on page 14.)
7. Increase the electronic load to the reference load test current value.

Instrument	Reference load test current
PWS4205	2.5 A
PWS4305	2.5 A
PWS4323	1.5 A
PWS4602	1.25 A
PWS4721	0.6 A

8. Enter the voltmeter reading into the table for checking DC Voltage Load Regulation under the reference load column for your product. (See Table 12 on page 14.)

9. Increase the electronic load to the maximum load test current value.

Instrument	Maximum load test current
PWS4205	4.9 A
PWS4305	4.9 A
PWS4323	2.94 A
PWS4602	2.45 A
PWS4721	1.17 A

10. Enter the voltmeter reading into the table for checking DC Voltage Load Regulation under the maximum load column for your product. (See Table 12 on page 14.)

11. Calculate the three values: Ref – Min, Max – Ref, and (Max – Ref)/0.98. Enter the values into the appropriate columns. (See Table 12 on page 14.)

12. Enter the largest of the three values calculated in step 11 into the Largest column.

Check DC Overvoltage Detection

This check procedure uses the same test setup as the previous procedure. (See Figure 3 on page 27.)

***NOTE.** Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

---

1. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Verify that the Analyze mX+b function is disabled, assuring that volts are being read.
2. Set the electronic load as follows:
   a. Set to Constant Current.
   b. Set to draw 1 Amp.
3. Set the DUT to 100% of the full scale (FS) output current.
4. Set the DUT to 4 V output voltage.

***NOTE.** OVP and Max Volt Set are submenus of the Protect menu.*

---

5. Set the DUT OVP (Over Voltage Protection) to ON, set the OVP threshold to 5 V, and turn Max Volt off.
   a. Press Shift-1 (Menu).
   b. Press the down arrow until Protect is shown and press Enter.
   c. Press the down arrow until OVP Set is shown and press Enter.
   d. Press the down arrow until On is shown and press Enter.
   e. Press 5 and press Enter.
   f. Press the down arrow until Max Volt Set is shown and press Enter.
   g. Press the down arrow until Off is shown and press Enter.
   h. Press the Esc key as needed to exit the menu system.
6. Turn the DUT output on.

***NOTE.** During the next step, closely monitor the voltmeter reading. Noting the highest output voltage achieved before OVP is triggered.*

---

7. Slowly increase the DUT output voltage until OVP is triggered. When triggered, the output voltage abruptly drops below 1 V, signals with beeps, and OVP is indicated in the display.

8. Enter the voltmeter reading (where OVP triggering occurred) into the table for checking DC Overvoltage Detection. (See Table 13 on page 14.)

9. Reset OVP.

   a. Press Shift-1 (Menu).

   b. Press the down arrow until Protect is shown and press Enter.

   c. Press the down arrow until Reset Protect is shown and press Enter.

   d. Press the right arrow to select YES and press Enter.

   e. Press the Esc key as needed to exit the menu system.

Check DC Current and DC Current Readback Accuracy

Equipment Required	
(Item 2) AC Power Source	(Item 5) High current hook up wire (bold line connections)
(Item 3) Electronic Load	(Item 7) High Accuracy 0.05 Ω Resistor
(Item 4) DC Voltmeter	(Item 8) Current Shunt Resistor Cabling

1. Set up the equipment as shown. (See Figure 4.)

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

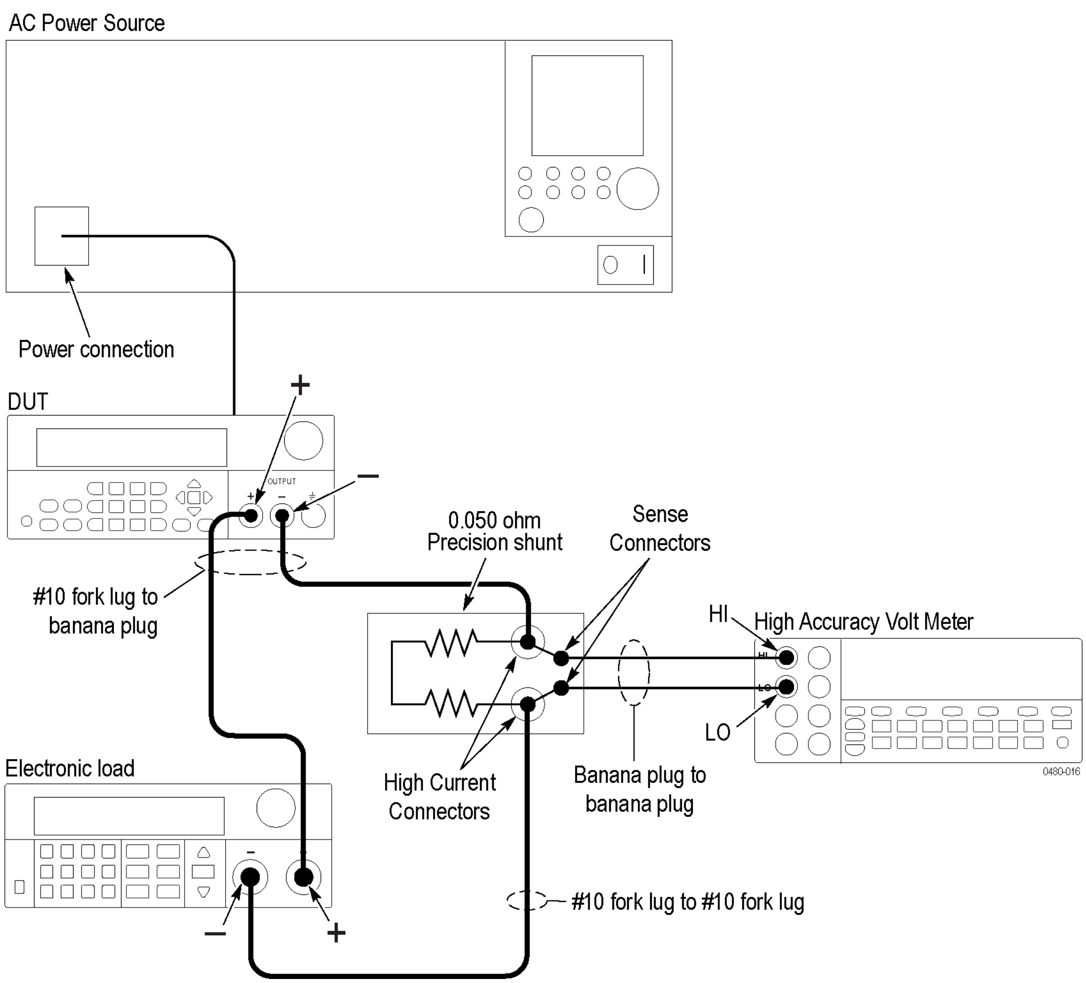


Figure 4: DC current accuracy and regulation test setup

2. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Set to show amps (instead of volts) by multiplying the voltmeter result by 20.
      - Press Analyze button
      - Press mX+B
      - Press mX
      - Set the value to 20
      - Enable scaling
3. Set the electronic load as follows:
   a. Set to Constant Voltage.
   b. Set to the specified voltage for your DUT. (See Table 14 on page 15.)
4. Set the DUT to 0% of the full scale (FS) output current.
5. Set the DUT to 100% of the FS output voltage.
6. Turn the DUT output on.
7. Enter the voltmeter reading into the table for checking DC current accuracy. (See Table 14 on page 15.)
8. Enter the voltmeter reading into the table for checking DC current readback accuracy. (See Table 15 on page 16.)
9. Enter the DUT readback current readout into the table for checking current readback accuracy under the current readout column. (See Table 15 on page 16.)
10. Calculate the difference of the two measurements taken in steps 8 and 9. Enter the absolute value of the calculated value into the difference column of the table. (See Table 15 on page 16.)
11. Increase the DUT output current by 25% of the FS output current.
12. Repeat steps 7 through 11 until you complete testing at 100% of the FS output current.

Check DC Current Line Regulation

This check procedure uses the same test setup as the previous procedure.(See Figure 4 on page 35.)

1. Change the AC Power Source output to the voltage specified in the following table.

DUT voltage selector switch	AC Power Source voltage
110	98 V
220	196 V

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

2. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Set to show amps (instead of volts) by multiplying the voltmeter result by 20.
      - Press Analyze button
      - Press mX+B
      - Press mX
      - Set the value to 20
      - Enable scaling
3. Set the electronic load as follows:
   a. Set to Constant Voltage.
   b. Set to the specified voltage for your DUT. (See Table 16 on page 17.)
4. Set the DUT to 100% of the full scale (FS) output voltage.
5. Set the DUT to 100% of the full scale (FS) output current.
6. Turn the DUT output on.
7. Enter the voltmeter reading into the table for checking current line regulation under the minimum line for your product. (See Table 16 on page 17.)
8. Change the AC Power Source output to the voltage specified in the following table.

DUT voltage selector switch	AC Power Source voltage
110	132 V
220	264 V

9. Enter the voltmeter reading into the Max line for your product. (See Table 16 on page 17.)

10. Change the AC Power Source output to the voltage specified in the following table.

DUT voltage selector switch	AC Power Source voltage
110	115 V
220	230 V

11. Enter the voltmeter reading into the Nom line for your product. (See Table 16 on page 17.)

12. Calculate the two values: Nom – Min and Max – Nom. Enter the values into the appropriate columns. (See Table 16 on page 17.)

13. Select the largest of the two calculations from step 12 and enter the value into the Largest column. (See Table 16 on page 17.)

14. Turn the DUT output off.

Check DC Current Load Regulation

This check procedure uses the same test setup as the previous procedure. (See Figure 4 on page 35.)

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

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1. Set the voltmeter as follows:
   a. Set to measure DC volts.
   b. Set to auto range.
   c. Set to show amps (instead of volts) by multiplying the voltmeter result by 20.
      - Press Analyze button
      - Press mX+B
      - Press mX
      - Set the value to 20
      - Enable scaling
2. Set the electronic load as follows:
   a. Set to Constant Voltage.
   b. Set to output the minimum test voltage level.

Instrument	Minimum test voltage
PWS4205	2.0 V
PWS4305	3.0 V
PWS4323	3.2 V
PWS4602	6.0 V
PWS4721	7.2 V

3. Set the DUT to 100% of the FS output current for your product.
4. Set the DUT to 100% of the FS output voltage for your product.
5. Turn the DUT output on.
6. Enter the voltmeter reading into the table for checking current load regulation at the minimum voltage for your product. (See Table 17 on page 17.)

7. Increase the electronic load to the Reference test voltage level.

Instrument	Reference test voltage
PWS4205	10.0 V
PWS4305	15.0 V
PWS4323	16.0 V
PWS4602	30.0 V
PWS4721	36.0 V

8. Enter the voltmeter reading into the table for checking current load regulation at the reference test voltage your product. (See Table 17 on page 17.)

9. Increase the electronic load to the Maximum test voltage level.

Instrument	Maximum test voltage
PWS4205	18.0 V
PWS4305	27.0 V
PWS4323	28.8 V
PWS4602	54.0 V
PWS4721	64.8 V

10. Enter the voltmeter reading into the table for checking current load regulation at the maximum voltage for your product. (See Table 17 on page 17.)

11. Calculate the two values: REF – Min and Max – REF. Enter the values into the appropriate columns. (See Table 17 on page 17.)

12. Select the larger of the two calculated values from step 11 and enter the value into the Largest column. (See Table 17 on page 17.)

13. Power off the DUT and test equipment.

Check Voltage Noise (7 MHz)

Equipment Required	
(Item 5) High current hook up wire (bold line connections)	(Item 12) Oscilloscope
(Item 10) Load Resistor	(Item 13) Oscilloscope 1X probe

1. Plug the DUT into your local line power from the mains.
2. Plug the test oscilloscope into the same mains outlet as the DUT.

NOTE. *Some AC Power Sources create large amounts of high frequency noise on the power line that the instrument may not fully reject. Noise directly on the mains is typically better controlled.*

Use the same mains outlet for both the DUT and test oscilloscope to avoid ground loops which may cause noise.

3. Power on the DUT and test oscilloscope.

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

4. Set up the equipment as shown. (See Figure 5.)

   Use the appropriate load resistor depending on the model of the DUT. (See Table 18 on page 18.)

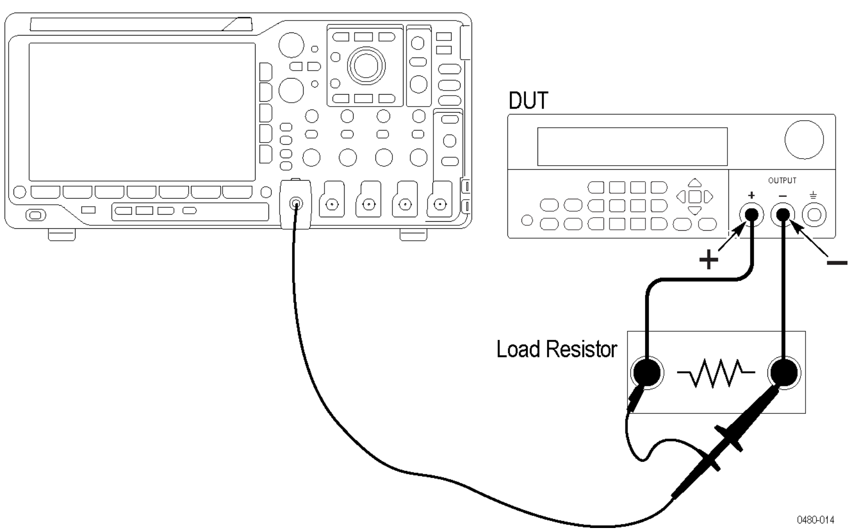

Figure 5: 7 MHz test setup

5. Set the oscilloscope as follows:
   a. 1 mV/division
   b. 1 MΩ input resistance
   c. 20 MHz bandwidth (BW) limit
   d. AC Coupled
   e. Auto-trigger
   f. 1 ms/div
   g. Set to measure V_{p-p} and V_{RMS}
6. Set the oscilloscope probe to 1X mode.
7. Set the DUT to the 100% FS output voltage.
8. Set the DUT to the 100% FS output current.
9. Turn the DUT output on.

WARNING. *Do not touch the load resistor. The load resistor may become hot enough to cause burns.*

10. Enter the oscilloscope measurements into the table for checking Noise at 7 MHz. (See Table 18 on page 18.)

Check Voltage Noise (20 MHz)

Equipment Required

(Item 5) High current hook up wire (bold line connections)	(Item 15) Coaxial cable (BNC M-M)
(Item 10) Load Resistor	(Item 16) BNC F-to-Banana
(Item 12) Oscilloscope	

1. Plug the DUT into your local line power from the mains.
2. Plug the test oscilloscope into the same mains outlet as the DUT.

NOTE. *Some AC Power Sources create large amounts of high frequency noise on the power line that the instrument may not fully reject. Noise directly on the mains is typically better controlled.*

Use the same mains outlet for both the DUT and test oscilloscope to avoid ground loops which may cause noise.

3. Power on the DUT and test oscilloscope.

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

4. Set up the equipment as shown. (See Figure 6.)

   Use the appropriate load resistor depending on the model of the DUT. (See Table 19 on page 18.)

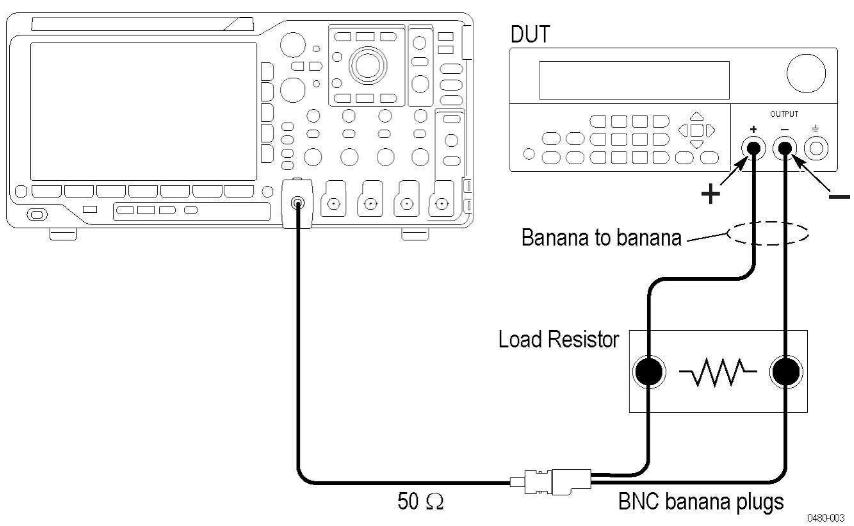

Figure 6: 20 MHz voltage noise test setup

5. Set the oscilloscope as follows:
   a. 1 mV/division
   b. 1 MΩ input resistance
   c. 20 MHz bandwidth (BW) limit
   d. AC Coupled
   e. Auto-trigger
   f. 1 ms/div
   g. Set to measure V_{p-p} and V_{RMS}
6. Set the DUT to the 100% FS output voltage.
7. Set the DUT to the 100% FS output current.
8. Turn the DUT output on.

⚠ ***WARNING.*** *Do not touch the load resistor. The load resistor may become hot enough to cause burns.*

9. Enter the oscilloscope measurements into the table for checking voltage noise at 20 MHz. (See Table 19 on page 18.)

Check Current Noise

Equipment Required	
(Item 5) High current hook up wire (bold line connections)	(Item 12) Oscilloscope
(Item 11) 1 Ω Load Resistor	(Item 14) Oscilloscope 10X probe

1. Plug the DUT into your local line power from the mains.
2. Plug the test oscilloscope into the same mains outlet as the DUT.

NOTE. *Some AC Power Sources create large amounts of high frequency noise on the power line that the instrument may not fully reject. Noise directly on the mains is typically better controlled.*

Use the same mains outlet for both the DUT and test oscilloscope to avoid ground loops which may cause noise.

3. Power on the DUT and test oscilloscope.

NOTE. *Ensure the warm-up criteria has been met as described in the Performance Verification Conditions.*

4. Set up the equipment as shown. (See Figure 7.)

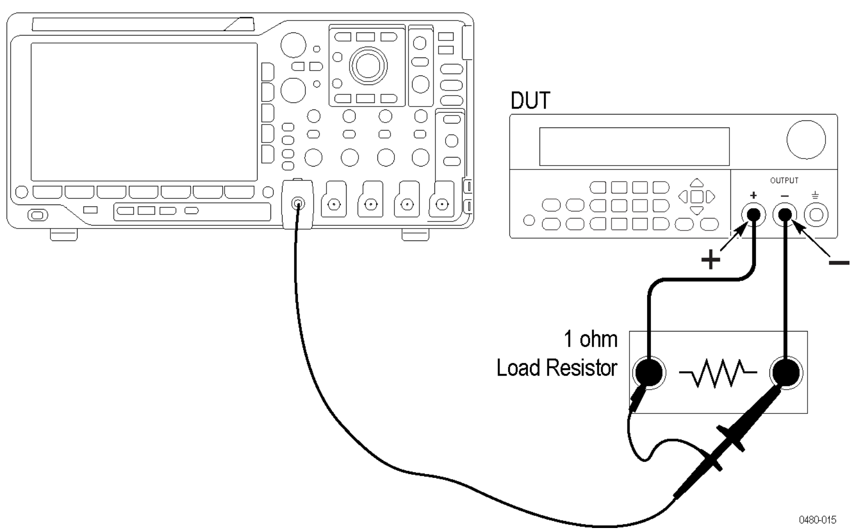

Figure 7: 20 MHz current noise test setup

5. Set the oscilloscope as follows:
   a. 1 mV/division
   b. 1 MΩ input resistance
   c. 20 MHz bandwidth (BW) limit
   d. AC Coupled
   e. Auto-trigger
   f. 1 ms/div
   g. Set to measure $V_{p\text{-}p}$ and V_{RMS}
6. Set the DUT to the 100% FS output voltage.
7. Set the DUT to the 100% FS output current.
8. Turn the DUT output on.

WARNING. *Do not touch the load resistor. The load resistor may become hot enough to cause burns.*

9. Enter the oscilloscope measurements into the table for checking current noise. (See Table 19 on page 18.)
10. Power off the DUT and test equipment.

This completes the performance verification procedure.