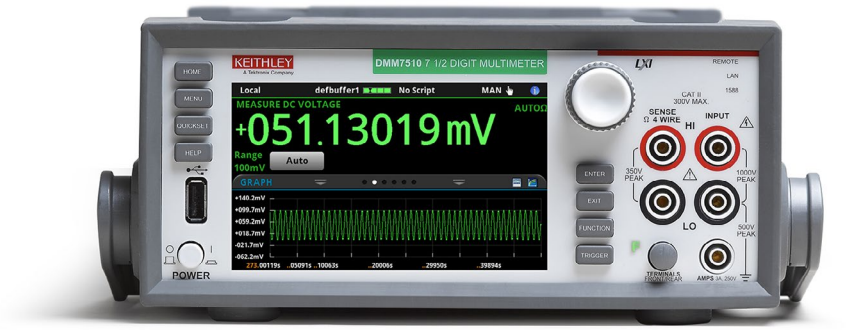
Datasheet

DMM 7510
7½-자리 그래픽샘플링 멀티미터



DMM7510은 정밀 디지털 멀티미터, 그래픽 터치스크린 디스플레이, 고속, 고해상도 디지타이저의 모든 장점을 결합하여 제작된 업계 최초의 그래픽 샘플링 멀티미터 입니다. 디지타이저는 DMM7510의 전례 없는 신호 분석 유연성을 제공하며, 5인치 용량성 터치스크린 디스플레이는 "핀치 및 줌" 단순성으로 쉽게 관찰, 상호작용 및 측정이 가능합니다. 고성능과 높은 사용 편의성의 이 조합은 테스트 결과에 대한 탁월한 통찰력을 제공합니다.

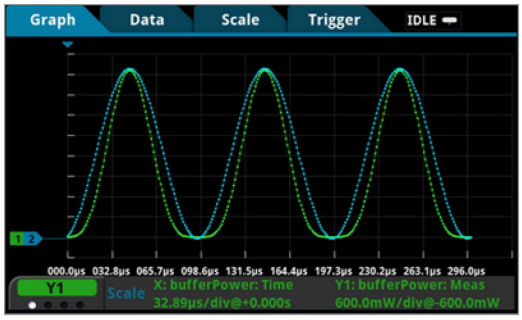
KEITHLEY
A Tektronix Company

주요 특징

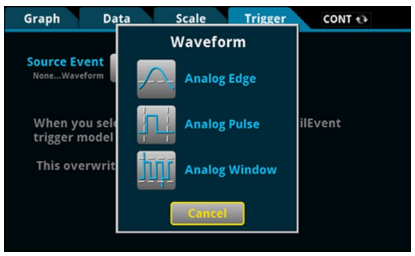
- 3½-µm ~ 7½ µm의 정밀 멀티미터 분해능
- 1 MS/sec 디지타이저를 사용하여 파형 또는 과도 상태 캡처 및 표시
- 대용량 내장 메모리 버퍼, 1100만 개 이상의 판독치를 표준 모드로 저장하거나 2750만 개 이상의 판독치를 컴팩트 모드로 저장
- 14 PPM 기본 1년 DCV 정확도
- 휴대용 장치 절전 모드 전류와 같은 저수준 신호 측정에 필요한 감도를 제공하는 100mV, 1Ω 및 10µA 범위
- 오프셋 보상 옴, 4와이어 및 건식 회로 기능을 사용하여 정확한 저저항 측정
- 온도 및 시간 드리프트를 최소화하여 정확도와 안정성을 향상시키는 자동 교정 기능
- 5인치 고해상도 터치스크린 인터페이스로 더 많은 화면 표시
- 전면판 USB 메모리 포트를 통해 판독치와 화면 이미지를 빠르게 저장할 수 있음
- 다중 연결 옵션: GPIB, USB 및 LXI 호환 LAN 인터페이스
- 2년 사양으로 교정 주기 연장 가능

내장 1 MS/sec 디지타이저를 사용하여 파형 캡처

파형과 과도 이벤트를 캡처하고 표시하는 것은 DMM7510의 전압 또는 전류 디지털화 기능을 통해 쉬워졌습니다. 내장 1 MS/sec, 18비트 디지타이저를 통해 별도의 계측기를 사용하지 않고도 파형을 수집할 수 있습니다. 디지털화 함수는 DC 전압과 전류 함수가 탁월한 동적 측정 범위를 제공하기 위해 사용하는 것과 동일한 범위를 사용합니다. 또한 전압 디지털화 함수는 동일한 DC 전압 입력 임피던스(10 G Ω 또는 10 M Ω) 레벨을 사용하여 DUT에서 로딩을 유의하게 감소시킵니다.



내장 그래핑 유틸리티는 최대 4개의 판독 버퍼에서 측정 또는 파형을 한 번에 표시 및 비교하는 기능을 지원합니다.



고급 트리거링 옵션을 사하면 신호를 정확하게 캡처할 수 있습니다.

Tektronix®

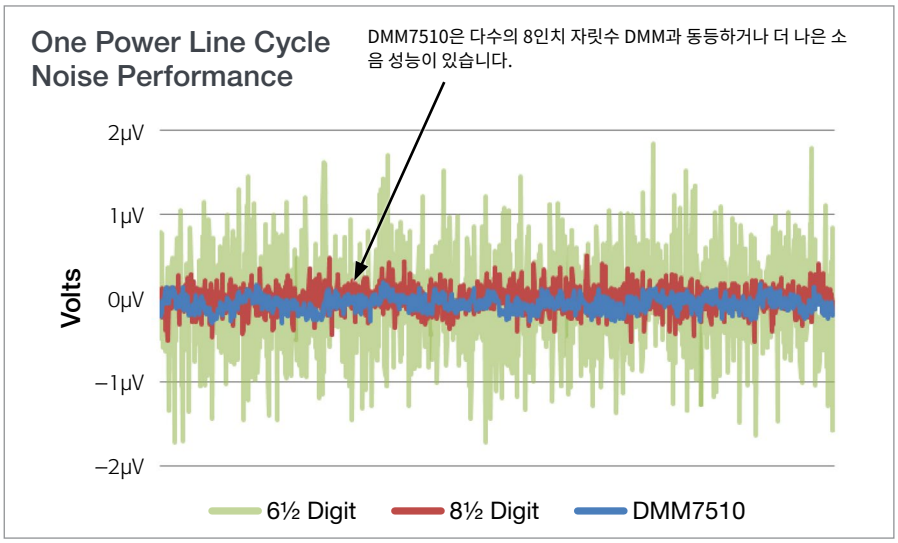
초저전류 배수 레벨의 정확한 측정 및 시각화

배터리 구동 저전력 제품의 테마 컨트롤러(MCU)와 같은 구성 요소의 전류 방전 및 제품의 총 전류 요구량을 확인하십시오. 또한, 제품의 모든 작동 상태에서 절전 모드에서 전송 모드로 전류 방전을 프로파일링 합니다. 향상된 정확도 DC 전류 기능을 사용하여 DMM7510은 pA 분해능 1과 0.375nA 허용오차로 1µA 슬립 모드 전류를 측정할 수 있습니다. 또한 디지털화 전류 기능을 사용하여 제품이 절전 모드에서 전송 모드로 전환될 때 DMM7510은 현재 파형 모양을 캡처할 수 있습니다.

DMM7510의 디지털화 기능이 있는 구성 요소 또는 제품의 모든 작동 상태(절전 모드에서 활성 전송 모드로)에서 전류 방전을 캡처 하십시오. 터치스크린 핀치 및 확대/축소 기능을 사용하여 파형의 특성에 집중하십시오.

자신감을 갖고 까다로운 측정 수행

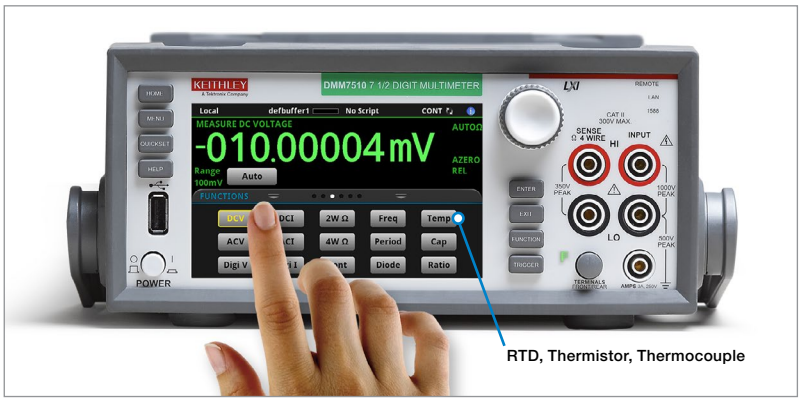
DMM7510의 디자인은 Keithley의 저수준 측정 전문 지식을 최대한 활용합니다. 저잡음 입력 스테이지 및 32 비트 A-D 변환기와 같은 기능을 통해 이 계측기는 계측 등급 계측에서만 볼 수 있는 DC 정확도를 제공하지만 솔루션 가격의 절반 정도입니다. DMM7510의 100mV, 10Ω 및 10µA 범위는 오늘날의 까다로운 전자 설계를 특성화 할 때 낮은 신호를 측정하는 데 필요한 감도를 제공합니다. 1 년 및 2 년 정확도 사양 외에도 자동 보정 기능을 통해 보정주기 간 정확도가 향상됩니다.

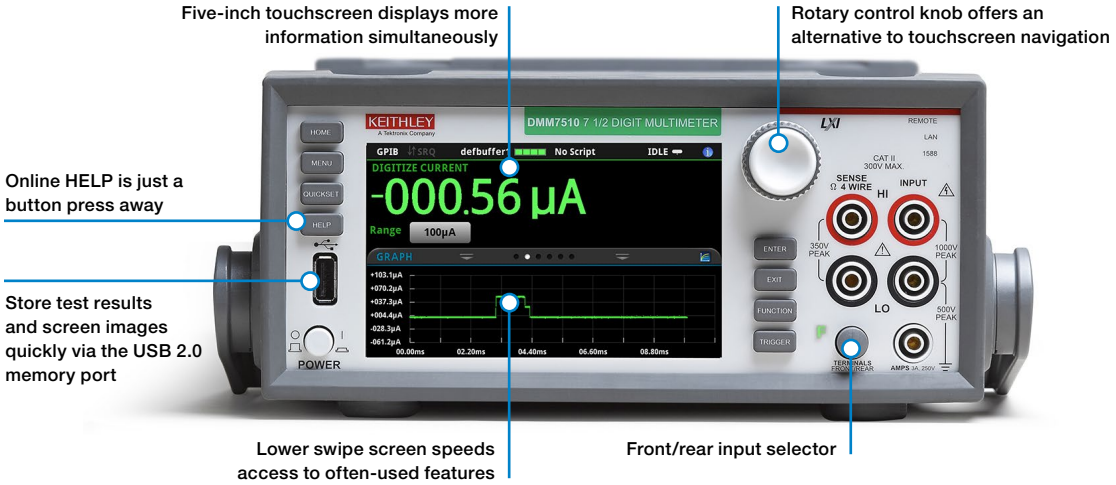


DMM7510의 1VDC 노이즈 성능과 일반적인 6µm 및 8µm의 노이즈 성능을 비교합니다.
모든 데이터는 입력에 낮은 열 단락을 적용하여 1 NPLC에서 수집되었습니다.

15 측정 기능

DMM7510은 15개의 기본 측정 기능을 제공한다. 디지털 전압 및 전류 기능 외에도 캐패시턴스, ACV 및 ACI, 온도(RTD, 서미스터, 열전대), 2와이어 및 4와이어 저항, 건조 회로옴, 주기, 주파수, 다이오드 테스트, DC 전압비 등이 포함됩니다. 계측기의 평면 메뉴 구조는 빠른 구성을 가능하게 하고 사용성을 향상시킵니다. 직관적인 설계로 기기 작동 방법을 익히고 기기 측정을 더 빠르고 확실하게 시작할 수 있습니다.



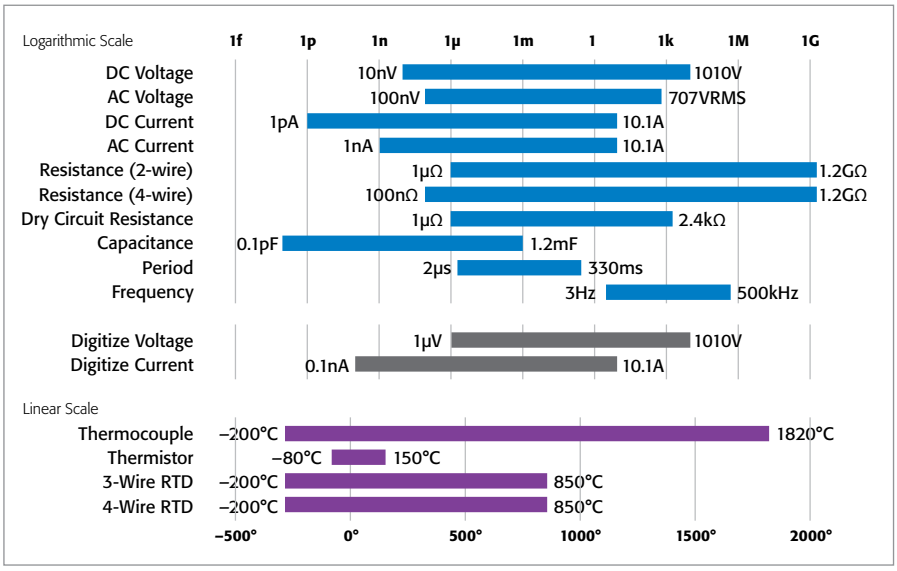


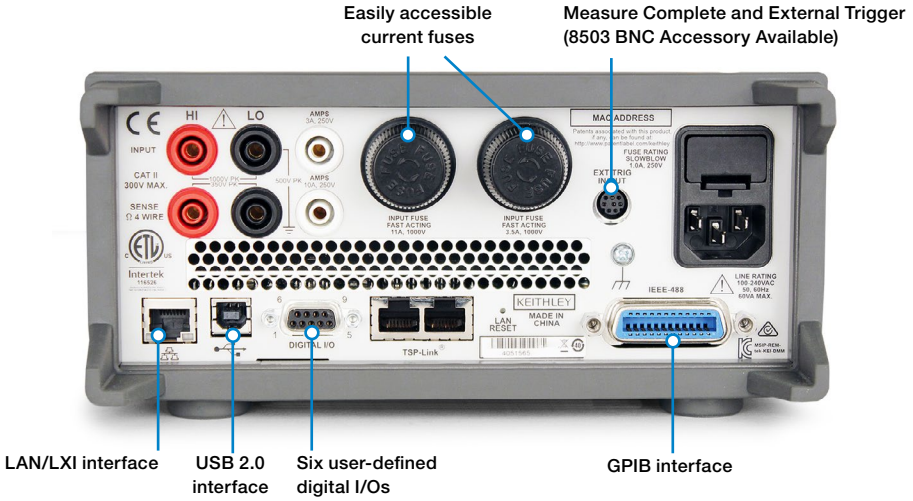
높은 테스트 생산성을 위해 설계

DMM7510의 전면 패널은 고급 터치스크린 외에도 USB 2.0 메모리 I/O 포트, HELP 키, 로터리 내비게이션/제어 노브, 전면/후면 입력 선택기 버튼 등 속도, 사용자 친화성 및 학습성을 향상시키는 다양한 기능이 있습니다.

전면 패널 버튼은 모두 백라이트 되어 시야를 강화해 줍니다. DMM7510의 후면 패널은 입력 커넥터, 원격 제어 인터페이스(GPIB, USB 2.0 및 LXI/이더넷), DD-9핀 디지털 I/O 포트(내부/외부 트리거 신호 및 핸들러 제어용), TSP-Link® 잭을 포함한 다중 기기 테스트 솔루션 구성을 단순화하는 연결 및 제어 기능을 합니다.

DMM7510 측정 기능





유연한 시스템 통합 및 프로그래밍

DMM7510은 사용자에게 최고의 프로그래밍 유연성을 제공하고 다중 계측기 테스트 시스템 구성을 단순화하기 위해 Keithley의 강력한 TSP® (Test Script Processor) 시스템 및 SCPI 프로그래밍 모드를 포함합니다.
내장 된 스크립팅 기능을 통해 외부 PC 컨트롤러 없이도 계측기에서 강력한 테스트 스크립트를 직접 실행할 수 있습니다.
이 테스트 스크립트는 사용하기 쉽지만 매우 효율적이고 컴팩트 한 스크립팅 언어인 Lua (www.lua.org)를 기반으로 하는 완벽한 테스트 프로그램입니다. 스크립트는 계측기 제어 명령 및 / 또는 프로그램 설명의 모음입니다.

프로그램 문은 스크립트 실행을 제어하고 변수, 함수, 분기 및 루프 제어와 같은 기능을 제공합니다. 이를 통해 개발 시간이 크게 단축 된 강력한 측정 어플리케이션을 만들 수 있습니다.

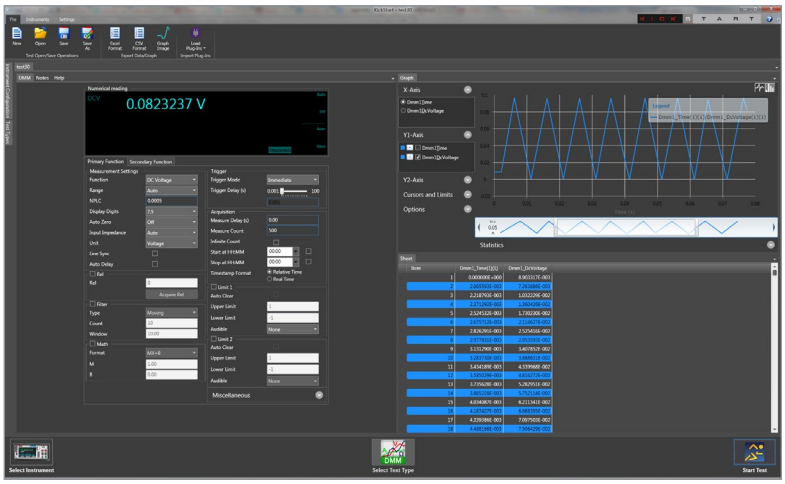
테스트 스크립트는 일반적인 프로그래밍 언어 (의사 결정 알고리즘 포함)로 실행 가능한 모든 루틴 시퀀스를 포함 할 수 있으므로 계측기는 의사 결정을 위해 PC와 통신 할 필요 없이 테스트의 모든 측면을 관리 할 수 있습니다.
이는 GPIB, 이더넷 또는 USB 트래픽 혼잡으로 인한 지연을 없애고 전체 테스트 시간을 크게 향상시킵니다.

TSP 기술은 또한 "메인 프레임 없는 채널 확장"을 제공합니다. TSP-Link® 채널 확장 버스 및 100 Base T 이더넷 케이블을 사용하면 마스터-슬레이브 구성에서 여러 DMM7510을 다른 TSP 지원 계측기와 연결할 수 있으므로 단일 통합 시스템으로 작동합니다.

이 계측기는 2450 및 2460 Graphical SourceMeter® SMU 계측기, Series 2600B SourceMeter SMU 계측기 및 Series 3700A 스위치/멀티 미터 시스템을 포함합니다.

TSP-Link는 GPIB 또는 IP 주소 당 최대 32개의 디바이스를 지원하므로 응용 프로그램의 요구 사항에 맞게 시스템을 쉽게 확장 할 수 있습니다. 표준 SCPI 프로그래밍 모드는 원격으로 프로그래밍 할 때 DMM7510의 모든 새로운 기능을 활용할 수 있도록 지원합니다. 또한 이 계측기는 다른 많은 DMM에서 사용하는 SCPI 언어와 코드 호환됩니다. 이 코드 호환성은 일반적으로 새로운 기능을 갖춘 새 계측기로 업그레이드하는 것과 관련된 코드를 다시 작성할 필요가 없습니다.

무료 계측기 제어 시작 소프트웨어



Keithley의 KickStart 기기 제어 시작 소프트웨어를 사용하면 몇 분 안에 측정을 시작할 수 있㎡へも.

KickStart는 광범위한 기능을 결합하여 테스트 생산성을 향상시킵니다.

- 기기 별 UI 패널
- 수동 기기 구성
- 기본 판독 표시 및 데이터 표보기
- 데이터 로깅
- 네이티브 X-Y 데이터 그래프
- 패닝 및 줌
- 기본 통계 (기기 기본, mX + b)
- 데이터 저장 / 내보내기
- 모든 원격 인터페이스 (GPIB, USB, LAN)를 사용하여 연결
- 기기 설정 저장
- 스크린 샷 캡처
- 명령 줄 대화 상자

바로 사용 가능한 계측기 드라이버 프로그래밍 간소화.

나만의 맞춤형 응용 프로그램 소프트웨어를 만들어야 합니까?
Native National Instruments LabVIEW®, IVI-C 및 IVI-COM 드라이버는 www.tek.com에서 다운로드 하여 프로그래밍 프로세스를 단순화 할 수 있습니다.

Specification Conditions

이 문서에는 DMM7510 7½-자리 그래픽 샘플링 멀티미터에 대한 사양 및 추가 정보가 수록되어 있습니다. 규격은 DMM7510이 시험되는 표준이다. 사양은 DMM7510이 테스트되는 표준입니다. 출고시 모델 DMM7510은 이러한 사양을 충족합니다. 보충 및 일반 값은 보증되지 않으며 23 ° C (73 ° F)에서 적용되며 유용한 정보로만 제공됩니다. 다음과 같은 조건에서 DMM7510 터미널에 측정 정확도가 지정됩니다.

- 90 분 예열 후.
- 1 PLC 또는 5 PLC; 1 PLC 미만의 NPLC 설정의 경우 RMS 노이즈 테이블에서 피크 노이즈 불확실성을 위해 적절한 ppm 범위를 추가하십시오.
- 달리 명시되지 않는 한 자동 영점 기능이 활성화되었습니다.
- 원격 감지 작동 또는 제대로 작동하지 않은 로컬 작동.
- 교정 기간 : 1 년 또는 2 년 (교정 기간은 고객 요구 사항에 따라 다를 수 있음).
- T_{ACAL} = 마지막 자동 보정의 주변 온도.
- T_{CAL} = 마지막 외부 교정의 주변 온도; 23°±1°C에서 수행 된 공장 교정.

DC Voltage

Accuracy (Input impedance AUTO)

Range [1]	Resolution	Input Impedance [2]	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [2]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [3]
100.00000 mV [4]	10 nV	>10 GΩ or 10 MΩ ±1 %	6 + 9	12 + 9	18 + 9	29 + 9	0.1 + 2.5
1.0000000 V [4]	100 nV	>10 GΩ or 10 MΩ ±1 %	4 + 1	9 + 2	15+ 2	26 + 2	0.1 + 0.5
10.000000 V [4]	1 µV	>10 GΩ or 10 MΩ ±1 %	2 + 0.7	9 + 1.2	14 + 1.2	22 + 1.2	0.1 + 0.05
100.00000 V [4]	10 µV	10 MΩ ±1 %	8 + 3	(18 + 5) [5]	(22 + 5) [5]	(30 + 5) [5]	(0.15 + 0.05) [5]
				35 + 5	40 + 5	45 + 5	2.0 + 0.5
1000.0000 V [4, 6]	100 µV	10 MΩ ±1 %	8 + 3	(19 + 5) [5]	(23 + 5) [5]	(31 + 5) [5]	(0.15 + 0.05) [5]
				35 + 5	40 + 5	45 + 4	2.0 + 0.5

RMS Noise **(additional peak noise uncertainty)** [7]

Applies to ±ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements for <1 PLC.

Input impedance set to Auto.

NOTES

1. 20% overrange on all ranges except 1% for 1000 V range.
2. Relative to calibration accuracy.
3. Add per degree from T_{CAL} ±5°C.
4. When properly zeroed using the Rel function with external cables.
5. Specified within 30 days of autocalibration, T_{OPER} ±5°C from T_{ACAL}.
6. For signal levels greater than 500 V, add 0.02 ppm/V to the ppm of the readings specification for measurements exceeding 500 V.
7. Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. V_{RMS} noise is typical. Additional peak noise is guaranteed.

Examples:

10 V at 0.006 PLC: 1.2 (from Accuracy table) + 11 (additional peak noise uncertainty) = 12.2 ppm of range.

10 V at 1 PLC: 1.2 + 0 = 1.2 ppm of range.

NPLC	Digits	100 mV	1 V	10 V	100 V	1000 V
5	7½	0.5	0.08	0.06	0.3	0.06
1	7½	0.5	0.09	0.07	0.4	0.07
0.2 [8]	6½	2 (10)	0.2 (1.6)	0.1 (1.1)	1.1 (9.4)	0.1 (1)
0.2	6½	2 (12)	0.2 (1.6)	0.1 (1)	1.1 (8.9)	0.2 (1.1)
0.06	5½	3 (17)	0.4 (2.7)	0.3 (2.1)	3 (17)	0.3 (2.4)
0.006	4½	6 (42)	3 (18)	1 (11)	20 (100)	3 (18)
0.0005	3½	30 (220)	20 (150)	20 (130)	120 (690)	20 (150)

DC Voltage Sense Accuracy

	Accuracy ±(ppm of reading + ppm of range)				
Range	24 Hour T_{CAL} ±1°C	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [9]
100.00000 mV	6 + 14	12 + 14	18 + 14	29 + 14	0.1 + 2.5
1.0000000 V	4 + 1.5	9 + 3	15 + 3	26 + 3	0.1 + 0.5
10.00000 V	2 + 1.0	9 + 1.8	14 + 1.8	22 + 1.8	0.1 + 0.05

DC Voltage Ratio

For input signals ≥1% of the range, ratio accuracy = ±[[V_{INPUT} ppm of reading + V_{INPUT} ppm of range * (V_{INPUT} range/V_{INPUT} input)] + [V_{SENSE} ppm of reading + V_{SENSE} ppm of range * (V_{SENSE} range/V_{SENSE} input)]].

DC Voltage Characteristics

ADC Linearity	1.0 ppm of reading + 1.0 ppm of range.
Input Impedance	100 mV to 10 V Ranges: Selectable >10 GΩ ll <400 pF (auto) or 10 MΩ ±1% (10 MΩ).
	100 V to 1000 V Ranges: 10 MΩ ±1%.
Input Bias Current	<50 pA at 23°C under the following conditions: Autozero off or input impedance 10 MΩ.
Common Mode Current	<2.1 µA peak-peak in 1 MHz bandwidth. <100 nA peak-peak in 1 kHz bandwidth.
Common Mode Voltage	500 V_{peak} LO terminal to chassis maximum.
DC Voltage Autozero Off Error	For ±1°C and ≤10 minutes, add ±(8 ppm of reading + 15 µV).

Normal Mode Rejection

For DC voltage, line frequency ±0.1%.

	5 PLC	1 PLC	≤0.2 PLC	≤0.01 PLC
Line Sync On	110 dB	90 dB	45 dB	—
Line Sync Off	60 dB	60 dB	—	—

NOTES

8. With line sync on.
9. Add per degree from T_{CAL} ±5°C.

Common Mode Rejection

For DC voltage and 1kΩ unbalanced in LO terminal; AC CMRR is 70 dB.

NPLC	5	1	0.2	≤ 0.2
Line Sync	On	On	On	Off
CMRR	140 dB	140 dB	120 dB	80 dB

Resistance

Enhanced Accuracy (within 30 days of autocalibration, T_{OPER} ±5°C from T_{ACAL}) [10]

Range [11]	Resolution	Test Current [12] (±5%)	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [13]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [14]
1.0000000 Ω	0.1 μΩ	10 mA	15 + 50	30 + 50	30 + 50	30 + 50	0.15 + 0.1
10.000000 Ω	1 μΩ	10 mA	15 + 5	30 + 5	30 + 5	30 + 5	0.15 + 0.1
100.00000 Ω	10 μΩ	1 mA	12 + 4	27 + 4	27 + 4	27 + 4	0.15 + 0.1
1.0000000 kΩ	100 μΩ	1 mA	12 + 3	24 + 3	24 + 3	24 + 3	0.15 + 0.1
10.000000 kΩ [15]	1 mΩ	100 μA	13 + 3	30 + 3	30 + 3	30 + 3	0.15 + 0.1
100.00000 kΩ [15, 16]	10 mΩ	10 μA	13 + 3	30 + 3	30 + 3	30 + 3	0.15 + 0.1
1.0000000 MΩ [15, 17]	100 mΩ	10 μA	14 + 3	30 + 4	30 + 4	30 + 4	0.15 + 0.1
10.000000 MΩ [18]	1 Ω	0.69 μA I10 MΩ	150 + 6	200 + 10	200 + 10	200 + 10	70 + 1
100.00000 MΩ [18]	10 Ω	0.69 μA I10 MΩ	800 + 30	2000 + 30	2000 + 30	2000 + 30	385 + 1
1.0000000 GΩ [18]	100 Ω	0.69 μA I10 MΩ	9000 + 100	9000 + 100	9000 + 100	9000 + 100	3000 + 1

Accuracy [19]

Range [20]	Resolution	Test Current [21] (±5%)	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [22]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [23]
1 Ω	0.1 μΩ	10 mA	15 + 50	40 + 50	50 + 50	70 + 50	2.5 + 5
10 Ω	1 μΩ	10 mA	15 + 5	40 + 5	50 + 5	70 + 5	2.5 + 0.5
100 Ω	10 μΩ	1 mA	12 + 4	35 + 4	47 + 4	65 + 4	5 + 0.25
1 kΩ	100 μΩ	1 mA	12 + 3	30 + 3	41 + 3	65 + 3	5 + 0.25
10 kΩ [24]	1 mΩ	100 μA	10 + 3	30 + 3	42 + 3	65 + 3	2.5 + 0.25
100 kΩ [24, 25]	10 mΩ	10 μA	13 + 3	38 + 3	50 + 3	65 + 3	5 + 1
1 MΩ [24, 26]	100 mΩ	10 μA	14 + 3	38 + 5	50 + 5	65 + 5	5 + 1
10 MΩ [27]	1 Ω	0.69 μA I10 MΩ	150 + 6	200 + 10	400 + 10	600 + 12	70 + 1
100 MΩ [27]	10 Ω	0.69 μA I10 MΩ	800 + 30	2000 + 30	2000 + 30	2600 + 30	385 + 1
1 GΩ [27]	100 Ω	0.69 μA I10 MΩ	9000 + 200	9000 + 200	13000 + 200	14000 + 200	3000 + 1

NOTES

10. Specifications are for 4-wire resistance, offset compensation on for ≤10 kΩ measurements, and offset compensation off for ≥10 kΩ measurements. 1 Ω range is 4-wire only. For 2-wire, with Rel, add 50 mΩ to ppm of range uncertainty. Without Rel and with 1756 test leads, add 100 mΩ to ppm of range uncertainty.
11. 20% overrange on all ranges.
12. Test current with offset compensation off, ±5%.
13. Relative to calibration accuracy.
14. Add per degree from T_{CAL} ±5°C.
15. Specifications are for external cable and load capacitance <1nF.
16. For offset compensation on, add 10ppm uncertainty to ppm of reading.
17. For 4-wire 1 MΩ, open lead detector on, add 10 ppm uncertainty to ppm of reading.
18. Specified for <10% lead resistance mismatch in HI and LO.
19. Specifications are for 4-wire resistance, offset compensation on for ≤10 kΩ measurements, and offset compensation off for ≥10 kΩ measurements. 1Ω range is 4-wire only. For 2-wire, with Rel, add 50 mΩ to ppm of range uncertainty. Without Rel and with 1756 test leads, add 100 mΩ to ppm of range uncertainty.
20. 20% overrange on all ranges.
21. Test current with offset compensation off.
22. Relative to calibration accuracy.
23. Add per degree from T_{CAL} ±5°C.
24. Specifications are for external cable and load capacitance <1 nF.
25. For offset compensation on, add 10ppm of uncertainty to ppm of reading.
26. For 4-wire, 1 MΩ, open lead detection on, add 10ppm uncertainty to ppm of reading.
27. Specified for <10% lead resistance mismatch in HI and LO.

Resistance Open Circuit DC Voltage [28]

Range [20]	2-wire	Offset Compensation Off	Offset Compensation On
		4-wire	4-wire
1 Ω	–	9.2 V	9.5 V
10 Ω	9.2 V	9.2 V	9.5 V
100 Ω, 1 kΩ	14.0 V	14.2 V	14.3 V
10 kΩ	9.5 V	9.5 V	0.0 V
100 kΩ, 1 MΩ	12.7 V	14.3 V	0.0 V (100 kΩ range only)
10 MΩ to 1 GΩ	6.9 V	6.9 V	–

4-Wire Ohms (≤10kΩ) Offset Compensation On

RMS Noise (additional peak noise uncertainty) [29]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements for <1 PLC.

Examples

1 kΩ at 0.006 PLC: 3 (from Accuracy table) + 26 (additional peak noise uncertainty) = 29 ppm of range.

1 kΩ at 1 PLC: 3 + 0 = 3 ppm of range.

NPLC	Digits	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
5	7½	2.8	0.3	0.3	0.07	0.3
1	7½	4.2	0.4	0.4	0.12	0.5
0.2 [30]	6½	30 (160)	3 (13)	3 (13)	0.4 (2.6)	1.2 (8.2)
0.2	6½	50 (250)	5 (22)	5 (22)	0.6 (3.2)	1.2 (8.3)
0.06	5½	110 (490)	11 (47)	11 (46)	1.1 (6.6)	2 (16)
0.006	4½	110 (710)	10 (70)	10 (70)	4 (26)	10 (60)
0.0005	3½	520 (3420)	50 (340)	50 (340)	40 (220)	50 (300)

2-Wire Ohms

RMS Noise (additional peak noise uncertainty) [29]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements for <1 PLC.

Examples

10 kΩ at 0.006 PLC: 3 (from Accuracy table) + 5 (50 mΩ with Rel) + 43 (additional peak noise uncertainty) = 51 ppm of range.

10 kΩ at 1 PLC: 3 + 5 + 0 = 8 ppm of range.

NPLC	Digits	10 Ω	100 Ω	1 kΩ	10 kΩ
5	7½	1.1	0.8	0.1	0.2
1	7½	0.6	0.6	0.09	0.4
0.2 [30]	6½	2 (17)	2 (10)	0.2 (1.5)	0.8 (6.3)
0.2	6½	2 (17)	2 (14)	0.3 (1.6)	0.8 (6.4)
0.06	5½	3 (22)	3 (19)	0.4 (3.7)	2 (12)
0.006	4½	6 (50)	6 (50)	3 (21)	6 (43)
0.0005	3½	30 (300)	30 (230)	20 (150)	30 (210)

NOTES

28. Open circuit voltage is typical, measured from input HI to LO, SHI and SLO open. For 1 Ω to 1 MΩ ranges using an external digital multimeter (DMM) set to 10 MΩ input impedance; for 10 MΩ to 1 GΩ ranges, set external DMM to >10 GΩ input impedance.
29. Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. RMS noise is typical. Additional peak noise is guaranteed.
30. With line sync on.

Resistance Characteristics

Maximum 4-Wire Ohms Lead Resistance	5 Ω per lead for 1Ω range, 10% of range per lead for 10 Ω to 1 kΩ ranges; 1 kΩ per lead for all other ranges.
Offset Compensation	Selectable on 4-wire, 1 Ω to 100 kΩ ranges.
Open Lead Detector	Default is off.
Autozero Off Error	For 2-wire ohms, ±1°C and ≤10 minutes, add ±(8ppm of reading) + 1.5 mΩ for 10 Ω, 15 mΩ for 100 Ω and 1 kΩ ranges, 150 mΩ for 10 kΩ range, 1.5 Ω for 100 kΩ range, and 15 Ω for all other ranges. For 4-wire ohms, ±1°C and ≤10 minutes, add ±(8 ppm of reading).
Input Current Limit	For signals with a magnitude of +12 V to +40 V or –12 V to –40 V: ±13 mA source or sink, typical. For signals with a magnitude of greater than +40 V or –40 V: ±130 µA source or sink, typical.

Dry Circuit Resistance

Enhanced Accuracy (within 30 days of autocalibration, T_{OPER} ±5ºC from T_{ACAL})

Range[31]	Resolution	Test Current[35] (±5%)	Open Circuit DUT Voltage[32]	Accuracy ±(ppm of reading + ppm of range)				
				24 Hour T_{CAL} ±1°C[33]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 years T_{CAL} ±5°C	Temperature Coefficient[34]
1.000000 Ω	1 µΩ	10 mA	25 mV	25 + 80	50 + 80	50 + 80	50 + 80	1.5 + 0.1
10.00000 Ω	10 µΩ	1 mA	25 mV	25 + 80	50 + 80	50 + 80	50 + 80	1.5 + 0.1
100.0000 Ω	100 µΩ	100 µA	25 mV	25 + 80	90 + 80	90 + 80	90 + 80	1.5 + 0.1
1.000000 kΩ	1 mΩ	10 µA	25 mV	25 + 80	180 + 80	180 + 80	180 + 80	1.5 + 0.1
10.00000 kΩ	10 mΩ	5 µA	25 mV	25 + 80	320 + 80	320 + 80	320 + 80	1.5 + 0.1

Accuracy

Range[31]	Resolution	Test Current[35] (±5%)	Open Circuit DUT Voltage[32]	Accuracy ±(ppm of reading + ppm of range)				
				24 Hour T_{CAL} ±1°C[33]	90 Day T_{CAL} ±°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient[34]
1.000000 Ω	1 µΩ	10 mA	25 mV	25 + 80	50 + 80	70 + 80	90 + 80	2.5 + 1
10.00000 Ω	10 µΩ	1 mA	25 mV	25 + 80	50 + 80	70 + 80	90 + 80	5 + 1
100.0000 Ω	100 µΩ	100 µA	25 mV	25 + 80	90 + 80	140 + 80	200 + 80	2.5 + 1
1.000000 kΩ	1 mΩ	10 µA	25 mV	25 + 80	180 + 80	400 + 80	600 + 80	5 + 1
10.00000 kΩ	10 mΩ	5 µA	25 mV	25 + 80	320 + 80	800 + 80	1300 + 80	8 + 1

RMS Noise (additional peak noise uncertainty)[36]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements when < 1 PLC.

NOTES

31. 20% overrange on all ranges, except 2.4 k for the 10 k range.
32. Maximum clamp voltages are DC, typical accuracy is ±20%. Add 20% for offset compensation on.
33. Relative to calibration accuracy.
34. Add per degree from T_{CAL} ±5°C.
35. Test current with offset compensation off.
36. Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. $_{RMS}$ noise is typical. Additional peak noise is guaranteed.

Examples:

10 Ω at 0.2 PLC: 80 (from Accuracy table) + 230 (additional peak noise uncertainty) = 310 ppm of range.

10 Ω at 1 PLC: 80 + 0 = 80 ppm of range.

NPLC	Digits	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
5	7½	10	11	6	5	0.9
1	7½	9	9	7	7	0.8
0.2 [37]	6½	30 (130)	30 (120)	30 (120)	30 (120)	3 (16)
0.2	6½	60 (220)	60 (230)	50 (190)	50 (190)	9 (35)
0.06	5½	70 (350)	70 (350)	50 (290)	50 (280)	20 (90)
0.006	4½	130 (750)	120 (830)	110 (700)	100 (690)	20 (110)
0.0005	3½	520 (3550)	530 (3520)	530 (3380)	500 (3370)	100 (670)

Dry Circuit Resistance Characteristics

Maximum 4-Wire Ohms Lead Resistance

0.5 Ω per lead for 1 Ω range.
10% of range per lead for 10 Ω to 100 Ω ranges.
50 Ω per lead for 1 kΩ to 10 kΩ ranges.

Input Current Limit

For signals greater than ±20 mV, current limited, ±13 mA typical.

Offset Compensation

Selectable on 1 Ω to 10 kΩ ranges.

Autozero Off Error

For ±1°C and ≤10 minutes, add ±8 ppm of reading.

DC Current

Enhanced Accuracy (within 30 days of autocalibration, T_{OPER} ±5°C from T_{ACAL})

Range [38]	Resolution	Maximum Burden Voltage	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [39]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [40]
10.000000 µA	1 pA	15 mV	30 + 30	75 + 30	75 + 30	75 + 30	0.15 + 0.1
100.00000 µA	10 pA	15 mV	20 + 5	60 + 9	60 + 9	60 + 9	0.15 + 0.1
1.0000000 mA	100 pA	15 mV	30 + 5	60 + 9	60 + 9	60 + 9	0.15 + 0.1
10.000000 mA	1 nA	20 mV	40 + 5	60 + 9	60 + 9	60 + 9	0.15 + 0.1
100.00000 mA	10 nA	200 mV	50 + 18	150 + 30	150 + 30	150 + 30	0.15 + 0.1
1.0000000 A	100 nA	400 mV	150 + 50	400 + 50	400 + 50	400 + 50	0.15 + 0.1
3.000000 A	1 µA	1300 mV	200 + 40	400 + 40	400 + 40	400 + 40	0.15 + 0.1
10.000000A [41]	1 µA	650 mV	700 + 275	800 + 275	1500 + 275	2000 + 275	50 + 10

NOTES

37. With line sync on.
38. 20% overrange supported for all ranges except for 3 A and 10 A, which are 1% supported.
39. Relative to calibration accuracy.
40. Add per degree from T_{CAL} ±5°C.
41. Rear input terminals only.

Accuracy

Range [38]	Resolution	Maximum Burden Voltage	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [39]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [40]
10.000000 µA	1 pA	15 mV	30 + 30	100 + 30	125 + 40	175 + 50	10 + 8
100.00000 µA	10 pA	15 mV	20 + 5	75 + 12	100 + 15	150 + 20	10 + 3
1.0000000 mA	100 pA	15 mV	30 + 5	75 + 12	100 + 15	150 + 20	10 + 3
10.000000 mA	1 nA	20 mV	40 + 5	75 + 12	100 + 15	150 + 20	10 + 3
100.00000 mA	10 nA	200 mV	50 + 18	300 + 30	400 + 30	500 + 30	50 + 5
1.0000000 A	100 nA	400 mV	150 + 50	400 + 50	450 + 50	500 + 50	10 + 10
3.000000 A	1 µA	1300 mV	200 + 40	400 + 40	450 + 40	500 + 40	10 + 10
10.000000 A [41]	1 µA	650 mV	700 + 275	800 + 275	1500 + 275	2000 + 275	50 + 10

RMS Noise (additional peak noise uncertainty) [42]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements when <1 PLC.

Examples

1 mA at 0.006 PLC: 9 (from Accuracy table) + 20 (additional peak noise uncertainty) = 29 ppm of range.

1 mA at 1 PLC: 9 +0 = 9 ppm of range.

NPLC	Digits	10 µA	100 µA	1 mA	10 mA	100 mA	1A	3A	10A [43]
5	7½	0.15	0.14	0.09	0.1	0.3	0.3	0.2	0.8
1	7½	0.4	0.13	0.1	0.1	0.5	0.5	0.3	1.2
0.2	6½	0 (220)	0 (23)	0.2 (3.4)	0.2 (1.6)	2 (10)	2 (11)	0.7 (4.6)	4 (32)
0.2 [44]	6½	120 (260)	12 (26)	1.2 (3.8)	0.3 (1.8)	1.9 (9.8)	2 (10)	0.8 (5)	8 (37)
0.06	5½	130 (280)	12 (29)	1.3 (5.6)	0.4 (3.9)	2 (14)	2 (14)	1.2 (7.7)	10 (59)
0.006	4½	130 (350)	14 (42)	3 (20)	2 (20)	4 (30)	4 (31)	7 (51)	20 (110)
0.0005	3½	260 (2110)	30 (300)	20 (150)	20 (160)	30 (190)	30 (190)	70 (510)	60 (420)

DC Current Characteristics

Range	10 µA	100 µA	1 mA	10 mA	100 mA	1 A	3 A	10 A [43]
Effective Internal Shunt Value [45]	1 kΩ	100 Ω	10 Ω	1 Ω	0.1 Ω	0.1 Ω	0.1 Ω	0.005 Ω
Autozero Off Error: For ±1°C and ≤10 minutes add ±(8 ppm of reading + range error)	150 pA	1.5 nA	15 nA	150 nA	15 µA	150 µA	150 µA	3 mA
Overload Recovery: For each additional sustained amp beyond ±1.5 A, add the following initial ppm of range error until thermally settled after overload recovery	15500	1800	150	150	6500	200	—	—

NOTES

42. Noise values are based on 1000 readings with autozero on and AMPS terminal open. RMS noise is typical. Additional peak noise is guaranteed.
43. Rear input terminals only.
44. With line sync on.
45. Values are typical and guaranteed by design.

Temperature

4-Wire RTD or 3-Wire RTD

Types: 100 Ω platinum PT100, D100, F100, PT385, PT3916; or user-configurable 0 Ω to 10 kΩ.

Type	Range	Resolution	Accuracy ±°C	
			2 Year, T_{CAL} ±5°C	Temperature Coefficient [46]
4-Wire RTD	–200 to 850 °C	0.01 °C	0.06 °C	0.003 °C/°C
3-Wire RTD [47]	–200 to 850 °C	0.01 °C	0.75 °C	0.003 °C/°C

Thermistor

Types: 2.252 kΩ, 5 kΩ, and 10 kΩ.

Type	Range	Resolution	Accuracy ±°C	
			2 Year, T_{CAL} ±5°C	Temperature Coefficient [46]
Thermistor	–80 to +150 °C	0.01 °C	0.08 °C	0.002 °C/°C

Thermocouple

Types: B, E, J, K, N, R, S, T

			Accuracy ±°C	
Type	Range	Resolution	2 Year, T_{CAL} ±5°C [48] Simulated Reference Junction	Temperature Coefficient [46]
B	350 to +1820 °C	0.1 °C	0.6 °C	0.03 °C/°C
E	–200 to +1000 °C	0.001 °C	0.2 °C	0.03 °C/°C
J	–200 to +760 °C	0.001 °C	0.2 °C	0.03 °C/°C
K	–200 to +1372 °C	0.001 °C	0.2 °C	0.03 °C/°C
N	–200 to +1300 °C	0.001 °C	0.2 °C	0.03 °C/°C
R	0 to +1768 °C	0.1 °C	0.6 °C	0.03 °C/°C
S	0 to +1768 °C	0.1 °C	0.6 °C	0.03 °C/°C
T	–100 to +400 °C	0.001 °C	0.2 °C	0.03 °C/°C

Continuity

Range [49]	Resolution	Test Current	Open Circuit Voltage	Accuracy ±(ppm of reading + ppm of range)	
				2 Year, T_{CAL} ±5°C	Temperature Coefficient [50]
1.0000 kΩ	100 mΩ	1 mA	14.0 V	100 + 100	2.5 + 1

Continuity Characteristics

Continuity High Limit User-selectable; default 10 Ω.

NOTES

46. Add per degree from T_{CAL} ±5°C; specifications without autocalibration.
47. For 3-wire RTD, accuracy is for <0.1 Ω lead resistance mismatch for input HI and LO. Add 0.25°C/0.1 Ω of HI-LO lead resistance mismatch.
48. Exclusive of cold-junction errors.
49. Specifications exclude lead resistance.
50. Add per degree from T_{CAL} ±5°C; specifications without autocalibration.

Capacitance

Accuracies specified for additional cable and stray capacitance properly zeroed with the Rel function.

Accuracy

Range [51]	Resolution	Charge Current [52, 53]	Maximum Circuit Voltage	Accuracy ±(% of reading + % of range)	
				2 years T_{CAL} ±5°C	Temperature Coefficient [50]
1.0000 nF	0.1 pF	1.1 µA	2.8 V	1 + 0.2	0.15 + 0.05
10.000 nF	1 pF	1.1 µA	2.8 V	1 + 0.1	0.15 + 0.01
100.00 nF	10 pF	10 µA	3 V	0.4 + 0.1	0.01 + 0.01
1.0000 µF	0.1 nF	100 µA	3 V	0.4 + 0.1	0.01 + 0.01
10.000 µF	1 nF	100 µA	3 V	0.4 + 0.1	0.01 + 0.01
100.00 µF	10 nF	1 mA	3 V	0.4 + 0.1	0.01 + 0.01
1000.0 µF	0.1 µF	10 mA	3 V	0.5 + 0.1	0.01 + 0.01

Diode

Voltage Measure Range [51]	Resolution	Bias Level (Selectable)	Accuracy ±(ppm of reading + ppm of range)			
			90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [50]
10.000000 V	1 µV	10 µA / 100 µA / 1 mA	20 + 5	30 + 5	45 + 5	2.5 + 1

Digitize Voltage

Accuracy (Input Impedance AUTO)

Range [54, 55]	Resolution [56]	Input Impedance [57]	Accuracy ±(ppm of reading + ppm of range)			
			90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [58]
100.000 mV	1 µV	>10 GΩ or 10 MΩ ±1%	210 + 100	220 + 100	230 + 100	15 + 20
1.00000 V	10 µV	>10 GΩ or 10 MΩ ±1%	110 + 75	120 + 75	130 + 75	15 + 20
10.0000 V	0.1 mV	>10 GΩ or 10 MΩ ±1%	110 + 75	120 + 75	130 + 75	10 + 20
100.000 V [59]	1 mV	10 MΩ ±1%	110 + 75	120 + 75	130 + 75	15 + 20
1000.00 V [60]	10 mV	10 MΩ ±1%	110 + 75	120 + 75	130 + 75	10 + 20

NOTES

51. 20% overrange on all ranges.
52. Charging current values are typical, guaranteed by design.
53. Discharge current limited to <13 mA.
54. For DC coupling, 20% overrange for 100 mV to 100 V. For AC coupling, 500% overrange 100 mV to 100 V. 1% for 1000 V range DC and AC coupling.
55. Accuracy with sample rate 1k per second, aperture auto, and 100 reading buffer average.
56. Power up default is 4½ digits.
57. User-selectable.
58. Add per degree from T_{CAL} ±5%.
59. For 100 V range, input impedance auto and without ACAL, add 100ppm of range additional uncertainty and 15 ppm/°C additional uncertainty for "of range" temperature coefficient for operation outside of T_{CAL} ±5°C.
60. For signal levels greater than 500 V, add 0.02 ppm/V to the ppm of the readings specification for measurements exceeding 500 V.

Signal Characteristics [61, 62, 63]

Typical AC and DC Coupled

Range	Analog Bandwidth (–3dB)	Maximum Flatness Error 3 Hz to 20 kHz [64]	THD 20 kHz Signal (–1dB FS) [65]	DC-coupled Settling Time (0.5%)	AC-coupled Filter FAST Settling Time (0.5%)	AC-coupled Filter SLOW Settling Time (0.5%)	AC Coupling Low Frequency (–3dB) point [66]
100.000 mV	600 kHz	0.015 dB	0.04 %	5 µs	80 ms	2.3 s	1 Hz
1.00000 V	600 kHz	0.01 dB	0.03 %	6 µs	80 ms	2.5 s	1 Hz
10.0000 V	600 kHz	0.01 dB	0.01 %	4 µs	80 ms	2.5 s	1 Hz

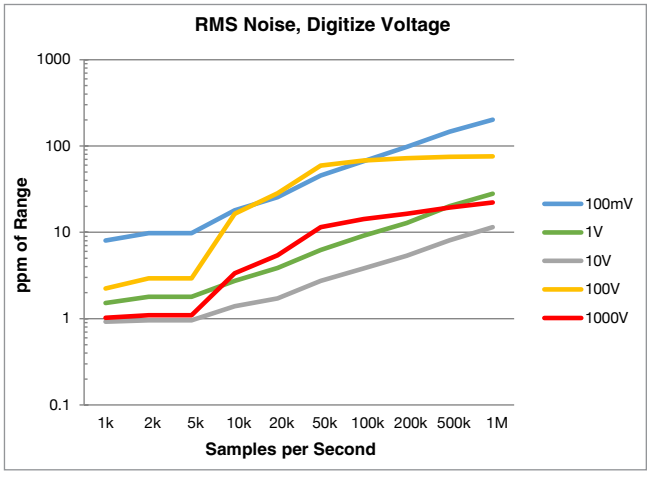
Typical DC Coupled

Range	Analog Bandwidth (–3dB)	Maximum Flatness Error 3 Hz to 1 kHz [64]	Total Harmonic Distortion (THD) 1 kHz Signal (–1dB FS) [65]	Settling Time (0.5%)
100.000 V	20 kHz [67]	0.1 dB	1.3 %	160 µs
1000.00 V	20 kHz	0.1 dB	1.8 %	80 µs

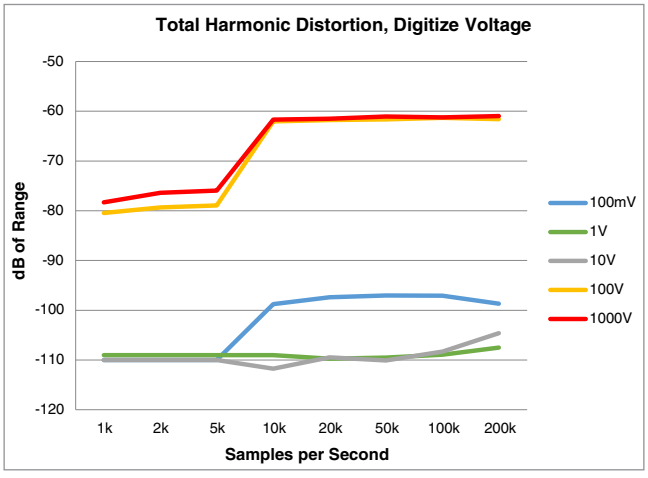
Typical AC Coupled

Range	Analog Bandwidth (–3dB)	Maximum Flatness Error 3 Hz to 20 kHz	Filter FAST Settling Time (0.5%)	Filter SLOW Settling Time (0.5%)	Low Frequency Coupling Point [66] (–3dB)
100.000 V	600 kHz	0.1 dB	80 ms	2.3 s	1 Hz
1000.00 V	600 kHz	0.1 dB	80 ms	2.3 s	1 Hz

DC-Coupled Additional Noise Uncertainty, Typical [68]



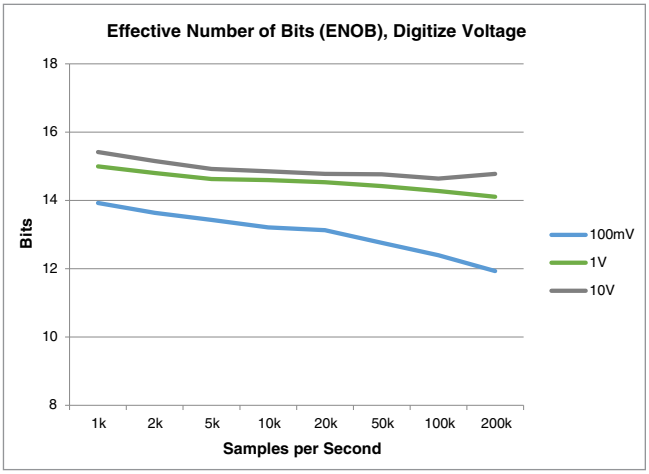
DC-coupled Total Harmonic Distortion (THD), Typical [69]



NOTES

61. Accuracy with sample rate 1M per second and aperture 1 µs.
62. Verified with sine wave input and DC content ≤3% of range.
63. For AC coupling, maximum crest factor of 5.
64. For DC coupled, 0dB reference frequency is 3 Hz. For AC coupled, 0dB reference frequency is 1 kHz. For AC coupled operation below 1 kHz, add 0.1 dB.
65. Exclusive of source input noise.
66. With AC coupling frequency = 3 Hz and AC coupling filter = Slow.
67. For input impedance auto, bandwidth is 6 kHz.
68. Specified with aperture auto and 4-wire short on input terminals. For 100 V range, input impedance 10 M , multiply by 2.5. For all ranges and sample rate >1 k, add an additional 3× RMS noise uncertainty to ppm of range.
69. Specified with aperture auto and 1 kHz sine wave input. Distortion is calculated using first five harmonics.

DC-Coupled Effective Number Of Bits (ENOB), Typical [70]



Digitize Current

DC Accuracy [71]

Range [72]	Resolution [73]	Burden Voltage	Accuracy ± (ppm of reading + ppm of range)			
			90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [74]
10.0000 µA	0.1 nA	15 mV	150 + 75	160 + 75	170 + 75	30 + 15
100.000 µA	1 nA	15 mV	150 + 75	160 + 75	170 + 75	30 + 15
1.00000 mA	10 nA	15 mV	150 + 75	160 + 75	170 + 75	30 + 15
10.0000 mA	100 nA	20 mV	150 + 75	160 + 75	170 + 75	30 + 15
100.000 mA	1 µA	200 mV	340 + 100	450 + 100	560 + 100	50 + 20
1.00000 A	10 µA	400 mV	400 + 110	500 + 110	600 + 110	50 + 25
3.00000 A	100 µA	1300 mV	650 + 150	900 + 150	900 + 150	50 + 25
10.0000 A [75]	100 µA	650 mV	950 + 350	1500 + 350	2000 + 350	50 + 25

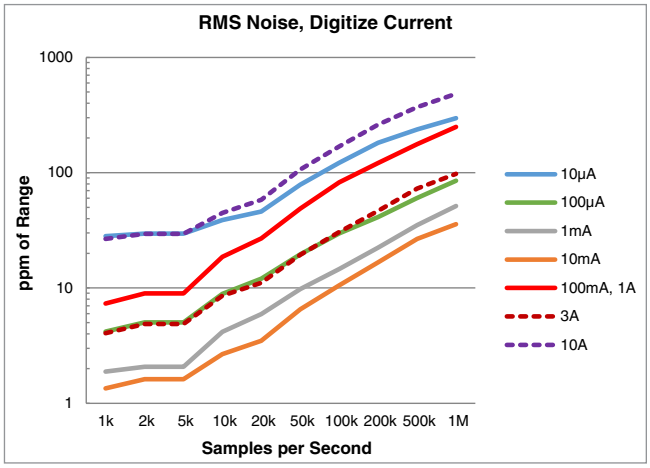
NOTES

70. Specified with aperture Auto, 100Hz sine wave for sample rate ≤5k, and 1kHz sine wave for sample rate ≥10k. For the 100V and 1000V ranges, use the 1V and 10V range ENOB, respectively; guaranteed by design.
71. Accuracy with sample rate 1k per second, aperture auto, and 100 reading buffer average.
72. 20% overrange on all ranges except 3.3% for 3A and 10A ranges.
73. Power up default is 4½ digits.
74. Add per degree from T_{CAL} ±5°C.
75. Rear input terminals only.

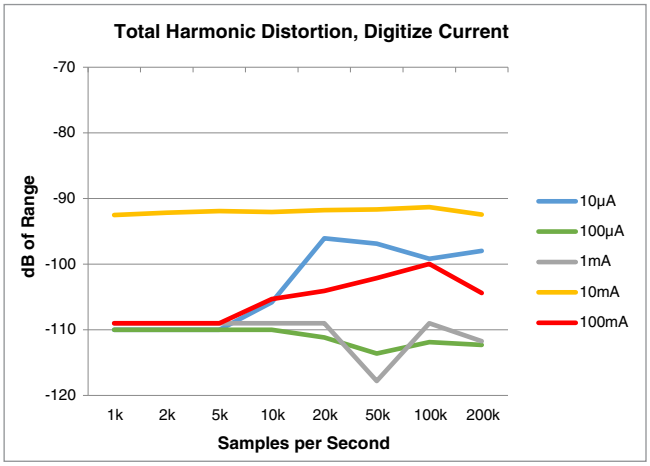
Signal Characteristics, Typical [76]

Range [72]	Maximum Flatness Error 3 Hz to 20 kHz	Analog Bandwidth (–3dB)	Total Harmonic Distortion (THD) 20 kHz Signal (–1dB FS)	DC-coupled Settling Time (0.5%)
10.0000 µA	0.15 dB	100 kHz	0.02 %	8 µs
100.000 µA	0.15 dB	100 kHz	0.01 %	7 µs
1.00000 mA	0.1 dB	100 kHz	0.01 %	3 µs
10.0000 mA	0.1 dB	100 kHz	0.01 %	8 µs
100.000 mA	0.1 dB	100 kHz	0.02 %	5 µs
1.00000 A [77]	0.1 dB	100 kHz	0.02 %	6 µs
3.0000 A [77]	0.1 dB	100 kHz	0.02 %	6 µs
10.0000 A [75, 77, 78]	0.1 dB	100 kHz	0.02 %	6 µs

Additional Noise Uncertainty, Typical [79]



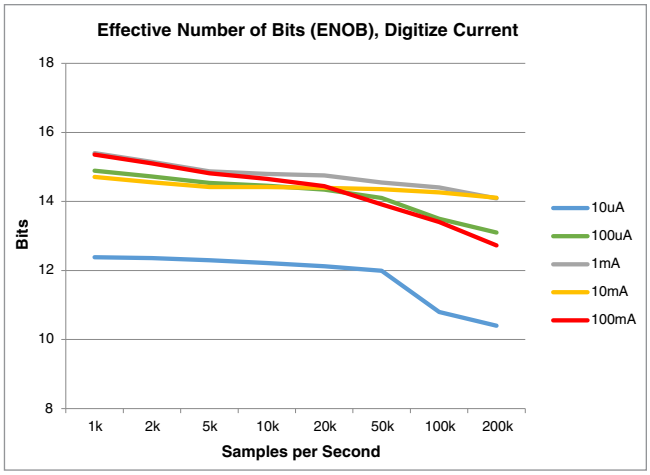
Total Harmonic Distortion (THD), Typical [80]



NOTES

76. Verified with sine wave input and DC content ≤3% of range.
77. 10A range is available only on the rear input terminals.
78. 10A flatness verified to 10kHz; 100kHz guaranteed by design.
79. Specified with aperture Auto and open input terminals. For all ranges and for ≥1k sample rate, add an additional 3× $_{RMS}$ noise uncertainty to ppm of range.
80. Specified with aperture Auto and 1kHz sine wave input. Distortion is calculated using first five harmonics. For the 1A, 3A, and 10A ranges, use the 100mA range accuracy; guaranteed by design.

Effective Number Of Bits (ENOB), Typical [81]



Digitizer Characteristics

Maximum Resolution	18 bits.
Measurement Input Coupling	DC or AC (voltage only).
Sampling Rate [82]	Programmable 1 k through 1 million.
Volatile Sample Memory with Timestamp	27.5 million.
Minimum Record Time	1 µs.
Timestamp Resolution	1 ns with standard or full buffer style. 1 µs with compact buffer style.
Timestamp Accuracy	With standard or full buffer style, 20 ns between adjacent readings, with total buffer time <2 s. With compact buffer style, 2 µs adjacent readings, with total buffer buffer time <2 s.
Maximum Record Length	8 million.

NOTES

81. Specified with aperture Auto, 100 Hz sine wave for sample rate ≤5 k, and 1 kHz sine wave for sample rate ≥10 k. For the 1 A, 3 A, and 10 A ranges, use the 100 mA ENOB; guaranteed by design.
82. Sample rate is not continuously adjustable. For valid discrete settings, see the DMM7510 Reference Manual.

True RMS AC Voltage and AC Current

Function	Range [83]	Resolution	1-Year Accuracy: ±(% of reading + % of range) T_{CAL} ±5°C					
			3 Hz to 5 Hz	5 Hz to 10 Hz	10 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz
Voltage [84]	100.0000 mV	0.1 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	1.000000 V	1 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	10.00000 V	10 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	100.0000 V	100 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	700.000 V	1 mV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
Temperature Coefficient/°C (all ranges)	–	–	0.01 + 0.003	0.03 + 0.003	0.005 + 0.003	0.006 + 0.005	0.01 + 0.006	0.03 + 0.01

Function	Range [83]	Resolution	1-Year Accuracy: ±(% of reading + % of range) T_{CAL} ± 5°C				
			3 Hz to 5 Hz	5 Hz to 10 Hz	10 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
Current [84]	1.000000 mA	1 nA	1.0 + 0.04	0.30 + 0.04	0.08 + 0.03	0.09 + 0.03	0.09 + 0.03
	10.00000 mA	10 nA	1.0 + 0.04	0.30 + 0.04	0.08 + 0.03	0.09 + 0.03	0.09 + 0.03
	100.0000 mA	100 nA	1.0 + 0.04	0.30 + 0.04	0.08 + 0.03	0.09 + 0.03	0.01 + 0.006
	1.000000 A	1 µA	1.0 + 0.04	0.30 + 0.04	0.20 + 0.04	0.88 + 0.04	0.01 + 0.006
	3.000000 A	1 µA	1.0 + 0.05	0.30 + 0.05	0.20 + 0.05	0. 88 + 0.05	2.0 + 0.04
	10.00000 A [85]	10 µA	1.0 + 0.05	0.40 + 0.05	0.40 + 0.05	0. 88 + 0.05	2.0 + 0.05
Temperature Coefficient/°C (all ranges)	–	–	0.10 + 0.004	0.030 + 0.004	0.005 + 0.003	0.006 + 0.005	0.006 + 0.005

Additional AC Uncertainties – Low Frequency Uncertainty

Additional Uncertainty ±(% of reading), Lower Frequency Uncertainty	Detector Bandwidth (BW)		
	3 BW (3 Hz to 300 kHz)	30 BW (30 Hz to 300 kHz)	300 BW (300 Hz to 300 kHz)
20 Hz to 30 Hz	0	0.3	—
30 Hz to 50 Hz	0	0	—
50 Hz to 100 Hz	0	0	4.0
100 Hz to 200 Hz	0	0	0.72
200 Hz to 300 Hz	0	0	0.18
300 Hz to 500 Hz	0	0	0.07
> 500 Hz	0	0	0

NOTES

83. 20% overrange on AC functions except 1% on 700 V, 3.33% on 3 A, and 1% on 10 A. Default resolution is 6½ digits.
84. Specifications are for detector bandwidth of 3Hz and sine wave inputs >5% of range. Detector bandwidth of 3 Hz and 30 Hz are multisample A/D conversions. Detector bandwidth of 300 Hz is a single A/D conversion, programmable from 0.0005 PLC to 15 PLC (60 Hz), 12 PLC (50 Hz). Default condition set to 1 PLC.
85. Rear terminals only.

Additional AC Voltage Crest Factor Uncertainties [86]

Additional Uncertainty ±(% of reading)

Input Signal Frequency	Detector Bandwidth	Maximum Crest Factor: 5 at Range Full Scale			
		1 to 2	2 to 3	3 to 4	4 to 5
3 Hz to 5 Hz	3 Hz	1.00	4.00	4.80	5.00
5 Hz to 10 Hz	3 Hz	0.50	1.20	1.30	1.40
10 Hz to 30 Hz	3 Hz	0.20	0.30	0.60	0.90
5 Hz to 100 Hz	30 Hz	0.20	0.30	0.60	0.90
100 Hz to 300 Hz	30 Hz	0.05	0.15	0.30	0.40
100 Hz to 300 Hz	300 Hz	0.50	1.20	1.30	1.50
500 Hz to 10 kHz	300 Hz	0.05	0.15	0.30	1.20

AC Voltage Characteristics

Measurement Method AC-coupled, true RMS.

Input Impedance 1 MΩ ± 2% || <150 pF.

Volt*Hertz Product <2.1 × 10^7 V*Hz verified; input frequency verified for <300 kHz.

AC Current Characteristics

Measurement Method AC-coupled, true RMS.

Range	1 mA	10 mA	100 mA	1 A	3 A	10 A [87]
Burden Voltage (RMS)	<16 mV	<20 mV	<0.2 V	<0.4 V	<1.3 V	<0.65 V
Overload Recovery: For each additional sustained ampere beyond ±1.5 A, add the following initial % of range error until thermally settled after overload recovery	0.006	0.006	0.12	0.05	—	—

Frequency and Period

Measurement Accuracy [88]

Aperture	Measurement Resolution	Accuracy, ±(ppm of reading + ppm of aperture time) Frequency: 3 Hz to 500 kHz Period: 333 ms to 2 µs	
		1 Year, T_{CAL} ±5°C	2 Year, T_{CAL} ±5°C
250 ms	0.1 ppm	80 + 0.333	160 + 0.333
100 ms	0.1 ppm	80 + 3.33	160 + 3.33
10 ms	0.1 ppm	80 + 33.3	160 + 33.3

NOTES

86. Applies for non-sine wave inputs, DC content ≤3% of range, maximum crest factor ≤5.0. For bandwidth 30Hz, autozero off, 6½ digits at 1 PLC, 3½ digits at 0.0005 PLC.
87. Rear input terminals only.
88. Specified for square wave inputs. Input signal must be >10% of ACV range. If input is <20 mV on the 100 mV range, then the frequency must be >10 Hz. For sine wave inputs, frequency must be >100 Hz. For frequencies ≤100 Hz, threshold level ≤50% of input signal and ≤7 Hz, threshold level ≤3% of range.

Threshold Level Accuracy [89]

Threshold Range	Threshold Resolution	Accuracy ±(% of reading) 2 Year, T_{CAL} ±5°C
100 mV to 700 V	0.05%	1.0%

Frequency and Period Characteristics

Measurement Method	Reciprocal counting technique.
Aperture	10 ms to 273 ms; default is 10 ms.

Typical Reading Rates, 60 Hz (50 Hz) Operation [90, 91, 92, 93]

		Functions: DC Voltage (10 V), 2-wire Ohms (≤10 kΩ), DC Current (1 mA)		Functions: 4-wire ohms (≤1 kΩ), 4-wire/3-wire RTD		Functions: Thermistor		Functions: Dry Circuit (≤1 kΩ)	
NPLC	Digits	Measurements Into Buffer	Measurements Into Computer	Measurements Into Buffer	Measurements Into Computer	Measurements Into Buffer	Measurements Into Computer	Measurements Into Buffer	Measurements Into Computer
1	7½	59.8 (49.8)	58 (48)	29 (24)	28 (24)	57 (48)	57 (48)	27 (23)	26 (22)
0.2	6½	295 (240)	250 (210)	128 (109)	119 (100)	230 (200)	230 (200)	100 (89)	96 (85)
0.06	5½	965 (810)	950 (800)	310 (280)	315 (280)	900 (750)	900 (750)	190 (180)	190 (180)
0.006	4½	7500 (6700)	7300 (6500)	750 (730)	740 (720)	6800 (6000)	6800 (6000)	295 (290)	295 (290)
0.0005	3½	26000 (26000)	24000 (24000)	860 (860)	860 (860)	18000 (18000)	18000 (18000)	310 (310)	310 (310)

Detector Bandwidth (Hz)	Digits	Functions: ACV, ACI	
		Measurements Into Buffer	Measurements Into Computer
3	6½	0.5 (0.5)	0.5 (0.5)
30	6½	3.3 (3.3)	3.3 (3.3)
300 [94]	6½	59.8 (49.8)	55 (46)
300 [94]	3½	26200 (26200)	24500 (24500)

Digitize, Typical

Sampling Rate	Digits	Resolution	Measurements Into Computer [93]
10 kS/s	5½	18	9700
20 kS/s	4½	16	19000
50 kS/s	4½	16	44400
100 kS/s	4½	15	80000
1 MS/s	3½	12	108000

NOTES

89. Threshold range is voltage $_{RMS}$ and threshold level voltage peak. Specified with 1kHz square wave. 100V and 700V threshold ranges guaranteed by design.
90. Reading speeds for autozero off, fixed range, autodelay off. Offset compensation off and open lead detector off where applicable.
91. Buffer measurements: For <0.2 PLC, multisample, single buffer transfer binary reading only.
92. PC measurements: For 1 and 0.2 PLC single reading and single transfer to computer (USB).
93. Reading rates using factory default operating conditions and autorange off, autodelay off. Speeds include measurement and data transfer out of the USB. ≥1000 readings with binary transfer over USB.
94. For bandwidth 300Hz, autozero off, 6½ digits at 1 PLC, 3½ digits at 0.0005 PLC.

System Performance, Typical

Mode 3½-digit, autozero off, 0.0005 PLC, excludes measurement time.

Time includes function change from DC voltage or 2-wire ohms to listed function.

Function	Function Change (ms)	Range Change (ms)
DC Voltage or 2-wire ohms (<10 kΩ)	6	1.3
4-wire ohms (<10 kΩ)	7	1.3
DC Current	7	1.3
Frequency or Period [95]	7	1.3
AC Voltage or AC Current	7	1.3
Digitize Voltage or Current	7	1.3

Ranges for Function Change Times

Function change times apply to the ranges listed in the table below.

Function	Range
DC Voltage	10 V
2-wire or 4-wire Ohms	1 kΩ
DC Current	1 mA
Dry-circuit Ohms	10 Ω
Thermocouple	Use DC Voltage rates
Thermistor	Use 2-wire Ohms rates
AC Current	1 mA
AC Voltage	1 V

Buffer Transfer Speed (Binary)	Measurements into Computer (per second)		
	USB	LAN	GPIB
Average for 1000 readings	280000	270000	190000
Average for 1000 readings with timestamp	170000	140000	100000

Triggering

Time Base Accuracy	25ppm.
Trigger Source	Analog DCV, DCI, or any system trigger.
Trigger Coupling	DC or AC (DCV function only).
Input Trigger Latency [96, 97, 98]	<225 ns.
Input Trigger Jitter [96, 97]	<50 ns.
Sample period Jitter [96, 97]	<1 ns.

DMM Rear-Panel Triggers

EXT TRIG IN and OUT	0 V to 5 V logic signal input and output, TTL compatible.
EXT trigger latency (IN and OUT)	<400 ns.
EXT trigger latency (IN or OUT)	<200 ns (guaranteed by design).

NOTES

95. For DC voltage or 2-wire ohms to frequency or period, 10ms aperture. For AC current or AC voltage, detector bandwidth is 300 Hz.
96. Guaranteed by design; for digital I/O only.
97. Stimulus command required to meet specifications.
98. If using trigger model, add 200 ns uncertainty.

Analog Triggering [99]

Analog Level, Edge, Or Window Trigger Types [100]

Trigger Characteristics	Voltage Input	Current Input
Input	100 mV to 1000 V	10 µA to 10 A
Resolution	0.05%	0.05%
Basic Accuracy (T_{ACAL} ±5°C) [101, 102]	1%	1%

Analog Trigger Latencies

	Digital I/O	External
Positive Logic	800 ns + 40 ns jitter	930 ns + 40 ns jitter
Negative Logic	800 ns + 40 ns jitter	840 ns + 40 ns jitter

Window Filter and Memory (buffer)

Window Filter Size	0 to 10% of reading, where 0 averages all readings.
Memory	Up to 27.5 million timestamped readings with the compact buffer style, with additional memory available using an external USB flash drive.
Maximum Internal Memory (Buffer)	27.5 million readings with the compact buffer style (6½-digit without formatting), 11 million readings with the standard or full buffer style.

NOTES

99. For DC or AC coupled, the trigger level can be set up to 100% of measure range.
100. Rising or falling edge triggering supported. Window trigger requires setting two independent levels.
101. Trigger event occurs after the threshold crossing at a time determined by total trigger latencies.
102. Accuracy specifications require user $_{ACAL}$ and are verified with level trigger amplitude set to 50% of range with a 100 Hz sine wave at 100% full scale of range. High frequency rejection is off. NPLC 0.0005 (DC voltage/DC current) or aperture 1 µs for digitize voltage or digitize current. Specified for fixed range, autozero off. For digitized DC voltage AC coupled, add 0.5%. For DC current and digitized DC current 3 A or 10 A ranges, add an additional 2%.

General Instrument Specifications

Specification Conditions	This document contains specifications and supplemental information for the DMM7510 Precision Sampling Digital Multimeter instrument. Specifications are the standards against which the DMM7510 is tested. Upon leaving the factory, the DMM7510 meets these specifications. Supplemental, typical, and characteristic values are non-warranted, apply at 23°C, and are provided solely as useful information. All specifications apply to front or rear terminal inputs, except 10 A specifications (rear terminals only).
Input Protection	1010 V DC (715 V_{RMS} V AC) all ranges and functions on HI and LO terminals; 350 V all ranges and functions on sense HI, sense LO terminals; 250 V rated current input terminal; fused 3 A and 10 A ranges; current input terminals protected to 1 kV.
3 A Input Fuse Protection	3.5 A, 1 kV fast blow type; Keithley part number DMM7510-FUSE-3A.
10 A Input Fuse Protection	11 A, 1 kV fast blow type; Keithley part number DMM7510-FUSE-10A.
AC Voltage input	**Maximum DCV:** 1000V on any AC voltage range.
Common Mode Isolation	500 VDC or ACVpeak LO to chassis. All terminals >10 GΩ, <350 pF any terminal to chassis.
Power Line	Universal input, 100 V to 240 V.
Line Frequency	50 Hz or 60 Hz, automatically sensed at power-up.
Power Consumption	60 VA.
Operating Environment	Specified for 0° to 50°C, ≤80% relative humidity at 35°C, altitude up to 2000 meters.
Storage Environment	–30° to 70°C.
Real Time Clock	Lithium battery backup (3+ years battery life).
EMC	Conforms to European Union EMC Directive.
Safety	NRTL listed to UL61010-1, and CSA C22.2 No 61010-1; conforms with European Union Low Voltage Directive.

Vibration	MIL-PRF-28800F Class 3, Random.
Warm-up	90 minutes to rated accuracy.
Input Signal Connections	Front and rear safety banana jacks.
Cooling	Forced air, fixed speed.
Dimensions	**Without handle and bumpers:** 88 mm high × 213 mm wide × 410 mm deep (3.46 in. × 8.39 in. × 16.13 in.).
	With handle and bumpers (bench configuration): 106 mm high × 255 mm wide × 425 mm deep (4.18 in. × 10.05 in. × 16.75 in.).
Shipping weight (with bumpers and handle)	4.08 kg (9.0 lb.).
Shipping weight (without bumpers and handle)	3.63 kg (8.0 lb.).
Digital I/O:	
Connector	9-pin female D.
5V Power Supply Pin	Limited to 500 mA at > 4 V (solidstate fuse protected).
Lines	Six input/output, user-defined, for digital I/O or triggering.
Input Signal Levels:	0.7 V (maximum logic low) 3.7 V (minimum logic high).
Input Voltage Limits:	–0.25 V (absolute minimum) +5.25 V (absolute maximum).
Maximum Source Current	+2.0 mA at >2.7 V (per pin).
Maximum Sink Current	–50 mA at 0.7 V (per pin, solid-state fuse protected).
Handler	User-defined start of test, end of test, four category bits
Math Functions	Rel, dB, Limit Test, Percentage, 1/x, and mX + b.
Remote Interface:	
LAN	RJ-45 connector, 10/100BT; Virtual Front Panel.
IP Configuration	Static or DHCP.
GPIB	IEEE-488.1 compliant. Supports IEEE-488.2 common commands and status model topology.
USB Device (rear panel, type B)	2.0 full speed, USBTMC compliant.
USB Host (front panel, type A)	USB 2.0, support for flash drives, FAT 32.
LXI Compliance	LXI version 1.4 Core 2011.
Language	Embedded Test Script Processor (TSP) accessible from any host interface; responds to high-speed test scripts comprised of remote commands and statements (for example, branching, looping, math); able to execute high-speed test scripts stored in memory without host intervention; also SCPI (default command set).
Accessories Supplied	Product Information CD-ROM, DMM7510 Quick Start Guide, Kickstart Software Quick Start Guide, power cord, 1 m USB cable (type A to type B), 3 m LAN cable, and 1756 Standard Test Lead Kit.
Accessories Available	(Calibration / Data / ISO 17025), software IVI/VISA drivers for Microsoft® Visual Basic®, Visual C/C++®, National Instruments (NI™) LabVIEW™, Keithley Test Script Builder, Keithley KickStart, and NI LabWindows™/CVI.
Display	Five-inch capacitive touch, color thin-film-transistor (TFT) WVGA (800×480) with LED backlight.
Password Protection	30 characters.
Expansion Interface	The TSP-Link® expansion interface allows TSP-enabled instruments to trigger and communicate with each other.
IP configuration	Static or DHCP (manual or automatic).

Supplied Accessories

1756	Test Leads
USB-B-1	USB Cable, Type A to Type B, 1 m (3.3 ft)
CA-180-3A	TSP-Link/Ethernet Cable Documentation CD
	DMM7510 QuickStart Guide
	Test Script Builder Software (available at www.keithley.com)
	KickStart Startup Software (available at www.keithley.com)
	LabVIEW and IVI Drivers (available at www.keithley.com)

Available Accessories

Test Leads and Probes

1752	Premium Safety Test Lead Kit
1754	2-Wire Universal 10-Piece Test Lead Kit
1756	General Purpose Test Lead Kit
5804	Kelvin (4-Wire) Universal 10-Piece Test Lead Kit
5805	Kelvin (4-Wire) Spring-Loaded Probes
5806	Kelvin Clip Lead Set
5808	Low Cost Single-pin Kelvin Probe Set
5809	Low Cost Kelvin Clip Lead Set
8606	High Performance Modular Probe Kit
8610	Low Thermal Shorting Plug

Replacement Fuses

DMM7510-FUSE-10A	11 A Current Fuse For DMM7510
DMM7510-FUSE-3A	3.5 A Current Fuse For DMM7510

Cables, Connectors, Adapters

CA-18-1	Shielded Dual Banana Cable, 1.2 m (4 ft.)

Communication Interfaces & Cables

KPCI-488LPA	IEEE-488 Interface for PCI Bus
KUSB-488B	IEEE-488 USB-to-GPIB Interface Adapter
7007-1	Shielded GPIB Cable, 1 m (3.2 ft)
7007-2	Shielded GPIB Cable, 2 m (6.5ft)
CA-180-3A	CAT5 Crossover Cable for TSP-Link / Ethernet
USB-B-1	USB Cable, Type A to Type B, 1 m (3.3 ft)

Triggering and Control

2450-TLINK	DB-9 to Trigger Link Connector Adapter
8501-1	Trigger Link Cable, DIN-to-DIN, 1 m (3.2 ft.)
8501-2	Trigger Link Cable, DIN-to-DIN, 2 m (6.5 ft.)
8503	DIN-to-BNC Trigger Cable

Rack Mount Kits

4299-8	Single Fixed Rack Mount Kit
4299-9	Dual Fixed Rack Mount Kit
4299-10	Dual Fixed Rack Mount Kit. Mount One DMM7510 and One Series 26xxB Instrument
4299-11	Dual Fixed Rack Mount Kit. Mount One DMM7510 and One Instrument from Series 2400, Series 2000, etc.
4299-12	Dual Fixed Rack Mount Kit. Mount One DMM7510 and One Keysight Instrument.
DMM7510-BenchKit	Ears and Handle for DMM7510-NFP-RACK and DMM7510-RACK Models

Available Services

Extended Warranties

DMM7510-EW	1 Year Factory Warranty Extended to 2 Years from Date of Shipment
DMM7510-3Y-EW	1 Year Factory Warranty Extended to 3 Years from Date of Shipment
DMM7510-5Y-EW	1 Year Factory Warranty Extended to 5 Years from Date of Shipment
DMM7510-NFP-EW	1 Year Factory Warranty Extended to 2 Years from Date of Shipment
DMM7510-NFP-3Y-EW	1 Year Factory Warranty Extended to 3 Years from Date of Shipment
DMM7510-NFP-5Y-EW	1 Year Factory Warranty Extended to 5 Years from Date of Shipment

Calibration Contracts

C/DMM7510-3Y-17025	KeithleyCare 3 Year ISO-17025 Calibration Plan
C/DMM7510-3Y-DATA	KeithleyCare 3 Year Calibration w/Data Plan
C/DMM7510-3Y-STD	KeithleyCare 3 Year Std Calibration Plan
C/DMM7510-5Y-17025	KeithleyCare 5 Year ISO-17025 Calibration Plan
C/DMM7510-5Y-DATA	KeithleyCare 5 Year Calibration w/Data Plan
C/DMM7510-5Y-STD	KeithleyCare 5 Year Std Calibration Plan
C/DMM7510-NFP-3Y-17025	KeithleyCare 3 Year ISO-17025 Calibration Plan
C/DMM7510-NFP-3Y-DATA	KeithleyCare 3 Year Calibration w/Data Plan
C/DMM7510-NFP-3Y-STD	KeithleyCare 3 Year Std Calibration Plan
C/DMM7510-NFP-5Y-17025	KeithleyCare 5 Year ISO-17025 Calibration Plan
C/DMM7510-NFP-5Y-DATA	KeithleyCare 5 Year Calibration w/Data Plan
C/DMM7510-NFP-5Y-STD	KeithleyCare 5 Year Std Calibration Plan
C/NEW DATA	Calibration Data for New Units
C/NEW DATA ISO	ISO-17025 Calibration Data for New Units

Ordering Information

DMM7510	7½-Digit Graphical Sampling Multimeter
DMM7510-NFP	7½-Digit Graphical Sampling Multimeter, with No Front Panel
DMM7510-RACK	7½-Digit Graphical Sampling Multimeter, with No Handle
DMM7510-NFP-RACK	7½-Digit Graphical Sampling Multimeter, with No Front Panel and No Handle

Warranty Information

Warranty Summary	This section summarizes the warranties of the DMM7510. For complete warranty information, refer to the DMM7510 Reference Manual. Any portion of the product that is not manufactured by Keithley is not covered by this warranty and Keithley will have no duty to enforce any other manufacturer's warranties.
Hardware Warranty	Keithley Instruments, Inc. warrants the Keithley manufactured portion of the hardware for a period of one year from defects in materials or workmanship; provided that such defect has not been caused by use of the Keithley hardware which is not in accordance with the hardware instructions. The warranty does not apply upon any modification of Keithley hardware made by the customer or operation of the hardware outside the environmental specifications.
Software Warranty	Keithley warrants for the Keithley produced portion of the software or firmware will conform in all material respects with the published specifications for a period of ninety (90) days; provided the software is used on the product for which it is intended in accordance with the software instructions. Keithley does not warrant that operation of the software will be uninterrupted or error-free, or that the software will be adequate for the customer's intended application. The warranty does not apply upon any modification of the software made by the customer.

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