Esame di Stato di abilitazione alla professione di Ingegnere

Sezione A

Settore dell'Informazione

Prova pratica: Classe 32/S

Tema n. 1

II sessione 2009

Il Candidato supponga di agire come consulente di un laboratorio di Taratura accreditato SIT, quindi operante in conformità ai requisiti della norma internazionale ISO-IEC 17025. Il Laboratorio dispone dei dispositivi di regolazione della tensione di alimentazione e delle grandezze ambientali e dei consueti dispositivi elettronici ed informatici presenti in un laboratorio sperimentale. I dispositivi, quando necessario ed opportuno, sono collegabili fra loro mediante il BUS IEEE 488-2. Il Laboratorio opera in condizioni di elevata automazione, in modo da minimizzare l'intervento degli operatori specializzati. Infine il Laboratorio è provvisto di un insieme di dispositivi campione come illustrato nel seguito.

Si vuole sottoporre a verifica di taratura un wattmetro digitale monofase, le cui principali caratteristiche sono:

- Portate in tensione: 60 V; 120 V; **240 V; 600 V**
- Portate in corrente: 0,1 A; 0,5 A; 1 A; 2 A; **5 A; 10 A**
- Risoluzione: 0,001 W per le portate minori
- Risoluzione: 0,01 W per le portate in grassetto
- Stabilità a breve termine: $1\cdot10^{-4}$ per la potenza apparente V·I
- Incertezza dichiarata dal costruttore:

Accuracy: All accuracy values are expressed as a percentage of rated power at full scale voltage and current at Unity Power Factor. Accuracy specifications apply to any power factor, lead or lag.

Accuracy:

Voltage Range	Current Range	Accuracy
60V	100mA	0.10%
	500mA	0.05%
	1A	0.05%
	2A	0.05%
	5A	0.10%
	10A	0.20%
120V	100mA	0.10%
	500mA	0.05%
	1A	0.05%

	2A	0.05%
	5A	0.10%
	10A	0.20%
240V	100mA	0.10%
	500mA	0.07%
	1A	0.07%
	2A	0.07%
	5A	0.12%
	10A	0.22%
600V	100mA	0.10%
	500mA	0.10%
	1A	0.10%
	2A	0.10%
	5A	0.15%
	10A	0.25%

Si vuole eseguire il controllo di taratura nei punti indicati nella tabella seguente:

Punti di controllo	Frequenza [Hz]	Sfasamento (cos φ)
50 V; 0,1 A	50	1; 0
100 V; 1 A	50; 1000	1; 0
230 V; 10 A	50	1; 0,5; 0

Tra le apparecchiature a disposizione si ha un calibratore Fluke 5520A, le cui principali caratteristiche sono riportate in Appendice A), che però risulta essere in condizioni di non riferibilità, per cui può essere utilizzato solo come generatore dei segnali in tensione ed in corrente.

Si devono perciò utilizzare i dispositivi seguenti, che si trovano in condizioni di riferibilità:

a) Shunt per corrente in AC. Portata: 10 A; valore di resistenza: 100 mΩ; Incertezza complessiva: $1\cdot10^{-4}$; comportamento resistivo fino a frequenza di 10 kHz.

b) Digital Multimeter (DMM) Hewlett Packard 3458A, le cui principali caratteristiche sono riportate in Appendice B Si hanno a disposizione tre DMM.

c) Contatore digitale a due canali. Campo di tensione: ± 10 V; risoluzione temporale: 100 ns; massimo ritardo nella misura sui due canali: 20 ns; deriva temporale: 3·10-7/anno; deriva termica: 1·10-7/K

d) Cavi vari per collegamenti

Il candidato progetti un procedimento che permetta di eseguire la verifica di taratura del dispositivo indicato, ed in particolare:

1. Individui le principali condizioni operative ed ambientali per poter eseguire correttamente la verifica.
2. Indichi il procedimento di misura suggerito per eseguire la verifica, progettato in modo da utilizzare al meglio le apparecchiature disponibili, ottenere una elevata automazione delle procedure e una minimizzazione degli operatori specializzati impegnati nella prova. Il procedimento dovrà essere descritto in modo da fornire la base per la stesura della corrispondente procedura tecnica.
3. Esegua una stima dell'incertezza di taratura seguendo le linee guida della norma UNI CEI ENV 13005 (Guida all'espressione dell'incertezza di misura)
4. Indichi le informazioni essenziali che devono essere riportate nel certificato di taratura
5. Individui i principali procedimenti *software* che permettono l'esecuzione automatizzata della verifica e di uno di questi è invitato a presentare il diagramma di flusso dettagliato
6. Indichi passo per passo l'insieme degli atti che l'operatore dovrà eseguire per l'esecuzione della verifica, mettendo in evidenza gli accorgimenti previsti per individuare/evitare sbagli banali e per salvaguardare la sicurezza degli operatori.

Nel caso in cui siano necessari ulteriori dispositivi, se ne indichino le principali caratteristiche in vista di un acquisto da parte del Laboratorio, giustificando la scelta.

1-12. Specifications

The following tables list the 5520A specifications. All specifications are valid after allowing a warm-up period of 30 minutes, or twice the time the 5520A has been turned off. (For example, if the 5520A has been turned off for 5 minutes, the warm-up period is 10 minutes.)

All specifications apply for the temperature and time period indicated. For temperatures outside of t_{cal} ±5 °C (t_{cal} is the ambient temperature when the 5520A was calibrated), the temperature coefficient as stated in the General Specifications must be applied.

The specifications also assume the Calibrator is zeroed every seven days or whenever the ambient temperature changes more than 5 °C. The tightest ohms specifications are maintained with a zero cal every 12 hours within ±1 °C of use. (See “Zeroing the Calibrator” in Chapter 4.)

Also see additional specifications later in this chapter for information on extended specifications for ac voltage and current. The dimensional outline for the 5520A Calibrator is shown in Figure 1-3.

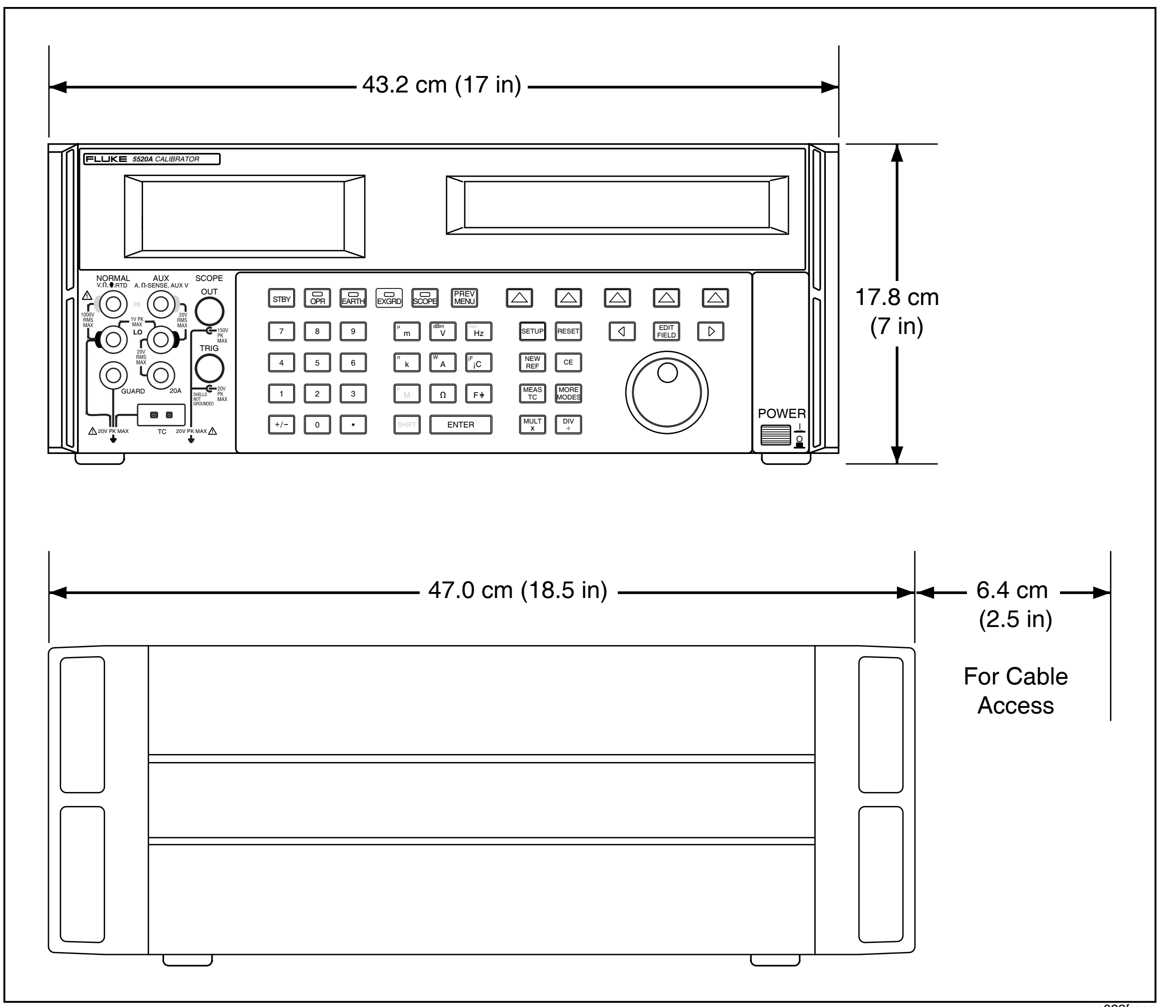

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Figure 1-3. 5520A Calibrator Dimensional Outline

1-13. General Specifications

Warmup Time	Twice the time since last warmed up, to a maximum of 30 minutes.
Settling Time	Less than 5 seconds for all functions and ranges except as noted.
Standard Interfaces	IEEE-488 (GPIB), RS-232, 5725A Amplifier
Temperature Performance	• Operating: 0 °C to 50 °C • Calibration (tcal): 15 °C to 35 °C • Storage: -20 °C to 70 °C [3]
Temperature Coefficient	Temperature Coefficient for temperatures outside tcal +5 °C is 0.1X/°C of the 90-day specification (or 1-year, as applicable) per °C.
Relative Humidity [1]	• Operating: <80% to 30 °C, <70% to 40 °C, <40% to 50 °C • Storage: <95%, non-condensing
Altitude	• Operating: 3,050 m (10,000 ft) maximum • Non-operating: 12,200 m (40,000 ft) maximum
Safety	Complies with IEC 1010-1 (1992-1); ANSI/ISA-S82.01-1994; CAN/CSA-C22.2 No. 1010.1-92
Analog Low Isolation	20 V
EMC	Designed to comply with FCC Rules Part 15; VFG 243/1991. If used in areas with Electromagnetic fields of 1 to 3 V/m, resistance outputs have a floor adder of 0.508 •. Performance not specified above 3 V/m. This instrument may be susceptible to electro-static discharge (ESD) from direct contact to the binding posts. Good static aware practices should be followed when handling this and other pieces of electronic equipment.
Line Power [2]	• Line Voltage (selectable): 100 V, 120 V, 220 V, 240 V • Line Frequency: 47 Hz to 63 Hz • Line Voltage Variation: ±10% about line voltage setting
Power Consumption	5500A Calibrator, 300 VA; 5725A Amplifier, 750 VA
Dimensions	5500A Calibrator: • Height: 17.8 cm (7 inches), standard rack increment, plus 1.5 cm (0.6 inch) for feet on bottom of unit; • Width: 43.2 cm (17 inches), standard rack width • Depth: 47.3 cm (18.6 inches) overall 5725A Amplifier: • Height, 13.3 cm (5.25 inches), standard rack increment, plus 1.5 cm (0.6 inch) for feet on bottom of unit; • Width, 43.2 cm (17 inches), standard rack width • Depth, 63.0 cm (24.8 inches) overall.
Weight (without options)	5500A Calibrator, 22 kg (49 lb); 5725A Amplifier 32 kg (70 pounds)
Absolute Uncertainty Definition	The 5500A specifications include stability, temperature coefficient, linearity, line and load regulation, and the traceability of the external standards used for calibration. You do not need to add anything to determine the total specification of the 5520A for the temperature range indicated.
Specification Confidence Interval	99%

[1] After long periods of storage at high humidity, a drying out period (with the power on) of at least one week may be required.

[2] For optimal performance at full dual outputs (e.g. 1000 V, 20A) choose a line voltage setting that is ± 7.5% from nominal.

[3] The DC Current ranges 0 to 1.09999 A and 1.1 A to 2.99999 A are sensitive to storage temperatures above 50 °C. If the 5520A is stored above 50 °C for greater than 30 minutes, these ranges must be re-calibrated. Otherwise, the 90 day and 1 year uncertainties of these ranges double.

1-17. AC Voltage (Sine Wave) Specifications

NORMAL (Normal Output)						
Range	**Frequency**	**Absolute Uncertainty, tcal ± 5 °C ± (ppm of output + μV)**		**Resolution**	**Max Burden**	**Max Distortion and Noise 10 Hz to 5 MHz Bandwidth ± (% output + floor)**
		90 days	**1 year**			
1.0 mV to 32.999 mV	10 Hz to 45 Hz	600 + 6	800 + 6	1 μV	50 Ω	0.15 + 90 μV
	45 Hz to 10 kHz	120 + 6	150 + 6			0.035 + 90 μV
	10 kHz to 20 kHz	160 + 6	200 + 6			0.06 + 90 μV
	20 kHz to 50 kHz	800 + 6	1000 + 6			0.15 + 90 μV
	50 kHz to 100 kHz	3000 + 12	3500 + 12			0.25 + 90 μV
	100 kHz to 500 kHz	6000 + 50	8000 + 50			0.3 + 90 μV [1]
33 mV to 329.999 mV	10 Hz to 45 Hz	250 + 8	300 + 8	1 μV	50 Ω	0.15 + 90 μV
	45 Hz to 10 kHz	140 + 8	145 + 8			0.035 + 90 μV
	10 kHz to 20 kHz	150 + 8	160 + 8			0.06 + 90 μV
	20 kHz to 50 kHz	300 + 8	350 + 8			0.15 + 90 μV
	50 kHz to 100 kHz	600 + 32	800 + 32			0.20 + 90 μV
	100 kHz to 500 kHz	1600 + 70	2000 + 70			0.20 + 90 μV [1]
0.33 V to 3.29999 V	10 Hz to 45 Hz	250 + 50	300 + 50	10 μV	10 mA	0.15 + 200 μV
	45 Hz to 10 kHz	140 + 60	150 + 60			0.035 + 200 μV
	10 kHz to 20 kHz	160 + 60	190 + 60			0.06 + 200 μV
	20 kHz to 50 kHz	250 + 50	300 + 50			0.15 + 200 μV
	50 kHz to 100 kHz	550 + 125	700 + 125			0.20 + 200 μV
	100 kHz to 500 kHz	2000 + 600	2400 + 600			0.20 + 200 μV [1]
3.3 V to 32.9999 V	10 Hz to 45 Hz	250 + 650	300 + 650	100 μV	10 mA	0.15 + 2 mV
	45 Hz to 10 kHz	125 + 600	150 + 600			0.035 + 2 mV
	10 kHz to 20 kHz	220 + 600	240 + 600			0.08 + 2 mV
	20 kHz to 50 kHz	300 + 600	350 + 600			0.2 + 2 mV
	50 kHz to 100 kHz	750 + 1600	900 + 1600			0.5 + 2 mV
33 V to 329.999 V	45 Hz to 1 kHz	150 + 2000	190 + 2000	1 mV	5 mA, except 20 mA for 45 Hz to 65 Hz	0.15 + 10 mV
	1 kHz to 10 kHz	160 + 6000	200 + 6000			0.05 + 10 mV
	10 kHz to 20 kHz	220 + 6000	250 + 6000			0.6 + 10 mV
	20 kHz to 50 kHz	240 + 6000	300 + 6000			0.8 + 10 mV
	50 kHz to 100 kHz	1600 + 50000	2000 + 50000			1.0 + 10 mV
330 V to 1020 V	45 Hz to 1 kHz	250 + 10000	300 + 10000	10 mV	2 mA, except 6 mA for 45 Hz to 65 Hz	0.15 + 30 mV
	1 kHz to 5 kHz	200 + 10000	250 + 10000			0.07 + 30 mV
	5 kHz to 10 kHz	250 + 10000	300 + 10000			0.07 + 30 mV

[1] Max Distortion for 100 kHz to 200 kHz. For 200 kHz to 500 kHz, the maximum distortion is 0.9% of output + floor as shown.

Note

- Remote sensing is not provided. Output resistance is < 5 mΩ for outputs ≥0.33 V. The AUX output resistance is < 1Ω. The maximum load capacitance is 500 pF, subject to the maximum burden current limits.

AC Voltage (Sine Wave) Specifications (cont)

AUX (Auxiliary Output) [dual output mode only] [1]						
Range	Frequency	Absolute Uncertainty, tcal ± 5 °C ± (% of output + µV) 90 days	1 year	Res-olution	Max Burden	Max Distortion and Noise 10 Hz to 100 kHz Bandwidth ± (% output + floor)
10 mV to 329.999 mV	10 Hz to 20 Hz	0.15 + 370	0.2 + 370	1 µV	5 mA	0.2 + 200 µV
	20 Hz to 45 Hz	0.08 + 370	0.1 + 370			0.06 + 200 µV
	45 Hz to 1 kHz	0.08 + 370	0.1 + 370			0.08 + 200 µV
	1 kHz to 5 kHz	0.15 + 450	0.2 + 450			0.3 + 200 µV
	5 kHz to 10 kHz	0.3 + 450	0.4 + 450			0.6 + 200 µV
	10 kHz to 30 kHz	4.0 + 900	5.0 + 900			1 + 200 µV
0.33 V to 3.29999 V	10 Hz to 20 Hz	0.15 + 450	0.2 + 450	10 µV	5 mA	0.2 + 200 µV
	20 Hz to 45 Hz	0.08 + 450	0.1 + 450			0.06 + 200 µV
	45 Hz to 1 kHz	0.07 + 450	0.09 + 450			0.08 + 200 µV
	1 kHz to 5 kHz	0.15 + 1400	0.2 + 1400			0.3 + 200 µV
	5 kHz to 10 kHz	0.3 + 1400	0.4 + 1400			0.6 + 200 µV
	10 kHz to 30 kHz	4.0 + 2800	5.0 + 2800			1 + 200 µV
3.3 V to 5 V	10 Hz to 20 Hz	0.15 + 450	0.2 + 450	100 µV	5 mA	0.2 + 200 µV
	20 Hz to 45 Hz	0.08 + 450	0.1 + 450			0.06 + 200 µV
	45 Hz to 1 kHz	0.07 + 450	0.09 + 450			0.08 + 200 µV
	1 kHz to 5 kHz	0.15 + 1400	0.2 + 1400			0.3 + 200 µV
	5 kHz to 10 kHz	0.3 +1400	0.4 + 1400			0.6 + 200 µV

[1] There are two channels of voltage output. The maximum frequency of the dual output is 30 kHz.

Note

- Remote sensing is not provided. Output resistance is < 5 mΩ for outputs ≥0.33 V. The AUX output resistance is < 1Ω. The maximum load capacitance is 500 pF, subject to the maximum burden current limits.

1-18. AC Current (Sine Wave) Specifications

LCOMP off						
Range	**Frequency**	**Absolute Uncertainty, tcal ± 5 °C ± (% of output + µA)**		**Compliance adder ± (µA/V)**	**Max Distortion & Noise 10 Hz to 100 kHz BW ± (% output + floor)**	**Max Inductive Load**
		90 days	**1 year**			**µH**
29.00 µA to 329.99 µA	10 Hz to 20 Hz	0.16 + 0.1	0.2 + 0.1	0.05	0.15 + 0.5 µA	200
	20 Hz to 45 Hz	0.12 + 0.1	0.15 + 0.1	0.05	0.1 + 0.5 µA	
	45 Hz to 1 kHz	0.1 + 0.1	0.125 + 0.1	0.05	0.05 + 0.5 µA	
	1 kHz to 5 kHz	0.25 + 0.15	0.3 + 0.15	1.5	0.5 + 0.5 µA	
	5 kHz to 10 kHz	0.6 + 0.2	0.8 + 0.2	1.5	1.0 + 0.5 µA	
	10 kHz to 30 kHz	1.2 + 0.4	1.6 + 0.4	10	1.2 + 0.5 µA	
0.33 mA to 3.2999 mA	10 Hz to 20 Hz	0.16 + 0.15	0.2 + 0.15	0.05	0.15 + 1.5 µA	200
	20 Hz to 45 Hz	0.1 + 0.15	0.125 + 0.15	0.05	0.06 + 1.5 µA	
	45 Hz to 1 kHz	0.08 + 0.15	0.1+ 0.15	0.05	0.02 + 1.5 µA	
	1 kHz to 5 kHz	0.16 + 0.2	0.2 + 0.2	1.5	0.5 + 1.5 µA	
	5 kHz to 10 kHz	0.4 + 0.3	0.5 + 0.3	1.5	1.0 + 1.5 µA	
	10 kHz to 30 kHz	0.8 + 0.6	1.0 + 0.6	10	1.2 + 0.5 µA	
3.3 mA to 32.999 mA	10 Hz to 20 Hz	0.15 + 2	0.18 + 2	0.05	0.15 + 5 µA	50
	20 Hz to 45 Hz	0.075 + 2	0.09 + 2	0.05	0.05 + 5 µA	
	45 Hz to 1 kHz	0.035 + 2	0.04 + 2	0.05	0.07 + 5 µA	
	1 kHz to 5 kHz	0.065 + 2	0.08 + 2	1.5	0.3 + 5 µA	
	5 kHz to 10 kHz	0.16 + 3	0.2 + 3	1.5	0.7 + 5 µA	
	10 kHz to 30 kHz	0.32 + 4	0.4 + 4	10	1.0 + 0.5 µA	
33 mA to 329.99 mA	10 Hz to 20 Hz	0.15 +20	0.18 + 20	0.05	0.15 + 50 µA	50
	20 Hz to 45 Hz	0.075 + 20	0.09 + 20	0.05	0.05 + 50 µA	
	45 Hz to 1 kHz	0.035 + 20	0.04 + 20	0.05	0.02 + 50 µA	
	1 kHz to 5 kHz	0.08 + 50	0.10 + 50	1.5	0.03 + 50 µA	
	5 kHz to 10 kHz	0.16 + 100	0.2 + 100	1.5	0.1 + 50 µA	
	10 kHz to 30 kHz	0.32 + 200	0.4 + 200	10	0.6 + 50 µA	
0.33 A to 1.09999 A	10 Hz to 45 Hz	0.15 + 100	0.18 + 100		0.2 + 500 µA	2.5
	45 Hz to 1 kHz	0.036 + 100	0.05 + 100		0.07 + 500 µA	
	1 kHz to 5 kHz	0.5 + 1000	0.6 + 1000	[3]	1 + 500 µA	
	5 kHz to 10 kHz	2.0 + 5000	2.5 + 5000	[4]	2 + 500 µA	
1.1 A to 2.99999 A	10 Hz to 45 Hz	0.15 + 100	0.18 + 100		0.2 + 500 µA	2.5
	45 Hz to 1 kHz	0.05 + 100	0.06 + 100		0.07 + 500 µA	
	1 kHz to 5 kHz	0.5 + 1000	0.6 + 1000	[3]	1 + 500 µA	
	5 kHz to 10 kHz	2.0 + 5000	2.5 + 5000	[4]	2 + 500 µA	
3 A to 10.9999 A	45 Hz to 100 Hz	0.05 + 2000	0.06 + 2000		0.2 + 3 mA	1
	100 kHz to 1 kHz	0.08 + 2000	0.10 + 2000		0.1 + 3 mA	
	1 kHz to 5 kHz	2.5 + 2000	3.0 + 2000		0.8 + 3 mA	
11A to 20.5 A [2]	45 Hz to 100 Hz	0.1 + 5000	0.12 + 5000		0.2 + 3 mA	1
	100 Hz to 1 kHz	0.13 + 5000	0.15 + 5000		0.1 + 3 mA	
	1 kHz to 5 kHz	2.5 + 5000	3.0 + 5000		0.8 + 3 mA	

[1] Max Distortion for 100 kHz to 200 kHz. For 200 kHz to 500 kHz, the maximum distortion is 0.9% of output + floor as shown.

[2] Duty Cycle: Currents < 11 A may be provided continuously. For currents > 11 A, see Figure 1-4. The current may be provided 60-T-I minutes any 60 minute period where T is the temperature in °C (room temperature is about 23°C) and I is the output current in Amps. For example, 17 A, at 23°C could be provided for 60-17-23 = 20 minutes each hour.

[3] For compliance voltages greater than 1 V, add 1 mA/V to the floor specification from 1 kHz to 5 kHz.

[4] For compliance voltages greater than 1 V, add 5 mA/V to the floor specification from 5 kHz to 10 kHz.

AC Current (Sine Wave) Specifications *(cont)*

LCOMP on					
Range	**Frequency**	**Absolute Uncertainty, tcal ± 5 °C ± (% of output + µA)**		**Max Distortion & Noise, 10 Hz to 100 kHz BW**	**Max Inductive Load**
		90 days	**1 year**	**± (% output + µA)**	**µH**
29.00 µA to	10 Hz to 100 Hz	0.2 + 0.2	0.25 + 0.2	0.1 + 1.0	
329.99 µA	100 Hz to 1 kHz	0.5 + 0.5	0.6 + 0.5	0.05 + 1.0	
0.33 mA to	10 Hz to 100 Hz	0.2 + 0.3	0.25 + 0.3	0.15 + 1.5	
3.2999 mA	100 Hz to 1 kHz	0.5 + 0.8	0.6 + 0.8	0.06 + 1.5	
3.3 mA to	10 Hz to 100 Hz	0.07 + 4	0.08 + 4	0.15 + 5	400
32.999 mA	100 Hz to 1 kHz	0.18 + 10	0.2 + 10	0.05 + 5	
33 mA to	10 Hz to 100 Hz	0.07 + 40	0.08 + 40	0.15 + 50	
329.99 mA	100 Hz to 1 kHz	0.18 + 100	0.2 + 100	0.05 + 50	
0.33 A to	10 Hz to 100 Hz	0.1 + 200	0.12 + 200	0.2 + 500	
2.99999 A	100 to 440 Hz	0.25 + 1000	0.3 + 1000	0.25 + 500	
3 A to 20.5 A	10 Hz to 100 Hz	0.1 + 2000 [2]	0.12 + 2000 [2]	0.1 + 0	400 [4]
[1]	100 Hz to 1 kHz	0.8 + 5000 [3]	1.0 + 5000 [3]	0.5 + 0	

[1] Duty Cycle: Currents < 11 A may be provided continuously. For currents >11 A, see Figure 1-4. The current may be provided 60-T-I minutes any 60 minute period where T is the temperature in °C (room temperature is about 23 °C) and I is the output current in amperes. For example, 17 A, at 23 °C could be provided for 60-17-23 = 20 minutes each hour.

[2] For currents >11 A, Floor specification is 4000 µA within 30 seconds of selecting operate. For operating times >30 seconds, the floor specification is 2000 µA.

[3] For currents >11 A, Floor specification is 1000 µA within 30 seconds of selecting operate. For operating times >30 seconds, the floor specification is 5000 µA.

[4] Subject to compliance voltages limits.

Range	**Resolution µA**	**Max Compliance Voltage V rms**
0.029 mA to 0.32999 mA	0.01	7
0.33 mA to 3.29999 mA	0.01	7
3.3 mA to 32.9999 mA	0.1	5
33 mA to 329.999 mA	1	5
0.33 A to 2.99999 A	10	4
3 A to 20.5 A	100	3

[1] Subject to specification adder for compliance voltages greater than 1 V rms.

1-25. Phase Specifications

1-Year Absolute Uncertainty, tcal ± 5 °C, (Δ Φ °)					
10 Hz to 65 Hz	**65 Hz to 500 Hz**	**500 Hz to 1 kHz**	**1 kHz to 5 kHz**	**5 kHz to 10 kHz**	**10 kHz to 30 kHz**
0.10°	0.25°	0.5°	2.5°	5°	10°

Phase (Φ) Watts	Phase (Φ) VARs	PF	Power Uncertainty Adder due to Phase Error					
			10 Hz to 65 Hz	**65 Hz to 500 Hz**	**500 Hz to 1 kHz**	**1 kHz to 5 kHz**	**5 kHz to 10 kHz**	**10 kHz to 30 kHz**
0°	90°	1.000	0.00%	0.00%	0.00%	0.10%	0.38%	1.52%
10°	80°	0.985	0.03%	0.08%	0.16%	0.86%	1.92%	4.58%
20°	70°	0.940	0.06%	0.16%	0.32%	1.68%	3.55%	7.84%
30°	60°	0.866	0.10%	0.25%	0.51%	2.61%	5.41%	11.54%
40°	50°	0.766	0.15%	0.37%	0.74%	3.76%	7.69%	16.09%
50°	40°	0.643	0.21%	0.52%	1.04%	5.29%	10.77%	22.21%
60°	30°	0.500	0.30%	0.76%	1.52%	7.65%	15.48%	31.60%
70°	20°	0.342	0.48%	1.20%	2.40%	12.08%	24.33%	49.23%
80°	10°	0.174	0.99%	2.48%	4.95%	24.83%	49.81%	100.00%
90°	0°	0.000	—	—	—	—	—	—

Note

1. To calculate exact ac watts power adders due to phase uncertainty for values not shown, use the following formula: $Adder(\%) = 100(1 - \frac{Cos(\Phi + \Delta\Phi)}{Cos(\Phi)})$. For example: for a PF of .9205 (Φ = 23) and a phase uncertainty of ΔΦ = 0.15, the ac watts power adder is: $Adder(\%) = 100(1 - \frac{Cos(23+.15)}{Cos(23)}) = 0.11\%$

Appendice B Specifications

Introduction

The 3458A accuracy is specified as a part per million (ppm) of the reading plus a ppm of range for dcV, Ohms, and dcl. In acV and acl, the specification is percent of reading plus percent of range. Range means the name of the scale, e.g. 1 V, 10 V, etc.; range does not mean the full scale reading, e.g. 1.2 V, 12 V, etc. These accuracies are valid for a specific time from the last calibration.

Absolute versus Relative Accuracy

All 3458A accuracy specifications are relative to the calibration standards. Absolute accuracy of the 3458A is determined by adding these relative accuracies to the traceability of your calibration standard. For dcV, 2 ppm is the traceability error from the Agilent factory. That means that the absolute error relative to the U.S. National Institute of Standards and Technology (NIST) is 2 ppm in addition to the dcV accuracy specifications. When you recalibrate the 3458A, your actual traceability error will depend upon the errors from your calibration standards. These errors will likely be different from the Agilent error of 2 ppm.

Example 1: Relative Accuracy; 24 Hour Operating temperature is Tcal ± 1°C

Assume that the ambient temperature for the measurement is within ± 1°C of the temperature of calibration (Tcal). The 24 hour accuracy specification for a 10 V dc measurement on the 10 V range is 0.5 ppm ± 0.05 ppm. That accuracy specification means:

0.5 ppm of Reading + 0.05 ppm of Range

For relative accuracy, the error associated with the measurement is:

(0.5/1,000,000 x 10 V) + (0.05/1,000,000 x 10 V) = ± 5.5 µV or 0.55 ppm of 10 V

Errors from temperature changes

The optimum technical specifications of the 3458A are based on auto-calibration (ACAL) of the instrument within the previous 24 hours and following ambient temperature changes of less than ±1°C. The 3458A's ACAL capability corrects for measurement errors resulting from the drift of critical components from time and temperature.

The following examples illustrate the error correction of auto-calibration by computing the relative measurement error of the 3458A for various temperature conditions. Constant conditions for each example are:

10 V DC input
10 V DC range
Tcal = 23°C
90 day accuracy specifications

Example 2: Operating temperature is 28°C;

With ACAL

This example shows basic accuracy of the 3458A using auto-calibration with an operating temperature of 28°C. Results are rounded to 2 digits.

(4.1 ppm x 10 V) + (0.05 ppm x 10 V) = 42 µV

Total relative error = 42 µV

Example 3: Operating temperature is 38°C;

Without ACAL

The operating temperature of the 3458A is 38°C, 14°C beyond the range of Tcal ±1°C. Additional measurement errors result because of the added temperature coefficient without using ACAL.

(4.1 ppm x 10 V) + (0.05 ppm x 10 V) = 42 µV

Temperature Coefficient (specification is per °C):

(0.5ppm x 10V + 0.01 ppm x 10V) x 14°C = 71 µV

Total error = 113 µV

Example 4: Operating temperature is 38°C;

With ACAL

Assuming the same conditions as Example 3, but using ACAL significantly reduces the error due to temperature difference from calibration temperature. Operating temperature is 10°C beyond the standard range of Tcal ±5°C.

(4.1 ppm x 10 V) + (0.05 ppm x 10 V) = 42 µV

Temperature Coefficient (specification is per °C):

(0.15ppm x 10V + 0.01ppm x 10V) x 10°C = 16µV

Total error = 58 µV

Example 5: Absolute Accuracy; 90 Day

Assuming the same conditions as Example 4, but now add the traceability error to establish absolute accuracy.

(4.1 ppm x 10 V) + (0.05 ppm x 10 V) = 42 µV

Temperature Coefficient (specification is per °C):

(0.15ppm x 10V + 0.01ppm x 10V) x 10°C = 16µV

Agilent factory traceability error of 2 ppm:

(2 ppm x 10 V) = 20 µV

Total absolute error = 78 µV

Additional errors

When the 3458A is operated at power line cycles below 100, additional errors due to noise and gain become significant. Example 6 illustrates the error correction at 0.1 PLC.

Example 6: operating temperature is 28×C; 0.1 PLC

Assuming the same conditions as Example 2, but now add additional error.

(4.1 ppm x 10 V) t (0.05 ppm x 10 V) = 42 µV

Referring to the Additional Errors chart and RMS Noise Multiplier table, additional error at 0.1 PLC is:

(2 ppm x 10 V) + (0.4 ppm x 1 x 3 x 10 V) = 32 µV

Total relative error = 74 µV

4 / AC Voltage

General Information

The 3458A supports three techniques for measuring true rms AC voltage, each offering unique capabilities. The desired measurement technique is selected through the SETACV command. The ACV functions will then apply the chosen method for subsequent measurements.

The following section provides a brief description of the three operation modes along with a summary table helpful in choosing the technique best suited to your specific measurement need.

SETACV SYNC

Synchronously Sub-sampled Computed true rms technique.

This technique provides excellent linearity and the most accurate measurement results. It does require that the input signal be repetitive (not random noise, for example). The bandwidth in this mode is from 1 Hz to 10 MHz.

SETACV ANA

Analog Computing true rms conversion technique.

This is the measurement technique at power-up or following an instrument reset. This mode works well with any signal within its 10 Hz to 2 MHz bandwidth and provides the fastest measurement speeds.

SETACV RNDM

Random Sampled Computed true rms technique.

This technique again provides excellent linearity; however, the overall accuracy is the lowest of the three modes. It does not require a repetitive input signal and is, therefore, well suited to wideband noise measurements. The bandwidth in this mode is from 20 HZ to 10 MHZ.

Selection Table

Technique	Frequency Range	Best Accuracy	Repetitive Signal Required	Readings /Sec Minimum	Readings /Sec Maximum
Synchronous Sub-sampled	1 Hz –10 MHz	0.010%	Yes	0.025	10
Analog	10 Hz – 2 MHz	0.03%	No	0.8	50
Random Sampled	20 Hz – 10 MHz	0.1%	No	0.025	45

Synchronous Sub-sampled Mode (ACV Function, SETACV SYNC)

Range	Full Scale	Maximum Resolution	Input Impedance	Temperature Coefficient[1] (% of Reading +% of Range) /°C
10 mV	12.00000	10 nV	1 MΩ±15% with<140pF	0.003 + 0.02
100 mV	120.00000	10 nV	1 MΩ±15% with<140pF	0.0025 + 0.0001[2]
1 V	1.2000000	100 nV	1 MΩ±15% with <140pF	0.0025 + 0.0001
10 V	12.000000	1 µV	1 MΩ±2% with <140pF	0.0025 + 0.0001
100 V	120.00000	10 µV	1 MΩ±2% with <140pF	0.0025 + 0.0001
1000 V	700.0000	100 µV	1 MΩ±2% with <140pF	0.0025 + 0.0001

AC Accuracy[2]

24 Hour to 2 Year (% of Reading + % of Range)

Range	ACBAND ≤ 2 MHz: 1 Hz to[3] 40 Hz	40 Hz to[3] 1 kHz	1 kHz to[3] 20 kHz	20 kHz to[3] 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz	300 kHz to 1 MHz	1 MHz to 2 MHz
10 mV	0.03 + 0.03	0.02 + 0.011	0.03 + 0.011	0.1 + 0.011	0.5 + 0.011	4.0 + 0.02		
100 mV–10 V	0.007 + 0.004	0.007 + 0.002	0.014 + 0.002	0.03 + 0.002	0.08 + 0.002	0.3 + 0.01	1 + 0.01	1.5 + 0.01
100 V	0.02 + 0.004	0.02 + 0.002	0.02 + 0.002	0.035 + 0.002	0.12 + 0.002	0.4 + 0.01	1.5 + 0.01	
1000 V	0.04 + 0.004	0.04 + 0.002	0.06 + 0.002	0.12 + 0.002	0.3 + 0.002			

1. Additional error beyond ±1°C, but within + 5°C of last ACAL.
   For ACBAND > 2 MHz, use 10 mV range temperature coefficient for all ranges.
2. Specifications apply full scale to 10% of full scale, DC < 10% of AC, sine wave input, crest factor = 1.4, and PRESET. Within 24 hours and ±1°C of last ACAL. Lo to Guard Switch on.
   Peak (AC + DC) input limited to 5 x full scale for all ranges in ACV function.
   Add 2 ppm of reading additional error for Agilent factory traceability of 10 V DC to US NIST.
3. LFILTER ON recommended.

AC Accuracy (continued): 24 Hour to 2 Year (% of Reading + % of Range)

	ACBAND >2 MHz				
Range	**45 Hz to 100 kHz**	**100 kHz to 1 MHz**	**1 MHz to 4 MHz**	**4 MHz to 8 MHz**	**8 MHz to 10 MHz**
10 mV	0.09 + 0.06	1.2 + 0.05	7 + 0.07	20 + 0.08	
100 mV – 10 V	0.09 + 0.06	2.0 + 0.05	4 + 0.07	4 + 0.08	15 + 0.1
100 V	0.12 + 0.002				
1000 V	0.3 + 0.01				

Transfer Accuracy

Range	% of Reading
100 mV – 100 V	(0.002 + Resolution in %)[1]

Conditions
- Following 4 Hour warm-up
- Within 10 min and ±0.5°C of the reference measurement
- 45 Hz to 20 kHz, sine wave input
- Within ±10% of the reference voltage and frequency

1. Resolution in % is the value of RES command or parameter (reading resolution as percentage of measurement range).

AC + DC Accuracy (ACDCV Function)

For ACDCV Accuracy apply the following additional error to the ACV accuracy. (% of Range)

DC <10% of AC Voltage Range	ACBAND ≤ 2 MHz	ACBAND > 2 MHz	Temperature Coefficient [2]
10 mV	0.09	0.09	0.03
100 mV – 1000 V	0.008	0.09	0.0025

DC >10% of AC Voltage Range	ACBAND ≤ 2 MHz	ACBAND > 2 MHz	Temperature Coefficient [2]
10 mV	0.7	0.7	0.18
100 mV – 1000 V	0.07	0.7	0.025

2. Additional error beyond ±1°C, but within ±5°C of last ACAL. (% of Range)/°C. For ACBAND >2 MHz, use 10 mV range temperature coefficient. Lo to Guard switch on.

Additional Errors

Apply the following additional errors as appropriate to your particular measurement setup. (% of Reading)

	Input Frequency [3]			
Source R	**0–1 MHz**	**1-4 MHz**	**4–8 MHz**	**8–10 MHz**
0 Ω	0	2	5	5
50 ΩTerminated	0.003	0	0	0
75 ΩTerminated	0.004	2	5	5
50 Ω	0.005	3	7	10

Crest Factor	Resolution Multiplier [1]
1–2	(Resolution in%) × 1
2–3	(Resolution in%) × 2
3–4	(Resolution in%) × 3
4–5	(Resolution in%) × 5

3. Flatness error including instrument loading.

Reading Rates [4]

ACBAND Low	Maximum Sec / Reading
1 – 5 Hz	6.5
5 – 20 Hz	2.0
20 – 100 Hz	1.2
100 – 500 Hz	0.32
>500 Hz	0.02

% Resolution	Maximum Sec / Reading
0.001 – 0.005	32
0.005 – 0.01	6.5
0.01 – 0.05	3.2
0.05 – 0.1	0.64
0.1 – 1	0.32
>1	0.1

4. Reading time is the sum of the Sec / Reading shown for your configuration. The tables will yield the slowest reading rate for your configuration. Actual reading rates may be faster. For DELAY– 1; ARANGE OFF.

Settling Characteristics

There is no instrument settling required.

Common Mode Rejection

For 1 kΩ imbalance in LO lead, > 90 dB, DC to 60 Hz.

High Frequency Temperature Coefficient

For outside Tcal ±5°C add the following error. (% of Reading)/°C

	Frequency	
Range	**2 – 4 MHz**	**4 – 10 MHz**
10 mV – 1 V	0.02	0.08
10 V – 1000 V	0.08	0.08

Maximum Input

	Rated Input	**Non-Destructive**
HI to LO	±1000 V pk	±1200 V pk
LO to Guard	±200 V pk	±350 V pk
Guard to Earth	±500 V pk	±1000 V pk
Volt – Hz Product	$1x10^8$	

Analog Mode (ACV Function, SETACV ANA)

Range	Full Scale	Maximum Resolution	Input Impedance	Temperature Coefficient [1] (% of Reading+ % of Range) / °C
10 mV	12.00000	10 nV	1 MΩ±15% with<140pF	0.003 + 0.006
100 mV	120.0000	100 nV	1 MΩ±15% with<140pF	0.002 + 0
1 V	1.200000	1 µV	1 MΩ±15% with<140pF	0.002 + 0
10 V	12.00000	10 µV	1 MΩ±2% with<140pF	0.002 + 0
100 V	120.0000	100 µV	1 MΩ±2% with<140pF	0.002 + 0
1000 V	700.000	1 mV	1 MΩ±2% with<140pF	0.002 + 0

1. Additional error beyond ±1°C, but within ±5°C of last A CAL.
2. Specifications apply full scale to 1/20 full scale, sinewave input, crest factor = 1.4, and PRESET. Within 24 hours and ±1°C of last ACAL, Lo to Guard switch on to.

   Maximum DC is limited to 400 V in ACV function.

   Add 2 ppm of reading additional error for factory traceability of 10V DC to US NIST.

ACAccuracy [2]

24 Hour to 2 Year (% Reading + % Range)

Range	10Hz to 20 Hz	20 Hz to 40 Hz	40 Hz to 100 Hz	100 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 250 kHz	250 kHz to 500 kHz	500 kHz to 1 MHz	1 MHz to 2 MHz
10 mV	0.4 + 0.32	0.15 +0.25	0.06 +0.25	0.02 + 0.25	0.15 + 0.25	0.7 + 0.35	4 + 0.7			
100 mV–10 V	0.4 + 0.02	0.15 +0.02	0.06 + 0.01	0.02 + 0.01	0.15 + 0.04	0.6 + 0.08	2 + 0.5	3 + 0.6	5+2	10+5
100 V	0.4 + 0.02	0.15 +0.02	0.06 + 0.01	0.03 + 0.01	0.15 + 0.04	0.6 + 0.08	2 + 0.5	3 + 0.6	5+2	
1000 V	0.42+0.03	0.17 +0.03	0.08 + 0.02	0.06 + 0.02	0.15 + 0.04	0.6 + 0.2				

AC+ DC Accuracy (ACDCV Function)

For ACDCV Accuracy apply the following additionat error to the ACV accuracy. (% of Reading + % of Range)

	DC < 10% of AC Voltage		DC >10% of AC Voltage	
Range	**Accuracy**	**Temperature Coefficient[3]**	**Accuracy**	**Temperature Coefficient [3]**
10 mV	0.0 + 0.2	0 + 0.015	0.15 + 3	0 + 0.06
100 mV–1000 V	0.0 + 0.02	0 + 0.001	0.15 + 0.25	0 + 0.007

3. Additional error beyond ±1°C, but within ±5°C of last ACAL, (% of Reading + % of Range) / °C.

Additional Errors

Apply the following additional errors as appropriate to your particular measurement setup.

LOW Frequency Error (% of Reading)

	ACBAND Low		
Signal Frequency	**10 Hz–1 kHz NPLC >10**	**1–10 kHz NPLC >1**	**>10 kHz NPLC> 0.1**
10–200 Hz	0		
200–500 Hz	0	0.15	
500–1 kHz	0	0.015	0.9
1–2 kHz	0	0	0.2
2–5 kHz	0	0	0.05
5–10 kHz	0	0	0.01

Crest Factor Error (% of Reading)

Crest Factor	Additional Error
1–2	0
2–3	0.15
3–4	0.25
4–5	0.40

Reading Rates [1]

		Sec / Reading	
ACBAND Low	NPLC	ACV	ACDCV
≥10 Hz	10	1.2	1
≥1 kHz	1	1	0.1
≥10 kHz	0.1	1	0.02

1. For DELAY–1: ARANGE OFF

   For DELAY 0; NPLC .1 , unspecified reading rates of greater than 500/Sec are possible.

Settling Characteristics

For first reading or range change error using default delays, add .01% of input step additional error.
The following data applies for DELAY 0.

Function	ACBAND Low	DC Component	Settling Time
ACV	≥ 10 Hz	DC < 10% AC	0.5 sec to 0.01%
		DC > 10% AC	0.9 sec to 0.01%
ACDCV	10 Hz–1 kHz		0.5 sec to 0.01%
	1 kHz–10 kHz		0.08 sec to 0.01%
	≥10 kHz		0.015 sec to 0.01%

Maximum Input

	Related Input	Non-Destructive
HI to LO	±1000 V pk	±1200 V pk
LO to Guard	±200 V pk	± 350 V pk
Guard to Earth	± 500 V pk	±1000 V pk
Volt – Hz Product	1×10^8	

Common Mode Rejection

For 1 kΩ imbalance in LO lead, > 90 dB, DC – 60 Hz.

Random Sampled Mode (ACV Function, SETACV RNDM)

Range	Full Scale	Maximum Resolution	Input Impedance	(Temperature Coefficients[2] % of Reading+% of Range)/°C
10 mV	12.000	1 µV	1 MΩ ±15% with<140 pF	0.002 + 0.02
100 mV	120.00	10 µV	1 MΩ ±15% with<140 pF	0.001 + 0.0001
1 V	1.2000	100 µV	1 MΩ ±15% with<140 pF	0.001 + 0.0001
10 V	12.000	1 mV	1 MΩ ±2% with<140 pF	0.001 + 0.0001
100 V	120.00	10 mV	1 MΩ ±2% with<140 pF	0.0015 + 0.0001
1000 V	700.0	100 mV	1 MΩ ±2% with<140 pF	0.001 + 0.0001

2. Additional error beyond±1° C. but within ±5°C of last ACAL.

   For ACBAND > 2 MHz, use 10 mV range temperature coefficient for all ranges.

AC Accuracy [3]

24 Hour to 2 Year (% of Reading + % of Range)

	ACBAND ≤ 2 MHz				ACBAND > 2 MHz				
Range	20 Hz to 100 kHz	100 kHz to 300 kHz	300 kHz to 1 MHz	1 MHz to 2 MHz	20 Hz to 100 kHz	100 kHz to 1 MHz	1 MHz to 4 MHz	4 MHz to 8 MHz	8 MHz to 10 MHz
10 mV	0.5+0.02	4+0.02			0.1+0.05	1.2+0.05	7 + 0.07	20 + 0.08	
100 mV-10 V	0.08+0.002	0.3+0.01	1+0.01	1.5+0.01	0.1 +0.05	2+0.05	4 + 0.07	4 + 0.08	15 + 0.1
100 V	0.12+0.002	0.4+0.01	1.5+0.01		0.12+0.002				
1000 V	0.3+0.01				0.3+0.01				

3. Specifications apply from full scale to 5% of full scale. DC < 10% of AC, sine wave input, crest factor=1.4, and PRESET. Within 24 hours and ±1°C of last ACAL. LO to Guard switch on.

   Add 2 ppm of reading additional error for Agilent factory traceability of 10V DC to US NIST.

   Maximum DC is limited to 400V in ACV function.

AC + DCV Accuracy (ACDCV Function)

For ACDCV Accuracy apply the following additional error to the ACV accuracy. (% of Range).

	DC ≤10% of AC Voltage			DC >10% of AC Voltage		
Range	ACBAND ≤ 2 MHz	ACBAND >2 MHz	Temperature Coefficient [1]	ACBAND ≤ 2 MHz	ACBAND >2 MHz	Temperature Coefficient[1]
10 mV	0.09	0.09	0.03	0.7	0.7	0.18
100 mV–1 kV	0.008	0.09	0.0025	0.07	0.7	0.025

1. Additional error beyond ±1°C, but within ±5°C of last ACAL. (% of Reading) / °C.
   For ACBAND > 2 MHz, use 10 mV range temperature coefficient for all ranges.

Additional Errors

Apply the following additional errors as appropriate to your particular measurement setup. (% of Reading)

	Input Frequency[2]			
Source R	0–1 MHz	1–4 MHz	4–8 MHz	8–10 MHz
0 Ω	0	2	5	5
50 Ω Terminated	0.003	0	0	0
75 Ω Terminated	0.004	2	5	5
50 Ω	0.005	3	7	10

Crest Factor	Resolution MultIplier
1–2	(Resolution in %) × 1
2–3	(Resolution in %) × 3
3–4	(Resolution in %) × 5
4–5	(Resolution in %) × 8

2. Flatness error including instrument loading.

Reading Rates [3]

	Sec/Reading	
% Resolution	ACV	ACDCV
0.1 – 0.2	40	39
0.2 – 0.4	11	9.6
0.4 – 0.6	2.7	2.4
0.6 – 1	1.4	1.1
1 – 2	0.8	0.5
2 – 5	0.4	0.1
>5	0.32	0.022

3. For DELAY –1;ARANGE OFF. For DELAY 0 in ACV, the reading rates are identical to ACDCV.

High Frequency Temperature Coefficient

For outside Tcal ±5°C add the following error.
(% of Reading) / °C

Range	2– 4 MHz	4– 10 MHz
10 mV – 1 V	0.02	0.08
10 V – 1000 V	0.08	0.08

Settling Characteristics

For first reading or range change error using default delays, add 0.01% of input step additional error. The following data applies for DELAY 0.

Function	DC Component	Settling Time
ACV	DC < 10% of AC	0.5 sec to 0.01%
	DC > 10% of AC	0.9 sec to 0.01%
ACDCV	No instrument settling required.	

Common Mode Rejection

For 1 kΩ imbalance in LO lead, > 90 dB, DC to 60 Hz.

Maximum Input

	Rated Input	Non-Destructive
HI to LO	±1000 V pk	±1200 V pk
LO to Guard	± 200 V pk	± 350 V pk
Guard to Earth	± 500 V pk	±1000 V pk
Volt – Hz Product	1×10^8	

5 / AC Current

AC Current (ACI and ACDCI Functions)

Range	Full Scale	Maximum Resolution	Shunt Resistance	Burden Voltage	Temperature Coefficient [1] (% of Reading + % of Range) / °C
100 µA	120.0000	100 pA	730 Ω	0.1 V	0.002+0
1 mA	1.200000	1 nA	100 Ω	0.1 V	0.002+0
10 mA	12.00000	10 nA	10 Ω	0.1 V	0.002+0
100 mA	120.0000	100 nA	1 Ω	0.25 V	0.002+0
1 A	1.050000	1 µA	0.1 Ω	< 1.5 V	0.002+0

AC Accuracy [2]

24 Hour to 2 Year (% Reading + % Range)

Range	10 Hz to 20 Hz	20 Hz to 45 Hz	45 Hz to 100 Hz	100 Hz to 5 kHz	5 kHz to 20 kHz[3]	20 kHz to 50 kHz[3]	50 kHz to 100 kHz[3]
100 µA[4]	0.4+0.03	0.15+0.03	0.06+0.03	0.06+0.03			
1 mA – 100 mA	0.4+0.02	0.15+0.02	0.06+0.02	0.03+0.02	0.06+0.02	0.4 +0.04	0.55+0.15
1 A	0.4+0.02	0.16+0.02	0.08+0.02	0.1+0.02	0.3+0.02	1+0.04	

AC + DC Accuracy (ACDCI Function)

For ACDCI Accuracy apply the following additional error to the ACI accuracy.
(% of Reading + % of Range).

DC≤10% of AC Accuracy	Temperature Coefficient [5]	DC>10% of AC Accuracy	Temperature Coefficient [5]
0.005+0.02	0.0+.001	0.15+0.25	0.0+0.007

Additional Errors

Apply the following additional errors as appropriate to your particular measurement setup.

LOW Frequency Error (% of Reading)

Signal Frequency	ACBAND Low 10 Hz-1 kHz NPLC >10	1 to 10 kHz NPLC >1	>10 kHz NPLC >0.1
10–200 Hz	0		
200–500 Hz	0	0.15	
500–1 kHz	0	0.015	0.9
1–2 kHz	0	0	0.2
2–5 kHz	0	0	0.05
5–10 kHz	0	0	0.01

Crest Factor Error (% of Reading)

Crest Factor	Additional Error
1 – 2	0
2 – 3	0.15
3 – 4	0.25
4 – 5	0.40

Reading Rates [6]

ACBAND Low	NPLC	Maximum Sec / Reading ACI	ACDCI
≥ 10 Hz	10	1.2	1
≥1 kHz	1	1	0.1
≥10 kHz	0.1	1	0.02

1. Additional error beyond ±1°C, but within ±5°C of last ACAL.
2. Specifications apply full scale to 1/20 full scale, for sine wave inputs, crest factor = 1.4, and following PRESET within 24 hours and ±1°C of last ACAL.

   Add 5 ppm of reading additonal error for Agilent factory traceabiltiy to US NIST. Traceability is the sum of the 10V and 10 kΩ traceability values.
3. Typical performance
4. 1 kHz maximum on the 100 µA range.
5. Additional error beyond ±1°C, but within ±5°C of last ACAL (% of Reading + % of Range) /° C.
6. For DELAY–1; ARANGE OFF. For DELAY 0; NPLC.1, unspecified reading rates of greater than 500/sec are possible.

Settling Characteristics

For first reading or range change error using default delays, add .01% of input step additional error for the 100 µA to 100 mA ranges. For the 1 A range add .05% of input step additional error.
The following data applies for DELAY 0.

Function	ACBAND Low	DC Component	Settling Time
ACI	≥10 Hz	DC < 10% AC	0.5 sec to 0.01%
		DC > 10% AC	0.9 sec to 0.01%
ACDCI	10 Hz – 1 kHz		0.5 sec to 0.01%
	1 kHz – 10 kHz		0.08 sec to 0.01%
	≥10 kHz		0.015 sec to 0.01%

Maximum Input

	Rated Input	Non-Destructive
I to LO	± 1.5 A pk	< 1.25A rms
LO to Guard	± 200 V pk	± 350 V pk
Guard to Earth	± 500 V pk	± 1000 V pk

6 / Frequency/ Period

Frequency / Period Characteristics

	Voltage (AC or DC Coupled) ACV or ACDCV Functions[1]	Current (AC or DC Coupled) ACI or ACDCI Functions [1]
Frequency Range	1 Hz – 10 MHz	1 Hz – 100 kHz
Period Range	1 sec – 100 ns	1sec – 10 µs
Input Signal Range	700 V rms – 1 mV rms	1 A rms – 10 µA rms
Input Impedance	1 MΩ±15% with<140 pF	0.1 – 730 Ω[2]

Accuracy

Range	24 Hour- 2 Year 0°C-55°C
1 Hz–40 Hz **1 s–25 ms**	0.05% ofReading
40 Hz – 10 MHz **25 ms–100 ns**	.01% ofReading

Reading Rates

Resolution	Gate Time[3]	Readings/sec[4]
0.00001%	1 s	0.95
>0.0001%	100 ms	9.6
> 0.001%	10 ms	73
> 0.01%	1 ms	215
> 0.1%	100 µs	270

Measurement Technique:
Reciprocal Counting
Time Base:
10 MHz ± 0.01%, 0°C to 55°C
Level Trigger:
±500% of Range in 5% steps

Trigger Filter:
Selectable 75 kHz Low Pass Trigger Filter
Slope Trigger:
Positive or Negative

1. The source of frequency measurements and the measurement input coupling are determined by the FSOURCE command.
2. Range dependent, see ACI for specific range impedance values.
3. Gate Time is determined by the specified measurement resolution.
4. For Maximum Input specified to fixed range operation. For auto range, the maximum speed is 30 readings/sec for ACBAND ≥ 1 kHz.

   Actual Reading Speed is the longer of 1 period of the input, the chosen gate time, or the default reading time-out of 1.2 sec.

11 / General Specifications

Operating Environment
Temperature Range: 0°C to 55°C
Operating Location: Indoor Use Only
Operating Altitude: Up to 2,000 Meters
Pollution Rating: IEC 664 Degree 2

Operating Humidity Range
up to 95% RH at 40°C

Physical Characteristics
88.9 mm H x 425.5 mm W x 502.9 mm D
Net Weight: 12 kg (26.5 lbs)
Shipping Weight 14.8 kg (32.5 lbs)

Storage Temperature
–40°C to + 75°C

Warm-Up Time
4 Hours to published specifications

Power Requirements
100/120 V, 220/240 V ±10%
48–66Hz, 360–420Hz (auto sensed)
<30 W, <80 VA (peak)
Fused: 1.5 @ 115 V or 0.5 A @230 V

Cleaning Guidelines
To clean the instrument, use a clean cloth slightly dampened with water.

Warranty Period
One year

Input Terminals
Gold-plated Tellurium Copper

Input Limits
Input HI to LO: 300 Vac Max (CAT II)

IEEE-488 Interface
Complies with the following:
IEEE-488.1 Interface Standard
IEEE-728 Codes/Formats Standard
CIIL (Option 700)

Included with Agilent 3458A:
Test Lead Set (Agilent 34118A)
Power Cord
User's Guide
Calibration Manual
Assembly Level Repair Manual
Quick Reference Guide

Field Installation Kits		Agilent Part Number
Option 001	Extended Reading Memory	03458-87901
Option 002	High Stability Reference	03458-80002
Extra Keyboard Overlays (5 each)		03458-84303

Available Documentation	Agilent Part Number
Product Note 3458A-1: Optimizing Throughput and Reading Rate	5953-7058
Product Note 3458A-2: High Resolution Digitizing with the 3458A	5953-7059
Product Note 3458A-3: Electronic Calibration of the 3458A	5953-7060
Extra Manual Set	03458-90000