

7.3 DC Voltage Specifications

7.3.1 DC Voltage Accuracy

Voltage Output	Accuracy ^[6] $\pm(\% \text{ of Output} + \text{Floor})$ 1Year — Tcal $\pm 5^\circ\text{C}$ ^[1]	Compliance Current
0V - 320.0mV	0.006% + 4.16 μ V	< 6mA
0.32V - 3.2V	0.006% + 41.6 μ V	< 6mA
3.2V - 32.0V	0.0065% + 416 μ V	< 20mA
32.0V - 320.0V	0.0065% + 4.48mV	< 6mA
320.0V - 1050.0V	0.006% + 19.95mV	< 6mA

7.3.2 DC Voltage Value Spans vs Resolution

Absolute Resolution	Span of Values
1 μ V	-320.000 mV to +320.000 mV
10 μ V	-3.20000 V to +3.20000 V
100 μ V	-32.0000 V to +32.0000 V
1mV	-320.000 V to +320.000 V
10mV	-1050.00 V to +1050.00 V

7.3.3 Other DCV Specifications

Settling Time:	to within 10% of accuracy: 0.08s
Load Regulation:	For loads <2M Ω : add (1400/R _{LOAD}) % of output
Maximum Capacitance:	1000pF.

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C
 [6] For loads < 2M Ω : add load regulation error.

7.4 AC Voltage Specifications

7.4.1 AC Voltage Accuracy

Voltage Output	Frequency Band ^[2] (Hz)	Accuracy ^[4] $\pm$ (% Output + Floor) 1 Year — Tcal ^[1] $\pm$ 5°C	Current Compliance	Total Harmonic Distortion (% of Output)
0V - 10.0mV	10 - 3k	0.04 + 384 μ V	6mA	0.06
	3k - 10k	0.04 + 512 μ V	6mA	0.10
	10k - 30k	0.06 + 960 μ V	6mA	0.13
	30k - 50k	0.09 + 1.92mV	6mA	0.20
	50k - 100k	0.20 + 5.12mV	6mA	0.32
10.0mV - 32.0mV	10 - 3k	0.04 + 96.0 μ V	6mA	0.06
	3k - 10k	0.04 + 128 μ V	6mA	0.10
	10k - 30k	0.06 + 240 μ V	6mA	0.13
	30k - 50k	0.09 + 480 μ V	6mA	0.20
	50k - 100k	0.20 + 1.28mV	6mA	0.32
32.0mV - 320.0mV	10 - 3k	0.04 + 19.2 μ V	6mA	0.06
	3k - 10k	0.04 + 25.6 μ V	6mA	0.10
	10k - 30k	0.06 + 48.0 μ V	6mA	0.13
	30k - 50k	0.09 + 96.0 μ V	6mA	0.20
	50k - 100k	0.20 + 256 μ V	6mA	0.32
320.0mV - 3.2V	10 - 3k	0.04 + 192 μ V	6mA	0.06
	3k - 10k	0.04 + 256 μ V	6mA	0.10
	10k - 30k	0.06 + 480 μ V	6mA	0.13
	30k - 50k	0.09 + 960 μ V	6mA	0.20
	50k - 100k	0.20 + 2.56mV	6mA	0.32
3.2V - 32.0V	10 - 3k	0.04 + 1.92mV	20mA	0.10
	3k - 10k	0.06 + 2.56mV	20mA	0.10
	10k - 30k	0.08 + 4.80mV	20mA	0.16
	30k - 50k	0.15 + 9.60mV	20mA	0.20
	50k - 100k	0.35 + 32.0mV	20mA	0.32
32.0V - 105.0V	10 - 3k	0.04 + 6.30mV	20mA	0.10
	3k - 10k	0.06 + 8.40mV	20mA	0.10
	10k - 30k	0.08 + 15.8mV	20mA	0.16
	30k - 50k	0.15 + 31.5mV	20mA	0.20
	50k - 100k	0.35 + 105mV	20mA	0.32
105.0V - 320.0V	40 - 100	0.05 + 19.2mV	6mA	0.50
	100 - 1k	0.05 + 19.2mV	6mA	0.32
	1k - 3k	0.08 + 19.2mV	6mA	0.32
	3k - 10k	0.08 + 32.0mV	20mA	0.32
	10k - 20k	0.12 + 48.0mV	20mA	0.32
	20k - 30k	0.15 + 64.0mV	20mA	0.32
320.0V - 800.0V	40 - 100	0.05 + 63.0mV	6mA	0.50
	100 - 1k	0.05 + 63.0mV	6mA	0.32
	1k - 3k	0.08 + 63.0mV	6mA	0.32
	3k - 10k	0.08 + 105mV	20mA	0.32
	10k - 20k ^[3]	0.12 + 158mV	20mA	0.32
	20k - 30k ^[3]	0.15 + 210mV	20mA	0.32
800.0V - 1050.0V	40 - 100	0.05 + 126mV	6mA	0.50
	100 - 1k	0.05 + 126mV	6mA	0.32
	1k - 3k	0.08 + 126mV	6mA	0.32
	3k - 10k	0.08 + 210mV	20mA	0.32
	10k - 20k ^[3]	0.12 + 315mV	20mA	0.32

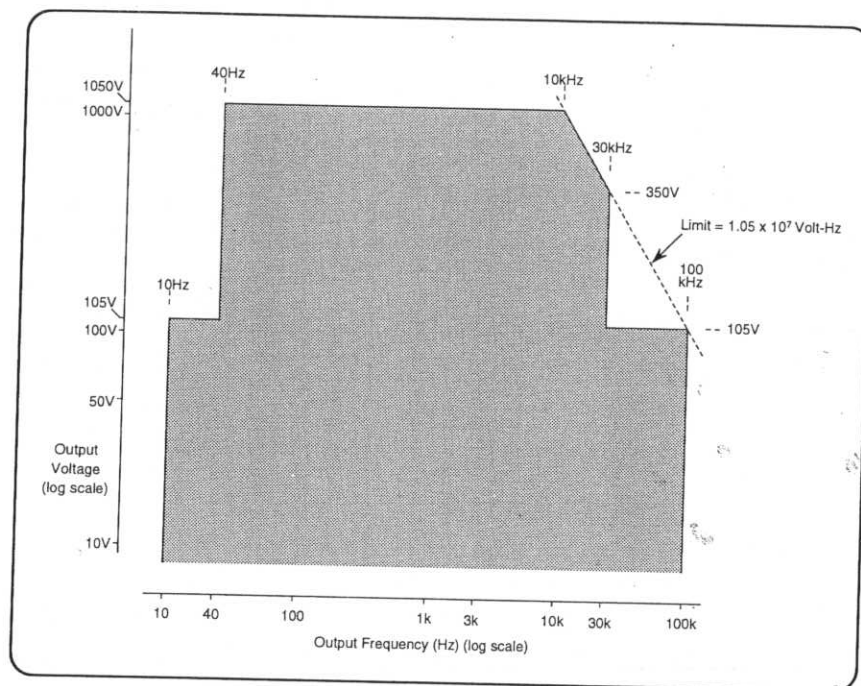
7.4.2 ACV Value Spans vs ACV Resolution

Absolute Resolution	Span of Values
1 μ V	000.000 mV to 320.000 mV
10 μ V	0.00000 V to 3.20000 V
100 μ V	00.0000 V to 32.0000 V
1mV	000.000 V to 320.000 V
10mV	0000.00 V to 1050.00 V

7.4.3 Frequency Spans vs Frequency Resolution

Absolute Resolution	Span of Frequencies
1mHz	010.000 Hz to 320.000 Hz
10mHz	0.01000 kHz to 3.20000 kHz
100mHz	00.0100 kHz to 32.0000 kHz
1Hz	000.010 kHz to 100.000 kHz

7.4.4 Volt-Hertz Profile



7.4.5 Other ACV Specifications

Settling Time (to within 10% of accuracy):
 $\leq 105V$: 0.08s
 $> 105V$: 0.5s

Load Regulation [5]:

For loads $< 1M\Omega$ $\leq 105V$ add:
 $[(1400/R_{LOAD}) + (C_{LOAD} \times F^2 \times 0.03)]$
 % of output

For loads $< 1M\Omega$ $> 105V$ add:
 $[(1400/R_{LOAD}) + (C_{LOAD} \times F^2 \times 0.19 + C_{LOAD} \cdot 3E7)]$
 % of output

Maximum Capacitance [5]:

1000pF; subject to Output Current Limitations at HF.

- NOTES:**
- [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C.
 - [2] Frequency Accuracy: 25ppm of output frequency.
 - [3] Availability of voltage and frequency combinations is subject to the Volt-Hertz limit (see V-Hz profile).
 - [4] For loads $< 1M\Omega$ add load regulation error.
 - [5] To calculate C_{LOAD} limit from Current compliance specification, while using 9005 lead set, allow $\approx 30pF$ for lead set.

7.5 DC Current Specifications

7.5.1 DC Current Accuracy

Current Output	Accuracy $\pm(\% \text{ of Output} + \text{Floor})$ 1Year — Tcal $\pm 5^\circ\text{C}$ [1]	Compliance Voltage (at 9000 terminals)	Compliance Voltage (at 9005 lead end)
0A - 320.0 μ A	0.020 + 16.0nA	4V	4V
0.32mA - 3.2mA	0.020 + 96nA	4V	4V
3.2mA - 32.0mA	0.020 + 1.28 μ A	4V	4V
32.0mA - 320.0mA	0.020 + 9.60 μ A	4V	4V
0.320A - 3.2A	0.065 + 160 μ A	1.7V	1.7V
3.2A - 10.5A	0.060 + 1.20mA	1.7V	1.4V
10.5A - 20.0A [7]	0.060 + 4.80mA	1.7V	1.4V

7.5.2 DC Current Value Spans vs Resolution

Absolute Resolution	Span of Values
1nA	-320.000 μ A to +320.000 μ A
10nA	-3.20000 mA to +3.20000 mA
100nA	-32.0000 mA to +32.0000 mA
1 μ A	-320.000 mA to +320.000 mA
1 μ A	-3.20000 A to +3.20000 A
10 μ A	-20.0000 A to +20.0000 A

7.5.3 Other DCI Specifications

Settling Time:	to within 10% of accuracy: 0.08s
Maximum Inductance:	0 - 3.2mA : 50 μ H 3.2mA - 320mA : 30 μ H 320mA - 3.2A : 18 μ H 3.2A - 10.5A : 5.5 μ H 10.5A - 20A : 2.5 μ H

NOTES:

[1] Tcal = temperature at calibration. Factory calibration temperature = 23°C

[7] With output 'ON', maximum duty cycle of (>10.5A : $\leq$ 10.5A) is (1 : 4). Continuous output >10.5A will automatically reduce to <10.5A after 2 Minutes.

7.6 AC Current Specifications

7.6.1 AC Current Accuracy

Current Output	Frequency Band [2] (Hz)	Accuracy [8] $\pm$ (% Output + Floor) 1 Year — Tcal [1] $\pm$ 5°C	Compliance Voltage (VRMS at 9000 terminals)	Compliance Voltage (VRMS at 9005 Lead End)	Total Harmonic Distortion (% of Output)	Compliance Error (A/V) for Vc > 0.5VRMS
0A - 32.0 μ A	10 - 3k	0.07 + 900nA	4V	4V	0.10	60nA/V
	3k - 10k	0.10 + 1.8 μ A	4V	4V	0.25	600nA/V
	10k - 20k	0.20 + 6.0 μ A	4V	4V	0.40	2.4 μ A/V
	20k - 30k	0.25 + 9.0 μ A	4V	4V	0.60	5.4 μ A/V
32.0 μ A - 3.2mA	10 - 3k	0.07 + 300nA	4V	4V	0.10	60nA/V
	3k - 10k	0.10 + 600nA	4V	4V	0.25	600nA/V
	10k - 20k	0.20 + 2.0 μ A	4V	4V	0.40	2.4 μ A/V
	20k - 30k	0.25 + 3.0 μ A	4V	4V	0.60	5.4 μ A/V
3.2mA - 32mA	10 - 3k	0.07 + 3.2 μ A	4V	4V	0.10	0.5 μ A/V
	3k - 10k	0.10 + 6.4 μ A	4V	4V	0.25	4 μ A/V
	10k - 20k	0.20 + 12.8 μ A	4V	4V	0.40	15 μ A/V
	20k - 30k	0.25 + 22.4 μ A	4V	4V	0.60	32 μ A/V
32mA - 320mA	10 - 3k	0.08 + 32.0 μ A	4V	4V	0.10	2 μ A/V
	3k - 10k	0.10 + 48.0 μ A	4V	4V	0.25	4 μ A/V
	10k - 20k	0.20 + 64.0 μ A	4V	4V	0.40	15 μ A/V
	20k - 30k	0.25 + 96.0 μ A	4V	4V	0.60	35 μ A/V
320mA - 3.2A	10 - 3k	0.10 + 480 μ A	1.2V	1.2V	0.20	90 μ A/V
	3k - 10k	0.25 + 2.56mA	1.2V	1.2V	1.10	600 μ A/V
3.2A - 10.5A	10 - 3k	0.20 + 3.0mA	1.2V	1.0V	0.20	0.3mA/V
	3k - 10k	0.50 + 10.0mA	1.2V	1.0V	1.10	2.1mA/V
10.5A - 20.0A [7]	10 - 3k	0.20 + 6.9mA	0.9V	0.5V	0.30	0.3mA/V
	3k - 10k	0.50 + 23.0mA	0.9V	0.5V	1.50	2.1mA/V

7.6.2 AC Current Value Spans vs AC Current Resolutions

Absolute Resolution	Span of Values (RMS)
1nA	000.000 μ A to 320.000 μ A
10nA	0.00000 mA to 3.20000 mA
100nA	00.0000 mA to 32.0000 mA
1 μ A	000.000 mA to 320.000 mA
10 μ A	0.00000 A to 3.20000 A
100 μ A	00.0000 A to 20.0000 A

7.6.3 Frequency Spans vs Frequency Resolutions

Absolute Resolution	Span of Frequencies
1mHz	010.000 Hz to 320.000 Hz
10mHz	0.01000 kHz to 3.20000 kHz
100mHz	00.0100 kHz to 30.0000 kHz

NOTES:

[1] Tcal = temperature at calibration. Factory calibration temperature = 23°C.

[2] Frequency Accuracy: 25ppm of output frequency.

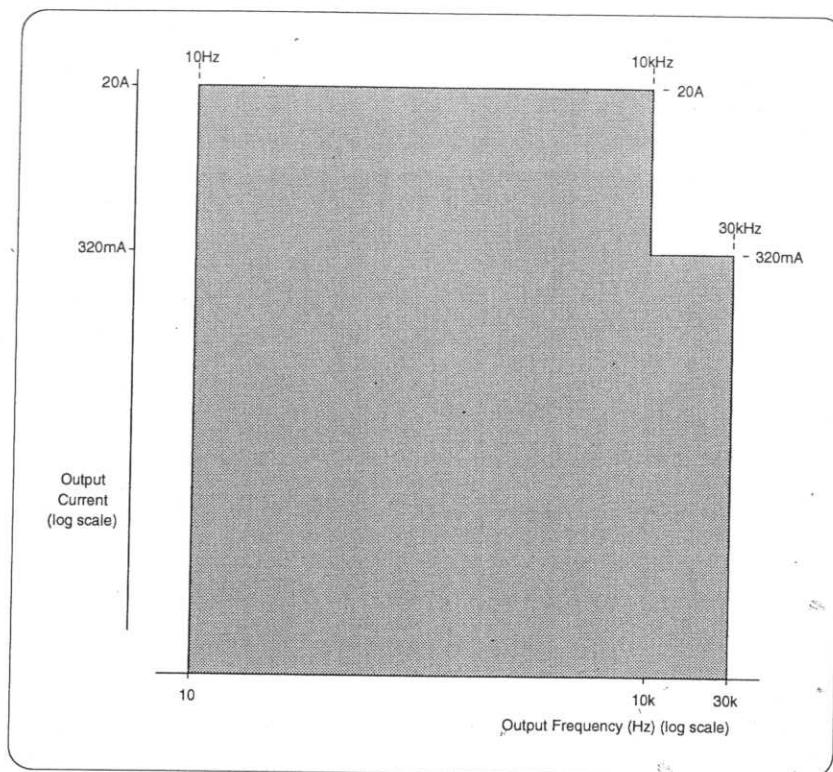
[7] With output 'ON', maximum duty cycle of (>10.5A : $\leq$ 10.5A) is (1 : 4). Continuous output >10.5A will automatically reduce to <10.5A after 2 Minutes.

[8] Total uncertainty includes compliance errors for Voltage $\leq$ 0.5VRMS. Above 0.5V, add appropriate compliance error.

(Other ACI Specifications overleaf)

7.6 AC Current Specifications (Contd.)

7.6.4 AC Current — Amp-Hertz Profile



7.6.5 Other ACI Specifications

Settling Time:	to within 10% of accuracy: 0.08s
Maximum Inductance:	0 - 3.2mA : 50μH 3.2mA - 320mA : 30μH 320mA - 3.2A : 18μH 3.2A - 10.5A : 5.5μH 10.5A - 20A : 2.5μH

7.7 Resistance Specifications

7.7.1 Resistance Accuracy

Resistance Output	Accuracy	
	(Low Source Current) $\pm(\% \text{ of Output} + \text{Floor})$ 1Year — Tcal $\pm 5^\circ\text{C}$ [1]	(High Source Current) $\pm(\% \text{ of Output} + \text{Floor})$ 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
0 Ω - 40.0 Ω	0.025 + 10.0m Ω	---
40.0 Ω - 400.0 Ω	0.020 + 20.0m Ω	0.015 + 20.0m Ω
400 Ω - 4.0k Ω	0.015 + 80.0m Ω	0.015 + 80.0m Ω
4k Ω - 40.0k Ω	0.025 + 800m Ω	0.015 + 800m Ω
40.0k Ω - 400.0k Ω	0.025 + 8.0 Ω	0.020 + 8.0 Ω
400.0k Ω - 4.0M Ω	0.065 + 200 Ω	0.025 + 200 Ω
4.0M Ω - 40.0M Ω	0.150 + 2.0k Ω	0.050 + 2.0k Ω
40.0M Ω - 400.0M Ω	0.260 + 40.0k Ω	0.060 + 40.0k Ω

7.7.2 Resistance Span vs Resolution

Absolute Resolution	Span of Values	
0.1m Ω	00.0000 Ω	to 40.0000 Ω
1m Ω	000.000 Ω	to 400.000 Ω
10m Ω	0.00000 k Ω	to 4.00000 k Ω
100m Ω	00.0000 k Ω	to 40.0000 k Ω
1 Ω	000.000 k Ω	to 400.000 k Ω
10 Ω	0.00000 M Ω	to 4.00000 M Ω
100 Ω	00.0000 M Ω	to 40.0000 M Ω
1k Ω	000.000 M Ω	to 400.000 M Ω

7.7.3 Constant Source Current — Low Current and High Current Limits

Hardware Configuration Limits on Span of Output Resistance	Constant Source Current Limits	
	HI CURRENT Off	HI CURRENT On
00.0000 Ω to 40.0000 Ω	0.25mA to 3.5mA	N/A
040.001 Ω to 400.000 Ω	25 μ A to 320 μ A	250 μ A to 3.5mA
0.40001 k Ω to 4.00000 k Ω	25 μ A to 320 μ A	250 μ A to 3.5mA
04.0001 k Ω to 40.0000 k Ω	2.5 μ A to 32 μ A	25 μ A to 350 μ A
040.001 k Ω to 400.000 k Ω	250nA to 3.2 μ A	2.5 μ A to 35 μ A
0.40001 M Ω to 4.00000 M Ω	25nA to 320nA	250nA to 3.5 μ A
04.0001 M Ω to 40.0000 M Ω	8nA to 32nA	25nA to 350nA
040.001 M Ω to 400.000 M Ω	4nA to 32nA	25nA to 200nA

7.7.4 Other Resistance Specifications

Maximum Measurement Voltage:	8V; $I_{\text{measure}} \times R_{\text{actual}} : \leq 8\text{V}$
Settling Time:	to within 10% of accuracy: 0 - 40k Ω : <0.08s 40k Ω - 4M Ω : <0.3s 4M Ω - 400M Ω : <1s
4-wire Lead Compensation:	Max total lead resistance : 50 Ω Nominal lead resistance rejection: 10000:1

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C

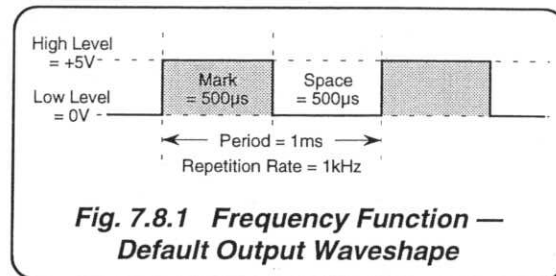
7.8 Frequency Function Specifications

7.8.1 Frequency Function Accuracy

Frequency Output	Accuracy $\pm$ (ppm of Output Frequency) 1Year — Tcal $\pm 5^{\circ}\text{C}$ [1]	Mark/Period Ratio (%)
0.5Hz - 10.0MHz	25.0	50

7.8.2 High and Low Voltage Limits and Voltage Accuracy

Frequency Span	Output Voltage V_o	Accuracy ($\pm$ Volts) 1Year — Tcal $\pm 5^{\circ}\text{C}$ [1]
0.5Hz to 10MHz	$V_o \leq 6\text{Vpk}$	0.06V
0.5Hz to 1kHz	$6\text{Vpk} < V_o \leq 30\text{Vpk}$	0.3V



7.8.3 Frequency Spans vs Frequency Resolution

Absolute Resolution	Span of Frequencies		Output Voltage	
			$\leq 6\text{Vpk}$	$> 6\text{Vpk}$
1mHz	000.500 Hz	to 320.000 Hz	*	*
10mHz	0.00050 kHz	to 1.00000 kHz	*	*
10mHz	1.00001 kHz	to 3.20000 kHz	*	---
100mHz	00.0005 kHz	to 32.0000 kHz	*	---
1Hz	000.001 kHz	to 320.000 kHz	*	---
10Hz	0.00001 MHz	to 3.20000 MHz	*	---
100Hz	00.0001 MHz	to 10.0000 MHz	*	---

7.8.4 Rise Times [9]

For signals $\leq 6\text{Vpk}$: <20ns.
For signals $> 6\text{Vpk}$: <1.5µs.

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C
[9] Specified into loads $R_L > 100\text{k}\Omega$ in parallel with $C_L \leq 150\text{pF}$.

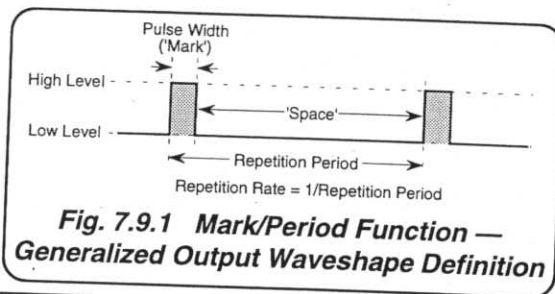
7.9 Mark/Period Function Specifications

7.9.1 Pulse Width and Repetition Period Intervals Accuracy

Output Voltage	Interval	Accuracy ±(% of Output + Floor) 1Year — Tcal ±5°C [1]
$V_o \leq 6V_{pk}$	Pulse Width: 0.30μs to 1999.99ms Repetition Period: 0.6μs to 2000ms	0.0025 + 10ns 0.0025
$6V_{pk} < V_o \leq 30V_{pk}$	Pulse Width: 10μs to 1999.99ms Repetition Period: 1ms to 2000ms	0.0025 + 200ns 0.0025

7.9.2 High and Low Voltage Limits and Voltage Accuracy

Output Voltage V_o	Accuracy (±Volts) 1Year — Tcal ±5°C [1]
$V_o \leq 6V_{pk}$	0.06V
$6V_{pk} < V_o \leq 30V_{pk}$	0.3V



7.9.3 Pulse Width Interval Spans vs Time Resolution

Absolute Resolution	≤6V pk	>6Vpk
100ns	000.3 μs to 999.9 μs*	010.00 μs to 990.0 μs**
100ns	00.0003 ms to 99.9999 ms*	00.0100 ms to 99.9999 ms**
1μs	000.001 ms to 999.999 ms	000.010 ms to 999.999 ms**
10μs	0000.01 ms to 1999.99 ms	0000.01 ms to 1999.99 ms

Notes * = Maximum Pulse Width interval must be at least 0.3μs less than that of the set Repetition Period.
 ** = Maximum Pulse Width interval must be at least 10μs less than that of the set Repetition Period.

7.9.4 Repetition Period Interval Spans vs Time Resolution

Absolute Resolution	≤6V pk	>6Vpk
100ns	000.6 μs to 999.9 μs	-----
100ns	00.0006 ms to 99.9999 ms	01.0000 ms to 99.9999 ms
1μs	000.001 ms to 999.999 ms	001.000 ms to 999.999 ms
10μs	0000.01 ms to 2000.00 ms	0001.00 ms to 2000.00 ms

7.9.5 Rise Times [9]

For signals ≤ 6Vpk: <20ns.
 For signals > 6Vpk: <1.5μs.

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C
 [9] Specified into loads $R_L > 100k\Omega$ in parallel with $C_L \leq 150pF$.

7.10 % Duty Cycle Function Specifications

7.10.1 Introduction

Duty Cycle is a derived (relative) quantity which describes the Pulse Width/Repetition Period ratio of a pulsed waveform, expressed in the 9000 as a percentage. The values of Pulse Width and Repetition Period will change with frequency, while maintaining the same percentage ratio.

Hardware limitations drive the % Duty Cycle to a limit only when the Pulse Width and Repetition Period intervals reach their individual limits at particular frequencies. This means that any accuracy specification must be expressed in terms of constituent time intervals.

7.10.2 '% Duty' Value: Screen Setting Limits

$$00.05\% \leq \% \text{ Duty} \leq 99.95\%$$

7.10.3 Repetition Period Interval Accuracy

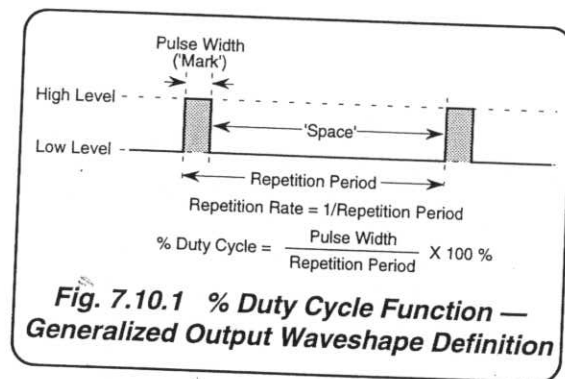
Output Voltage	Interval	Accuracy $\pm(\% \text{ of Output} + \text{Floor})$ 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
$V_o \leq 6\text{Vpk}$	100 μs to 2000ms	0.0025
$6\text{Vpk} < V_o \leq 30\text{Vpk}$	1ms to 2000ms	0.0025

7.10.4 Duty Cycle Accuracy

Output Voltage	Total Accuracy 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
$V_o \leq 6\text{Vpk}$	35ns
$6\text{Vpk} < V_o \leq 30\text{Vpk}$ [10]	225ns

7.10.5 High and Low Voltage Limits and Voltage Accuracy

Output Voltage V_o	Accuracy ($\pm$ Volts) 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
$V_o \leq 6\text{Vpk}$	0.06V
$6\text{Vpk} < V_o \leq 30\text{Vpk}$	0.3V



7.10.6 Repetition Period Interval Spans vs Time Resolution

Absolute Resolution	$\leq 6\text{Vpk}$		$> 6\text{Vpk}$	
100ns	100.0 μs	to 999.9 μs	-----	
100ns	00.1000 ms	to 99.9999 ms	01.0000 ms	to 99.9999 ms
1 μs	000.001 ms	to 999.999 ms	001.000 ms	to 999.999 ms
10 μs	0000.01 ms	to 2000.00 ms	0001.00 ms	to 2000.00 ms

7.10.7 Rise Times [9]

For signals $\leq 6\text{Vpk}$: $< 20\text{ns}$.
 For signals $> 6\text{Vpk}$: $< 1.5\mu\text{s}$.

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C .
 [9] Specified into loads $R_L > 100\text{k}\Omega$ in parallel with $C_L \leq 150\text{pF}$.
 [10] Minimum Mark or Space interval: $10\mu\text{s}$.

7.11 Auxiliary Functions — Specifications

The Functions listed below are described as 'Auxiliary Functions' because they do not have their own individual front panel hard keys, but instead are accessed via the front-panel 'Aux' hard key, by screen selection from the 'Auxiliary Functions' menu. Their specifications appear in the following sub-sections:

- 7.12 Capacitance Function Specifications
- 7.13 Conductance Function Specifications
- 7.14 K-Type Temperature Function Specifications
- 7.15 PRT Temperature Function Specifications
- 7.16 Logic Pulses Function Specifications
- 7.17 Logic Levels Function Specifications

7.12 Capacitance Specifications

7.12.1 Capacitance Accuracy

Capacitance Output	Accuracy ±(% of Output + Floor) 1Year — Tcal ±5°C [1]	
	Stim Repetition Rate ≤ 350Hz	Stim Repetition Rate 350Hz to 1.5kHz
0.5nF - 4.0nF	0.3 + 15pF	0.6 + 30.0pF
4.0nF - 40.0nF	0.3 + 30pF	0.6 + 60.0pF
40.0nF - 400.0nF	0.3 + 160pF	0.6 + 320pF
400nF - 4.0μF	0.4 + 1.6nF	0.8 + 3.2nF
4.0μF - 40.0μF	0.5 + 16.0nF	1.0 + 32.0nF
40.0μF - 400.0μF	0.5 + 160nF	1.0 + 320nF
400.0μF - 4.0mF	0.5 + 1.6μF	1.0 + 3.2μF
4.0mF - 40.0mF	1.0 + 60μF	2.0 + 120μF

7.12.2 Capacitance Span vs Resolution

Absolute Resolution	Span of Values	
0.1pF	0.5000 nF	to 4.0000 nF
1pF	00.500 nF	to 40.000 nF
10pF	000.50 nF	to 400.00 nF
100pF	0.0005 μF	to 4.0000 μF
1nF	00.001 μF	to 40.000 μF
10nF	000.01 μF	to 400.00 μF
100nF	0.0001 mF	to 4.0000 mF
1μF	00.001 mF	to 40.000 mF

7.12.3 Measurement and Discharge Current

Capacitance Output	Measurement Current Range	Maximum Discharge Current
0.5nF - 4.0nF	0.02μA to 500μA	1mA
4.0nF - 40.0nF	0.02μA to 500μA	5mA
40.0nF - 400.0nF	0.04μA to 1mA	10mA
400nF - 4.0μF	0.5μA to 1mA	10mA
4.0μF - 40.0μF	5μA to 3mA	10mA
40.0μF - 400.0μF	5μA to 3mA	10mA
400.0μF - 4.0mF	5μA to 3mA	10mA
4.0mF - 40.0mF	5μA to 3mA	10mA

7.12.4 Other Capacitance Specifications

Maximum Measurement Voltage:	±3.5V (except 40μF range which is limited to ±2.5V).
Settling Time:	to within 10% of accuracy : <0.08s
4-wire Lead Compensation:	Max total lead resistance : 10Ω

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C

7.13 Conductance Specifications

7.13.1 Conductance Accuracy

Conductance Output	Accuracy $\pm(\% \text{ Output})$ 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
2.5nS -25.0nS	0.40
25.0nS -250.0nS	0.20
250.0nS -2.5 μS	0.12
2.5 μS -25.0 μS	0.05
25.0 μS -250.0 μS	0.05
250.0 μS -2.5mS	0.04

7.13.2 Conductance Span vs Resolution

Absolute Resolution	Span of Values
0.1pS	02.5000 nS to 25.0000 nS
1pS	002.500 nS to 250.000 nS
10pS	0.00250 μS to 2.50000 μS
100pS	00.0025 μS to 25.0000 μS
1nS	000.002 μS to 250.000 μS
10nS	0.00001 mS to 2.00000 mS

7.13.3 Constant Source Current — Low Current and High Current Limits

Hardware Configuration Limits on Span of Output Conductance	Constant Current Source Limits	
	HI CURRENT Off	HI CURRENT ON
02.5000 nS to 25.0000 nS	4nA to 32nA	2.5nA to 200nA
025.001 nS to 250.000 nS	8nA to 32nA	25nA to 350nA
0.25001 μS to 2.50000 μS	25nA to 320nA	250nA to 3.5 μA
02.5001 μS to 25.0000 μS	250nA to 3.2 μA	2.5 μA to 35 μA
025.001 μS to 250.000 μS	2.5 μA to 32 μA	25 μA to 350 μA
0.25001 mS to 2.00000 mS	25 μA to 320 μA	250 μA to 3.5mA

7.13.4 Other Conductance Specifications

Maximum Measurement Voltage:	8V; $I_{\text{measure}} / U_{\text{actual}} : \leq 8\text{V}$
Settling Time:	to within 10% of accuracy : 2.5nS - 250nS : <1s 250nS - 25 μS : <0.3s 25 μS - 2.5mS : <0.08s
4-wire Lead Compensation:	Max total lead resistance : 50 Ω Nominal lead resistance rejection: 10000:1

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C

7.14 K-Type Temperature Specifications

7.14.1 K-Type Temperature Accuracy

Temperature Output (Screen Resolution Shown)	Accuracy ^[11] [12] ±(% of Output + Floor) 1Year — Tcal ±5°C [1]
Celsius: -0250.0°C - -0150.0°C -0150.0°C - +1350.0°C	0.05 + 1.0°C 0.02 + 0.5°C

NOTE: To calculate the Model 9000's accuracy in °F (Fahrenheit) or K (Kelvin) proceed as follows:-

1. Convert the temperature in °F or K to °C using one of the following formulae as appropriate:

$$^{\circ}\text{C} = \text{K} - 273$$

$$^{\circ}\text{C} = \frac{(^{\circ}\text{F} - 32) \times 5}{9}$$

2. Calculate the Model 9000's accuracy ($\Delta^{\circ}\text{C}$) at this °C temperature from the accuracy table above.
3. Convert $\Delta^{\circ}\text{C}$ back to °F or K using one of the following formulae as appropriate:

$$\Delta\text{K} = \Delta^{\circ}\text{C}$$

$$\Delta^{\circ}\text{F} = \frac{\Delta^{\circ}\text{C} \times 9}{5}$$

Example:

To calculate accuracy at 2000°F

$$^{\circ}\text{C} = \frac{(2000 - 32) \times 5}{9} = 1093^{\circ}\text{C}$$

$$\Delta^{\circ}\text{C} = (0.02\% \times 1093) + 0.5 = 0.72^{\circ}\text{C}$$

$$\Delta^{\circ}\text{F} = \frac{0.72 \times 9}{5} = 1.30^{\circ}\text{F}$$

7.14.2 Other K-Type Specifications

Settling Time:	to within 10% of accuracy: 0.08s
Load Regulation:	(1400/R _{LOAD}) % of output
Maximum Capacitance:	1000pF.

- NOTES:** [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C.
 [11] K-type compensated output determined from pre-defined tables based on Type K Reference Table NIST Monograph 125.
 [12] For loads <1MΩ add load regulation error.

7.15 PRT Temperature Accuracy Specifications

7.15.1 PRT Temperature Accuracy

Temperature Output ^[13]	Accuracy ±(% of Output + Floor) 1Year — Tcal ±5°C ^[1]
Celsius: -200°C - +100°C +100°C - +850°C	0.00 + 0.15°C 0.00 + 0.30°C
Fahrenheit: -328°F - +212°F +212°F - +1562°F	0.00 + 0.27°F 0.00 + 0.54°F
Kelvin: 73K - 373K 373K - 1123K	0.00 + 0.15K 0.00 + 0.30K

7.15.2 Constant Source Current — Low Current and High Current Limits

Hardware Configuration Limits on Span of Output Resistance	Constant Source Current Limits	
	HI CURRENT Off	HI CURRENT On
00.0000 Ω to 40.0000 Ω 040.001 Ω to 400.000 Ω	0.25mA to 3.5mA 25μA to 320μA	N/A 250μA to 3.5mA

7.15.3 Other PRT Temperature Specifications

Maximum Measurement Voltage:	8V; $I_{\text{measure}} \times R_{\text{actual}} \leq 8V$
Settling Time:	to within 10% of accuracy: <0.08s
4-wire Lead Compensation:	Max total lead resistance : 50Ω Nominal lead resistance rejection: 10000:1

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C.

[13] Temperature vs Resistance curve is based on DIN 43760 Standard for temperature coefficient for platinum wire (mean $\alpha = 0.00385\Omega/\Omega/^{\circ}\text{C}$).

7.16 Logic-Pulses Function Specifications

7.16.1 Pulse Width and Repetition Period Intervals Accuracy

Interval	Accuracy $\pm(\% \text{ of Output} + \text{Floor})$ 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
Pulse Width: 0.30 μs to 1999.99ms	0.0025 + 10.0ns
Repetition Period: 0.6 μs to 2000.00ms	0.0025

7.16.3 Fixed High and Low Levels and Voltage — Accuracy

Selected Logic	Signal Level	Voltage	Accuracy ($\pm\text{Volts}$) 1Year — Tcal $\pm 5^\circ\text{C}$ [1]
TTL	High	+5.00 V	0.06
	Low	0.00 V	0.06
CMOS	High	+5.00 V	0.06
	Low	0.00 V	0.06
ECL	High	-0.90 V	0.06
	Low	-1.75 V	0.06

7.16.1 'Pulse Width' Interval vs Resolution

Absolute Resolution	Pulse Width
100ns	000.3 μs to 999.9 μs *
100ns	00.0003 ms to 99.9999 ms*
1 μs	000.001 ms to 999.999 ms
10 μs	0000.01 ms to 1999.99 ms

Notes * = Maximum Pulse Width interval must be at least 0.3 μs less than that of the set Repetition Period.

7.16.2 'Repetition Period' Interval vs Resolution

Absolute Resolution	Repetition Period
100ns	000.6 μs to 999.9 μs
100ns	00.0006 ms to 99.9999 ms
1 μs	000.001 ms to 999.999 ms
10 μs	0000.01 ms to 2000.00 ms

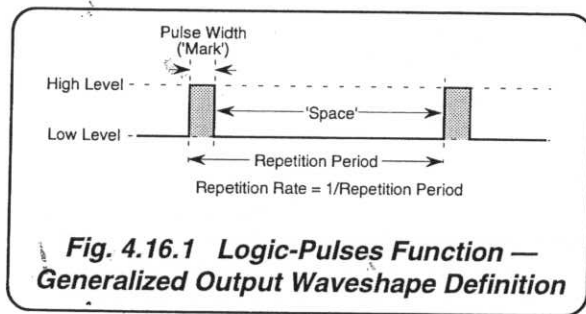


Fig. 4.16.1 Logic-Pulses Function — Generalized Output Waveshape Definition

NOTES: [1] Tcal = temperature at calibration. Factory calibration temperature = 23°C.

7.17 Logic-Levels Function Specifications

7.17.1 Logic-Levels Accuracy

The accuracy of each DC signal voltage is the same as that of the equivalent voltage in DC Voltage Function (*Sub-section 7.3*).

7.17.2 Logic-Levels DC Signal Voltage Boundaries

Logic Type	Signal Level	Screen Indication	Default Value ('H' or 'L')	Boundaries	Adjustment Limits
TTL	High	HIGH LVL	+5.00V	$V \geq +2.00V$	+5.50V
	Intermediate	-----	---	$+0.8V < V < +2.00V$	---
	Low	LOW LVL	0.00V	$V \leq 0.8V$	0.00V
CMOS	High	HIGH LVL	+5.00V	$V \geq +3.50V$	+6.00V
	Intermediate	-----	---	$+1.5V < V < +3.50V$	---
	Low	LOW LVL	0.00V	$V \leq 1.5V$	0.00V
ECL	High	HIGH LVL	-0.9V	$V \geq -1.11V$	0.00V
	Intermediate	-----	---	$-1.48V < V < -1.11V$	---
	Low	LOW LVL	-1.75V	$V \leq -1.48V$	-5.20V