

**FLUKE**

# DC Reference & Transfer Standards

## Automated Voltage Measurement System



## New technology sets standard for automated DC intercomparison



### **Integrated approach**

Although Direct Voltage is one of the fundamental measurement parameters in electrical metrology, no one has previously taken a fully integrated approach to the problem of Volt maintenance.

Within a compact bench or rack mount unit, the Fluke 7000 Volt Maintenance System combines multiple Voltage reference modules, high integrity hardware averaging, and advanced scanning and measurement technology. Of particular value to the modern commercial calibration laboratory is full automation of Volt maintenance. The 7000 achieves this through the optional 7050 Windows™ based software and a powerful Microsoft Excel™ add-in.

### **Automating the Volt**

Complete automation of Volt maintenance significantly reduces the burden and risk of error in maintaining fully traceable standards for the Volt. Most of the Volt maintenance systems currently in use consist of equipment and software from a

variety of manufacturers. This often leads to variability in set-up, difficulties in the management of expanded uncertainty and obtaining support for the system all of which results in inefficient use of time.

### **Patented technology**

The heart of the Fluke 7000 Series is the fully isolated, compact 7000 solid state 10V and 1.018V direct Voltage standard. Designed to be robust and portable, its internal batteries support *hot shipment* and *plug-in*. However, should complete power be lost at any time, patented Reference Conditioning technology overcomes reference device hysteresis and restores the last powered value to the module. The 7000 modules also feature patented DC-DC convertor technology, which achieves unparalleled isolation from the external AC-DC Line power adaptor. This makes the 7000 series particularly well suited to Josephson Junction direct comparison, as it speeds up intercomparison and reduces measurement uncertainty.

Ten, four and single housings are available for 7000 modules. The ten and four housings will accept either the Nanoscan or Transref units. The Nanoscan provides hardware averaging, a 4-wire buffer and remote control of its scan and measurement functions. The Transref provides a convenient hardware averaged output as well as the ability to access the output of individual modules using the Nanoscan System. The 70004T is an ideal product for support of transfers between single or multiple working standards at remote locations. Furthermore high isolation, low thermal EMF optical MOSFET technology is used to switch the output of each module through the housing backplane to the hardware average. Full reversal switching further ensures maximum rejection of thermal EMF offsets.



### Statistical methods and extended benefits

The 7000 Volt Maintenance System uses reversal scanning and statistical methods based on reference independence to reduce measurement uncertainty for each module. External DC references, including the Fluke 732A or 732B are well established and although of differing technology, can be included in the intercomparison process, either by direct connection to the Nanoscan module (one external input) or via multiple 7000S External Scan Modules. Furthermore a Nanoscan and a Transref unit can be linked together to form a powerful combination of Reference, Working and Transportable Standards. A measurement system will support a maximum of 21 internal or external Voltage references.

### Low-noise high-sensitivity

The Nanoscan unit contains a low-noise high-sensitivity null detector that compares individual 10-Volt reference outputs with

the hardware average of a selected group of 7000 Reference modules. The use of the hardware average provides for ultra low noise comparisons with external standards such as the Josephson Junction array. The Nanoscan is supplied with an optical fiber interface for direct connection to a PC via its RS232 port. Scan control and measurement analysis is provided by the 7050 software.

### Timed scan sequences

The 7050 Windows™ based software and its Microsoft Excel™ add-in completes the package and enables you to realize the full potential of 7000 System

automation. The software facilitates rapid installation, detection of hardware configuration and set-up, control and monitoring of complex scan sequences.

The values of the hardware average and the predicted value of each Voltage reference are computed, as are drift rates and associated uncertainties. Scan results can be transferred to Excel™ for further numerical and graphical analysis. The generation of reports, certificates and graphs as a result of importing and exporting traceability is also supported.



# Specifications

FLUKE



Model	7000/7001	7004N/T	7010N/T	732B	734A <sup>[1]</sup>
<b>10V Output</b>					
Stability ( $\pm$ ppm), 90 days	0.9	0.8	0.7	0.7	0.7
Stability ( $\pm$ ppm), 1 year	1.8	1.2	1.0	1.6	1.2
<b>Predictability</b>					
After 5 points, 3 mo. apart	$\pm 0.5$ ppm/year typ.	$\pm 0.2$ ppm/year typ.	$\pm 0.1$ ppm/year typ.	$\pm 0.4$ ppm/year typ.	$\pm 0.2$ ppm/year typ.
<b>Temperature Coefficient</b>					
(15 - 35°C)	< 0.05 ppm	< 0.03 ppm	< 0.02 ppm	< 0.04 ppm	< 0.04 ppm
<b>Noise</b>					
0.01 to 10Hz	< 0.10 ppm RMS	< 0.05 ppm RMS	< 0.03 ppm RMS	< 0.06 ppm RMS	< 0.03 ppm RMS
Std. dev. of 90 days regression	< 0.10 ppm RMS	< 0.06 ppm	< 0.04 ppm	< 0.065 ppm	< 0.04 ppm RMS
<b>Hysteresis recovery</b>					
(after battery discharge )	< 0.1 ppm <sup>[2]</sup>	< 0.1 ppm <sup>[2]</sup>	< 0.07 ppm <sup>[2]</sup>	0.2 ppm <sup>[3]</sup>	0.2 ppm <sup>[3]</sup>
<b>Output Current</b>					
	12 mA	12 mA	12 mA	12 mA	12 mA
<b>Output Resistance</b>					
	< 10 mOhm	125 Ohm <sup>[4]</sup>	50 Ohm <sup>[3]</sup>	< 1 mOhm	< 1 mOhm
<b>10V 4 wire Output</b> (relative to Average)					
<b>Output current</b>					
	n/a	12mA max.	12mA max.	n/a	n/a
<b>Load Regulation</b>					
Zero to 2mA	n/a	< 0.1 ppm	< 0.1 ppm	n/a	n/a
2mA to 12mA	n/a	< 0.5 ppm	< 0.5 ppm	n/a	n/a
<b>External Standard Input</b>					
Range:	n/a	+9.990 to +10.010V	+9.990 to +10.010V	n/a	n/a
Input Impedance	n/a	100 Mohm + 10pF	100 Mohm + 10pF	n/a	n/a
<b>Null Detector</b>					
Range:	n/a	-9999.9 to +9999.9 $\mu$ V	-9999.9 to +9999.9 $\mu$ V	n/a	n/a
<b>Measurement Errors</b>					
Chan. to Average:	n/a	$\pm 0.3\%$ of difference	$\pm 0.3\%$ of difference	n/a	n/a
Chan.to out of Ave.	n/a	$\pm 0.1\%$ of difference	$\pm 0.1\%$ of difference	n/a	n/a
External Standard	n/a	$\pm 0.001\%$	$\pm 0.001\%$	n/a	n/a
Chan. to Chan.	n/a	$\pm 0.1 \mu$ V	$\pm 0.1 \mu$ V	n/a	n/a
<b>Oven Temperature Monitor</b>					
Accuracy:	n/a	$\pm 3^\circ$ C	$\pm 3^\circ$ C	n/a	n/a
Stability/Repeatability:	n/a	$\pm 0.1^\circ$ C/year	$\pm 0.1^\circ$ C/year	n/a	n/a
<b>Battery Type</b>					
	NiMH	NiMH	NiMH	lead acid	lead acid
Back-up Period	16 hrs	16 hrs	16 hrs	72 hours	72 hours
Recharge time (typical)	2 hour	2 hour	2 hour	24 hours	24 hours
Half Life:	5 yrs.	5 yrs.	5 yrs.		
Reference conditioning (power loss recovery)	Yes	Yes	Yes	No	No
<b>Temperature</b>					
Operating	+15°C to 35°C	+15°C to 35°C	+15°C to 35°C	+15°C to 35°C	+15°C to 35°C
Transit	-18°C to 45°C	-18°C to 45°C	-18°C to 45°C	-40°C to 50°C	-40°C to 50°C
Warm-up period	10 min. to $\pm 0.1$ ppm of final output value	20 min to $\pm 0.2$ ppm 2 hours to final value	20 min to $\pm 0.2$ ppm 2 hours to final value	1 hour (power off for less than 1 hour)	1 hour (power off for less than 1 hour)
<b>Power</b>					
	< 1W	< 6W	< 12W	< 10W	< 40W
<b>Mechanical Dimensions</b>					
(H x W x D)	137 x 85 x 290 mm (3.5 x 2.1 x 11.4 in)	133 x 449 x 355 mm (5.24 x 17.68 x 13.19 in)	265 x 449 x 355 mm (10.43 x 17.68 x 13.19 in)	135 x 99 x 419 (5.3 x 3.9 x 16.5 in)	191 x 432 x 502 (7.5 x 17 x 19.75 in)
<b>Weight</b>					
	2.1kg (4.5lbs)	9.6kg (21.2lbs)	20kg (44.1lbs)	5.9 kg (13 lbs)	29.6 kg (65 lbs)
<b>General</b> Safety					
	UL3111 ; CE marked	UL3111 ; CE marked	UL3111 ; CE marked	UL1244 ; CE marked	UL1244 ; CE marked
	EN61010-1-1;1993	EN61010-1-1;1993	EN61010-1-1;1993	CSA C22.2 # 231	CSA C22.2 # 231
	/A2;1995 ; CETL	/A2;1995 ; CETL	/A2;1995 ; CETL	IEC 348 ; IEC 1010	IEC 348 ; IEC 1010

Notes: All specifications, including 732B, are stated with 98% Confidence Level

<sup>[1]</sup> 734A specifications are using a mathematical average of four cells.

<sup>[3]</sup> Conditioning not available. Specification assumes reference remains within a temp controlled environment.

<sup>[2]</sup> After conditioning cycle and maintained within environments down to 10°C.

<sup>[4]</sup> Actual resistance = 500/n, where n = number of references in the Average.

The simple and proven way to maintain and disseminate your volt



### **Established approach**

The 732B is a Direct Voltage standard with 10V and 1.018V outputs. The 734A consists of four 732Bs, that are mechanically and electrically isolated, housed in a rack-mountable enclosure.

The 734A is designed to be a direct Voltage standard for primary or secondary calibration and standard laboratories. Because it is made up of four independent standards, inter-comparisons of the standards and statistical methods can be used to reduce uncertainties significantly over time. Each 732B can be removed from the 734A and used as a portable standard to transfer a value from a primary 734A reference to remote service or production locations for traceability, without disturbing the primary reference.

### **Small, portable and rugged**

Each standard is small, light and rugged, ideal for shipment. The long 72-hour battery life allows the 732B to be shipped

over great distances under power. An optional external battery and charger extends battery life still further, to more than 130 hours.

The 732B is robust and can withstand a lot of abuse. The outputs can be shorted indefinitely and are protected up to 1100V DC, 25mA, without damaging the cell or affecting its output.

### **Confidence**

The 732B is based on the proven technology of the Fluke 732A. Thousands are now in service world wide in a variety of applications – from maintaining an institutional reference to transferring values from national labs or Josephson Arrays.

### **Stability**

Stability for each output is  $\pm 1.6$  ppm per year (10V) and  $\pm 0.6$  ppm per month (1.018V). Each 10V output can drive up to 12 mA of current to simplify use with instrumentation like the 5700A.

### **A fractional ppm Voltage reference for your facility**

With the 732B, the 734A, and now the 7000 Series it is remarkably easy to establish a fraction of a part-per-million Voltage reference in your laboratory. Over time, with frequent automated inter-comparison of cells, and regular calibrations on one or more cells, you can reduce the uncertainty of a four cell unit by a factor of 3 or more.

### **Artifact calibration package**

Combined with the Fluke 742A-1 and 742A-10k Resistance standards, a 732B, 7001 or 7004 make a tough and compact artifact calibration support package for instruments like the Fluke 5700A/5720A Calibrators or the Agilent 3458A Multimeter.

## Ordering Information

7001	Solid-State 10-Volt DC Voltage Reference with External Power Supply
7000	10-Volt DC Voltage Reference (compatible with Model 7001, Model 7004N/7010N and Model 7004T/7010T)
7004T	4-Reference Transref Volt Maintenance System with 12V DC Power Supply
7010T	10-Reference Transref Volt Maintenance System with 12V DC Power Supply
7004N	4-Reference Nanoscan Volt Maintenance System complete with Low-Thermal Lead Set, Interface Cabling for a second Nanoscan/Transref unit, Fiber-Optic Cabling for connection to a PC, and a 12V DC Power Supply (requires at least one Model 7000 10-volt Solid State DC Voltage Reference Module)
7010N	10-Reference Nanoscan Volt Maintenance System complete with Low-Thermal Lead Set, Interface Cabling for a second Nanoscan/Transref unit, Fiber-Optic Cabling for connection to a PC, and a 12V DC Power Supply (requires at least one Model 7000 10-volt Solid State DC Voltage Reference Module)
7000S	10-Volt External Reference Input Module (installs into a Model 7004N, 7010N, 7004T or 7010T chassis)
7050	Software - PC Windows™ based Software for Controlling 7004N/7010N Nanoscan Systems
732B	DC Standard. Output calibration optional.
734A	Reference Standard. Includes four 732Bs in a rack-width enclosure. Calibration of each 732B output optional. See Accessories and Options below.

## Accessories and Options

7001-65	Ruggedized Transit Case complete with Environmental Monitor (for 7001)
7004-65	Ruggedized Transit Case with Environmental Monitor (for 7004)
7000-742A	Artifact Resistance Standards comprising of 1x742A-1 Ohm and 1x742A-10K Ohm
732B-000	10V Output Voltage Calibration for one 732B, shipped hot*
732B-100	10V Output Voltage Calibration and Drift Rate Characterization for one 732B, shipped hot*
732A-7001	Enclosure. Holds up to four 732Bs.
732B-7001	External Battery and Charger
732B-7002	Transit Case. Holds one or two 732Bs, or one 732B and one 732B-7001 External Battery and Charger
5440B-7002	Low Thermal EMF Copper Plug-In Cables
Y734A	Rack-Mount Kit for 734A or 734A-7001

\*Under power

**Fluke. Keeping your world  
up and running.**

For more information call:

In the U.S.A.  
(800) 443-5853 or Fax (425) 356-5116

In Canada  
(800)-36-FLUKE or Fax (905) 890-6866

In Europe/M-East/Africa  
(31 40) 2 678 200 or Fax (31 40) 2 678 222

From other countries  
(425) 356-5500 or Fax (425) 356-5116

Fluke Corporation  
PO Box 9090, Everett,  
WA USA 98206

Web access: <http://www.fluke.com/>

©2000 Fluke Corporation. All rights reserved.  
Trademarks are the property of their respective owners.

DS249 / G0518NEN A / 1586169 B-ENG-N A