

**FLUKE®**

# **7000**

Volt Maintenance System

## Users Manual

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# Table of Contents

Chapter	Title	Page
	<b>Safety Issues .....</b>	<b>xi</b>
	General Safety Summary .....	xi
	Explanation of Safety Related Symbols and Terms .....	xi
	Protective Earth (Ground).....	xi
	Protection Class I.....	xi
	Do Not Operate Without Covers .....	xii
	Safe Operating Conditions .....	xii
	The Power Cable and Power Supply Disconnection .....	xii
	Instrument Terminal Connections .....	xii
	Installation Category I .....	xii
	Maintenance and Repair .....	xiii
	Moving .....	xiii
	Cleaning.....	xiii
<b>1</b>	<b>The 7000 Volt Maintenance System.....</b>	<b>1-1</b>
	Introduction.....	1-3
	Models 7004N and 7010N Nanoscan Systems.....	1-3
	Models 7004T and 7010T Transref Systems .....	1-3
	Model 7001 Stand-alone 10 V DC Voltage Reference.....	1-3
	Plug-In Modules .....	1-4
	Model 7000 Reference Module .....	1-4
	Model 7000S Scan Modules.....	1-4
	Power Supply.....	1-4
	Model 7004N .....	1-4
	Model 7010N .....	1-5
	Model 7004T.....	1-6
	Model 7010T.....	1-7
	Model 7001 .....	1-8
	Model 7050 Volt Maintenance Software .....	1-8
	5700 Series Artifact Calibration Support.....	1-8
	Model 7000 Reference Module Plug-in .....	1-9
	7000S 10 V Scan Module.....	1-10
	7000N Nanoscan Module.....	1-10
	7000T Transref Module.....	1-11

Operating Modes.....	1-11
Model 7004N and 7010N Nanoscan Systems .....	1-11
Model 7004T and 7010T Transref Systems .....	1-11
Model 7001.....	1-12
7000 Series Accessories and Spare Parts.....	1-12
Accessories.....	1-12
Spare Parts.....	1-12
7000 System General Specifications .....	1-13
Line Power Supply Adapter .....	1-13
12 V DC Power Supply.....	1-13
Mechanical (Excluding Line Power Adapter).....	1-14
Environmental Conditions.....	1-14
Miscellaneous.....	1-14
10 V Average Output.....	1-15
1 V Divided Output.....	1-15
4 Wire Buffer.....	1-16
External Standard Input .....	1-16
Null Detector.....	1-16
Temperature Monitor.....	1-16
7000 Reference Module.....	1-17
7000 Module - 10 V Output .....	1-17
7000 Module - Divided Output .....	1-17
7000 Module - General.....	1-18
7000S 10 V Scan Module .....	1-18
Contacting Fluke.....	1-18
<b>2 Installing the 7000 Series .....</b>	<b>2-1</b>
Introduction.....	2-3
Lifting and Carrying the 7000 Series.....	2-3
Lifting and Carrying from Bench Height .....	2-3
Lifting and Putting Down at Low Level.....	2-3
Unpacking and Inspection.....	2-3
Storage .....	2-3
Preparation for Shipment .....	2-4
Preparation for Operation .....	2-4
Rack Mounting .....	2-4
Power Input.....	2-4
Line Power Adapter.....	2-4
Initial System Configuration and Calibration .....	2-5
Connectors and Pin Designations .....	2-6
7000N Rear Panel Connections.....	2-6
Optical RS232 .....	2-6
12 V DC Power Input.....	2-7
Control Bus Out .....	2-8
Control Bus In.....	2-8
Signal Bus .....	2-9
Reverse.....	2-9
7000N Front Panel Connections.....	2-10
1 V Output.....	2-10
10 V Average Output .....	2-10
10 V 4 Wire Buffered Output.....	2-10
Case Terminal .....	2-11
External Standard Input.....	2-11
7000T Rear Panel Connections .....	2-12

Control Bus Input.....	2-12
12 V DC Power Input.....	2-12
Signal Bus .....	2-12
7000T Front Panel Connections .....	2-13
10 V Average Output .....	2-13
Case Terminal .....	2-13
Adding 7000 or 7000S Modules.....	2-14
Removing 7000 or 7000S Modules .....	2-14
<b>3      7000 Series Module Controls and Indicators.....</b>	<b>3-1</b>
Introduction.....	3-3
7000 Reference Module Front Panel .....	3-3
Front Panel Controls.....	3-3
In Average.....	3-3
Conditioning Enable.....	3-4
1.018 V or 1 V Output Selection.....	3-5
10 V Output Adjustment .....	3-5
Boost Charge.....	3-5
7000 Reference Module Indicators.....	3-6
Power OK.....	3-7
Lo Charge.....	3-7
Oven Fail.....	3-7
Conditioning.....	3-8
In Average.....	3-8
Selected .....	3-8
Indicator Summary Table.....	3-8
7000S 10 V Scan Module Front Panel Controls .....	3-9
7000S Front Panel Controls.....	3-9
7000S Front Panel Indicators .....	3-9
7000N Nanoscan Module Front Panel Controls .....	3-10
Front Panel Controls.....	3-10
Local.....	3-10
Hold.....	3-10
Up Down Channel Select .....	3-11
External Standard Select .....	3-11
Reverse.....	3-11
Include Reversal Switch.....	3-11
Front Panel Scan Status Display.....	3-12
Channel Field .....	3-12
Deviation Field.....	3-12
ID Number Field .....	3-12
Temperature Field .....	3-12
Miscellaneous Display Messages.....	3-13
7000T Transref Module Front Panel Controls.....	3-13
7001 Rear Panel- Earth Terminal .....	3-14
<b>4      Volt Maintenance Terminology and Practices.....</b>	<b>4-1</b>
Introduction.....	4-3
Laboratory Reference Standard .....	4-3
Transfer Standard .....	4-3
System Average.....	4-4
Switching 7000s In and Out of Average .....	4-4
Reversal Measurements.....	4-5
Data Capture.....	4-6

	Scanbase .....	4-7
	Scan ID No. ....	4-7
	Data Transfer .....	4-7
	Pre and Post Import Scans .....	4-7
	Volt Maintenance Practices .....	4-7
	Basic Procedures .....	4-8
	Basic Confidence .....	4-9
	Import Calibration.....	4-9
	Value of HAV (Hardware Average) .....	4-10
	Export Calibration.....	4-10
<b>5</b>	<b>Using the 7000 System - Manual Mode .....</b>	<b>5-1</b>
	Introduction.....	5-3
	Initial Settings .....	5-3
	Explanation of Channels Numbers .....	5-3
	Nanoscan Setup .....	5-3
	Measuring Differences.....	5-3
	Channel Difference - Forward Mode.....	5-4
	Channel Difference - Reverse Mode .....	5-4
	Import of Calibration .....	5-4
	Drift Rate Calculation.....	5-5
	Calculation of the HAV .....	5-5
	Export of Calibration .....	5-5
<b>6</b>	<b>Using the 7050 Volt Maintenance Software .....</b>	<b>6-1</b>
	Introduction.....	6-3
	Installing the 7050 Volt Maintenance Software .....	6-3
	Basic PC Requirements .....	6-3
	Computer Hardware .....	6-3
	Computer Software .....	6-3
	Installing the 7050 Software.....	6-4
	On Line Help .....	6-5
	Uninstalling the 7050 Software .....	6-5
	Software Dialogue Box Explanations.....	6-5
	Data Capture Application .....	6-5
	Starting the Data Capture Application .....	6-5
	Communications Port Setup.....	6-6
	PC COM Port Settings .....	6-6
	Data Scan Setup.....	6-7
	Delayed Start.....	6-8
	Scan Status .....	6-9
	Excel 'Fluke7050' Add-in (Accessing the Data Analysis Functions in Excel).....	6-10
	Captured Data Import.....	6-10
	HAV Maintenance .....	6-10
	Explanation of the Dialogue Controls.....	6-11
	Calculate HAV .....	6-14
	Drift Rate Calculator.....	6-15
	Perform Export - Information Entry.....	6-15
	Perform Export - Result .....	6-17
	Perform Import - Information Entry.....	6-17
	Perform Import - Result .....	6-20
	Produce Certificate.....	6-20
	Produce Report.....	6-21

Explanation of the Dialogue Controls..... 6-22  
Produce Graph..... 6-23  
Software Support ..... 6-24  
    United States..... 6-25  
    United Kingdom ..... 6-25

**Appendices**

A Routine Maintenance and Test..... A-1





# ***List of Tables***

<b>Table</b>	<b>Title</b>	<b>Page</b>
1-1.	Accessories.....	1-5
2-1.	7000N Nanoscan Module Connections.....	2-7
2-2.	Extension Bus Out Connections.....	2-8
2-3.	Signal Bus Connector Pins.....	2-9
2-4.	Reverse Connector Pins .....	2-10
3-1.	S1 Adjustment.....	3-3
3-2.	S2 Adjustment.....	3-4
3-3.	S5 Adjustment.....	3-5
3-4.	Power Up - Conditioning Enabled (as supplied from the manufacturer).....	3-7
3-5.	Power Up - Conditioning Disabled .....	3-7
3-6.	Power Down.....	3-8
3-7.	Include Reversal Switch Adjustment .....	3-10



# List of Figures

Figure	Title	Page
1-1.	Model 7004N .....	1-4
1-2.	Model 7010N .....	1-5
1-3.	Model 7004T .....	1-6
1-4.	Model 7010T .....	1-7
1-5.	Model 7001 .....	1-8
1-6.	7000 Reference Module Plug-in .....	1-9
1-7.	7000S 10 V Scan Module.....	1-10
1-8.	7000N Nanoscan Module.....	1-11
1-9.	7000T Transref Module .....	1-11
2-1.	7000N Rear Panel .....	2-6
2-2.	Optical RS232 Interface Connections .....	2-7
2-3.	12 V DC Power Input DIN Socket Connector .....	2-7
2-4.	7000N and 7000T Back Panel Connections.....	2-9
2-5.	7000N Front Panel Connections .....	2-10
2-6.	10 V 4-wire Buffered Output .....	2-11
2-7.	7000N Rear Panel Connections.....	2-12
2-8.	7000T Front Panel Connections.....	2-13
3-1.	7000 Reference Module Front Panel Controls .....	3-3
3-2.	7000 Reference Module Indicators .....	3-5
3-3.	7000S Front Panel Indicators .....	3-8
3-4.	7000N Front Panel Controls.....	3-9
3-5.	Channel Field Indicator.....	3-11
3-6.	7000T Transref Module Front Panel Controls .....	3-12
4-1.	Forward (Normal) Measurement.....	4-5
4-2.	Reverse Measurement .....	4-5
4-3.	Backplane Connections .....	4-6
4-4.	Reversal Switches in the 7000S Scan Module .....	4-6



## **Safety Issues**

### **⚠ Warning**

**Read this entire section thoroughly before attempting to install, operate or service the 7000 Series Volt Maintenance System.**

## **General Safety Summary**

This instrument has been designed and tested in accordance with the British and European standard publication EN61010:1993/ A2:1995, and has been supplied in a safe condition.

This manual contains information and warnings that must be observed to keep the instrument in a safe condition and ensure safe operation. Operation or service in conditions or in a manner other than specified could compromise safety. For the correct and safe use of this instrument, operating and service personnel must follow generally accepted safety procedures, in addition to the safety precautions specified.

To avoid injury or fire hazard, **do not** switch on the instrument if it is damaged or suspected to be faulty. **Do not** use the instrument in damp, wet, condensing, dusty, or explosive gas environments.

Whenever it is likely that safety protection has been impaired, make the instrument inoperative and secure it against any unintended operation. Inform qualified maintenance or repair personnel. Safety protection is likely to be impaired if, for example, the instrument shows visible damage, or fails to operate normally.

## **Explanation of Safety Related Symbols and Terms**

**⚠ Danger** Electric shock risk

The product is marked with this symbol to indicate that hazardous voltages (>30 VDC or AC peak) may be present.

**⚠ Warning** Refer to documentation.

Identifies conditions and actions that pose hazard(s) to the user.

**Caution** statement

Identifies conditions and actions that may damage the product.

**⏚** Earth (Ground) terminal.

Functional Earth (Ground) only - must not be used as a Protective Earth.

## **Protective Earth (Ground)**

### **Protection Class I**

When powering this instrument from an AC line supply, it must only be used with the power supply provided and it must be operated with a Protective Earth/Ground connected via the powercable's protective earth/ground conductor. The Protective Earth/Ground connects to the instrument before the line & neutral connections when the supply plug is inserted into the power socket on the power supply unit.

### **⚠ Warning**

**Any interruption of the protective ground conductor inside or outside the power supply is likely to make the instrument dangerous. Intentional interruption is prohibited.**

### **Do Not Operate Without Covers**

To avoid electric shock or fire hazard, do not operate the power supply with its covers removed. The covers protect users from live parts, and unless otherwise stated, must only be removed by qualified service personnel for maintenance and repair purposes.

### **Safe Operating Conditions**

Only operate the instrument within the manufacturer's specified operating conditions. Specification examples that must be considered include:

- ambient temperature
- ambient humidity
- power supply voltage & frequency (if operating the instrument from an AC line supply)
- maximum terminal voltages or currents
- altitude
- ambient pollution level
- exposure to shock and vibration

#### **⚠ Warning**

**To avoid electric shock or fire hazard, do not apply to or subject the power supply to any condition that is outside specified range. See Chapter 1 of this manual for detailed instrument specifications and operating conditions.**

#### **Caution**

**Consider direct sunlight, radiators and other heat sources when assessing ambient temperature.**

### **The Power Cable and Power Supply Disconnection**

To avoid electric shock and fire hazard when the instrument is being operated from an AC line supply, make sure that the power cable is not damaged, and that it is adequately rated against power supply network fusing. If the power cable plug is to be the accessible disconnect device, the power cable must not be longer than 3 meters.

### **Instrument Terminal Connections**

When the instrument is being powered from an AC line supply, make sure that the power supply is correctly protectively earthed (safety grounded) via the power cable before and while any other connection is made.

### **Installation Category I**

Measurement and/or guard terminals are designed for connection at Installation (Overvoltage) Category I. To avoid electric shock or fire hazard, the instrument terminals must not be directly connected to the AC line power supply, or to any other voltage or current source that may (even temporarily) exceed the instrument's peak ratings.

**⚠ Warning**

**To avoid injury or death, do not connect or disconnect signal leads while they are connected to a hazardous voltage or current source. Always ensure that signal leads are in a safe condition before handling in any way.**

**Maintenance and Repair**

Observe all applicable local and/or national safety regulations and rules while performing any work. First disconnect the instrument from all signal sources, then from the AC line supply before removing any cover. Any adjustment, parts replacement, maintenance or repair should be carried out only by authorized Fluke technical personnel.

**⚠ Warning**

**For continued protection against injury and fire hazard, use only manufacturer supplied parts relevant to safety. Safety tests must be performed after replacing any part relevant to safety.**

**Moving**

First disconnect the instrument from all signal sources, then from the AC line supply before moving the instrument. A single 7000-Series rack can weigh as much as 20 kg (44 lbs). Avoid over-reaching, rapid movement or twisting motions when you move the instrument and employ two people if necessary.

**Cleaning**

First disconnect the instrument from all signal sources, then from the AC line supply before cleaning. Use only a damp, lint-free cloth to clean fascia and case parts.

Observe any additional safety instructions or warnings given in this manual.





# **Chapter 1**

## **The 7000 Volt Maintenance System**

<b>Title</b>	<b>Page</b>
Introduction.....	1-3
Models 7004N and 7010N Nanoscan Systems.....	1-3
Models 7004T and 7010T Transref Systems.....	1-3
Model 7001 Stand-alone 10 V DC Voltage Reference.....	1-3
Plug-In Modules.....	1-4
Model 7000 Reference Module.....	1-4
Model 7000S Scan Modules.....	1-4
Power Supply.....	1-4
Model 7004N.....	1-4
Model 7010N.....	1-5
Model 7004T.....	1-6
Model 7010T.....	1-7
Model 7001.....	1-8
Model 7050 Volt Maintenance Software.....	1-8
5700 Series Artifact Calibration Support.....	1-8
Model 7000 Reference Module Plug-in.....	1-9
7000S 10 V Scan Module.....	1-10
7000N Nanoscan Module.....	1-10
7000T Transref Module.....	1-11
Operating Modes.....	1-11
Model 7004N and 7010N Nanoscan Systems.....	1-11
Model 7004T and 7010T Transref Systems.....	1-11
Model 7001.....	1-12
7000 Series Accessories and Spare Parts.....	1-12
Accessories.....	1-12
Spare Parts.....	1-12
7000 System General Specifications.....	1-13
Line Power Supply Adapter.....	1-13
12 V DC Power Supply.....	1-13

Mechanical (Excluding Line Power Adapter) .....	1-14
Environmental Conditions .....	1-14
Miscellaneous .....	1-14
10 V Average Output .....	1-15
1 V Divided Output .....	1-15
4 Wire Buffer .....	1-16
External Standard Input .....	1-16
Null Detector .....	1-16
Temperature Monitor .....	1-16
7000 Reference Module .....	1-17
7000 Module - 10 V Output .....	1-17
7000 Module - Divided Output .....	1-17
7000 Module - General .....	1-18
7000S 10 V Scan Module .....	1-18
Contacting Fluke .....	1-18

## **Introduction**

Traditionally, maintaining a high-performance 10 V DC Voltage reference meant using several independent voltage references that were regularly compared with each other to identify excessive drift in any one unit, and routinely compared with external voltage standards to maintain traceability. The results of comparisons with higher-order external standards allowed a history to be established for the group of references so that their future performance could be predicted with a high degree of confidence from their recorded drift rate and date of last calibration.

Fluke's 7000-Series Volt Maintenance System replaces these traditional systems with a fully integrated solution that includes all the hardware and software necessary to automate inter-comparisons and to import/export 10 V traceability. The system can accommodate up to 20 internal or external 10 V reference standards and includes an integrated scanner and null detector plus PC-based control, data capture and analysis software to operate the system and predict its long-term performance.

Automation of the volt maintenance process using the PC-based software ensures consistency and eliminates the possibility of human error. Direct import of captured data in the industry standard Excel™ spreadsheet program allows sophisticated data reporting and analysis, making maintenance of a 10 V DC Reference simplicity itself.

There are several 7000-Series models to choose from, all built on a modular system that is based around plug-in modules and three rack sizes.

## **Models 7004N and 7010N Nanoscan Systems**

The Model 7004N and 7010N Nanoscan units are primarily designed as laboratory standards, accommodating up to four or ten Model 7000 zener reference modules respectively. They both incorporate a 7000N Nanoscan Module that provides a 10 V Average Output, a 1 V Divided Output and a 4-wire buffered 10 V Output, together with a measurement scan controller, a null detector and a fiber-optic based RS232 interface to a PC. Both the Model 7004N and Model 7010N Nanoscan systems may be extended to include additional reference modules by adding a second Nanoscan or Transref unit (see "Plug-In Modules" later in this chapter).

The Model 7004N with four Model 7000 Reference Modules installed is intended as a general purpose Laboratory Reference Standard. The Model 7010N with ten Model 7000 Reference Modules installed represents the ultimate in Laboratory Reference Standards, providing 1-year predictability of better than 0.2 ppm per year.

## **Models 7004T and 7010T Transref Systems**

The Model 7000T and Model 7010T Transref units are designed primarily as Multi-Cell Transportable References, accommodating up to four or ten Model 7000 zener reference modules respectively. Each unit also generates a 10 V Average Output that enables user's to perform a quick check on the unit's stability after transportation. Transref units may also be used as extension racks for Nanoscan units, in which case they are fully controlled from the Nanoscan module.

## **Model 7001 Stand-alone 10 V DC Voltage Reference**

The Model 7001 is a stand-alone unit that incorporates a single Model 7000 10 V Reference Module. It is designed as a low-cost, entry-level solution to 10 V standards laboratory metrology, or as a transportation system for single Model 7000 references.

## Plug-In Modules

### Model 7000 Reference Module

Model 7000 10 V Reference Modules form the heart of Nanoscan, Transref and Model 7001 Volt Maintenance Systems. Each reference module incorporates an ultra-stable zener diode based 10 V source and support circuitry. A temperature controlled low-temperature oven minimizes aging of the zener reference diode while still maintaining a very low temperature coefficient. For convenience when moving the system within the laboratory or to/from a shop-floor environment, and to maintain the oven temperature during line supply failures, each module contains a backup battery. However, the Model 7000 Reference Module is not solely dependent on its batteries to maintain its calibration during transportation. If battery power is lost during extended periods of transit, a patented zener reference conditioning technique will recover any hysteresis in the zener diode that may have been introduced by exposure to low temperatures. As a result, unpredicted delays during shipment do not mean loss of calibration. The highest level of performance, however, is obtained when Model 7000 Reference Modules remain permanently powered, by a combination of their internal batteries and an external supply.

### Model 7000S Scan Modules

Model 7000S Scan Modules enable external 10 V references to be included in a 7000-Series Nanoscan system, allowing users to import the traceability of existing 10 V standards.

### Power Supply

7000-Series Volt Maintenance Systems are powered from a universal line power adapter. As an option, they can be powered from an external 12 V DC supply. A patented DC/DC isolation technique provides additional internal isolation, resulting in exceptionally low levels of common-mode noise at the 10 V Reference Module outputs. This is particularly valuable to Josephson Junction Interface applications.

### Model 7004N

The Model 7004N is a 3U high rack supplied with a pre-installed 7000N Nanoscan module and an external 12 V DC Power Supply. The rack has four spare slots, each of which can accommodate either a Model 7000 Reference Module or a Model 7000S Scan Module. Unused slots are covered by blanking plates.

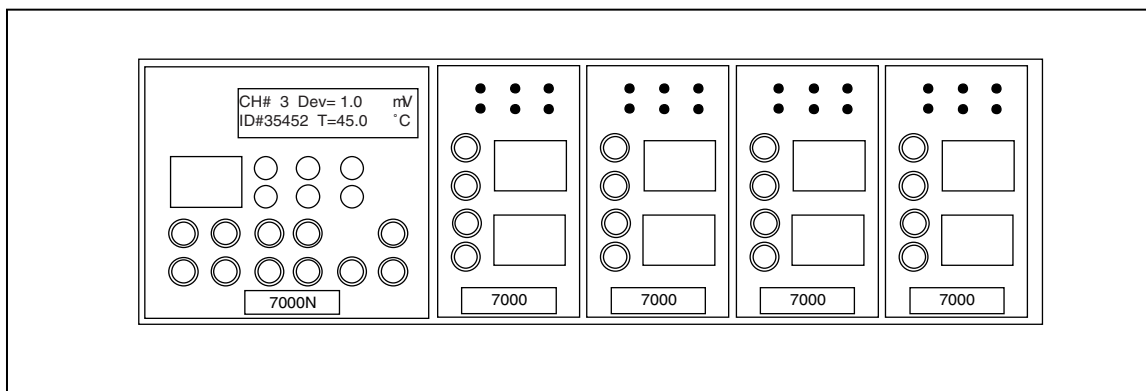


Figure 1-1. Model 7004N

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The rack must contain at least one Model 7000 Reference Module switched "In Average" in order to generate a System Average output.

As standard, the Model 7004N is supplied with the following accessories:

**Table 1-1. Accessories**

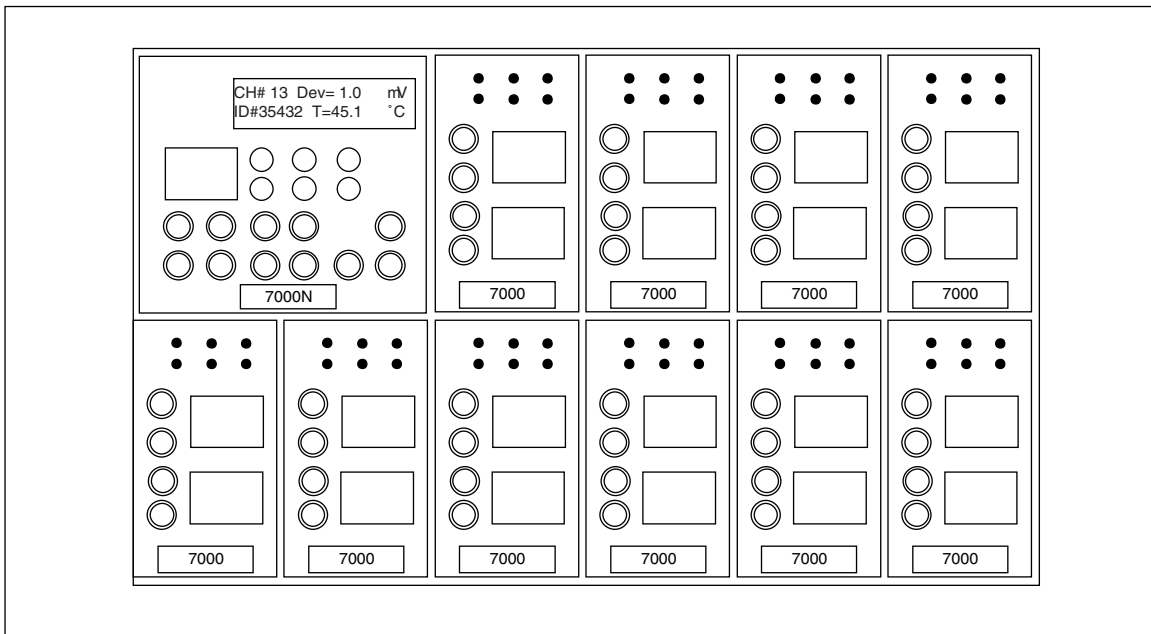
Part No.	Description
1571645	1.5 m Low Thermal Lead Set, gold spade to spade lead for general purpose signal connections.
1571623	0.75 m Lemo Lead to extend the Backplane Signal Bus into another rack.
1571638	0.75 m 15 way D Type Lead to extend the Backplane Control Bus into another rack.
1571661	Module Extraction Tool
1571650	10 m Fiber Optic Cable
1571593	RS232 to Fiber Optic Adapter for PC
1571587	9-pin male D-type to 25-way female D-type Adapter for PC

The accessory 7004-65, a Ruggedized Transit Case with Min-Max Thermometer, is also available. It may be used to transport the Model 7004N when it is sent to an external standards laboratory for recalibration. The Min-Max Thermometer records the upper and lower temperature extremes experienced inside the case during transportation.

**Model 7010N**

The Model 7010N is a 6U high rack supplied with a pre-installed 7000N Nanoscan module and an external 12 V DC Power Supply. The rack has ten spare slots, each of which can accommodate either a Model 7000 Reference Module or a Model 7000S Scan Module. Unused slots are covered by blanking plates.

The rack must contain at least one Model 7000 Reference Module switched "In Average" in order to generate a System Average output.



**Figure 1-2. Model 7010N**

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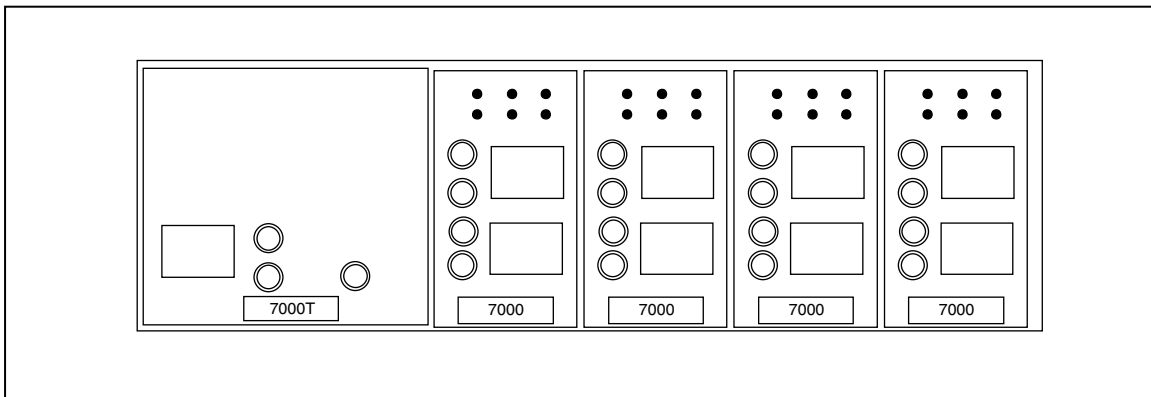
As standard Model 7010N is supplied with the following accessories:

Part No.	Description
1571645	1.5 m Low Thermal Lead Set, gold spade to spade lead for general purpose signal connections.
1571623	0.75 m Lemo Lead to extend the Backplane Signal Bus into another rack.
1571638	0.75 m 15 way D Type Lead to extend the Backplane Control Bus into another rack.
1571661	Module Extraction Tool with handle
1571650	10 m Fiber Optic Cable
1571593	RS232 to Fiber Optic Adapter for PC
1571587	9 pin male D type to 25 way female D type Adapter for PC
No transit case is available for the Model 7010N.	

### **Model 7004T**

The Model 7004T is a 3U high Rack supplied with a pre-installed 7000T Transref Module and an external 12 V DC Power Supply. The rack has four spare slots, each of which can accommodate either a Model 7000 Reference Module or a Model 7000S Scan Module. Unused slots are covered by blanking plates.

If the Model 7004T is being used as a Transfer Standard, the rack must contain at least one Model 7000 Reference Module to provide the System Average output. If the 7004T is only being used as an Extension Rack to a 7000-Series Nanoscan System it need not contain a 7000 Reference Module. It could be entirely populated by 7000S Scan Modules. (Note: If the 7004T only contains 7000S Scan Modules, there will be no 10 V Average Output on the 7000T Module.)



**Figure 1-3. Model 7004T**

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As standard, Model 7004T is supplied with the following accessory:

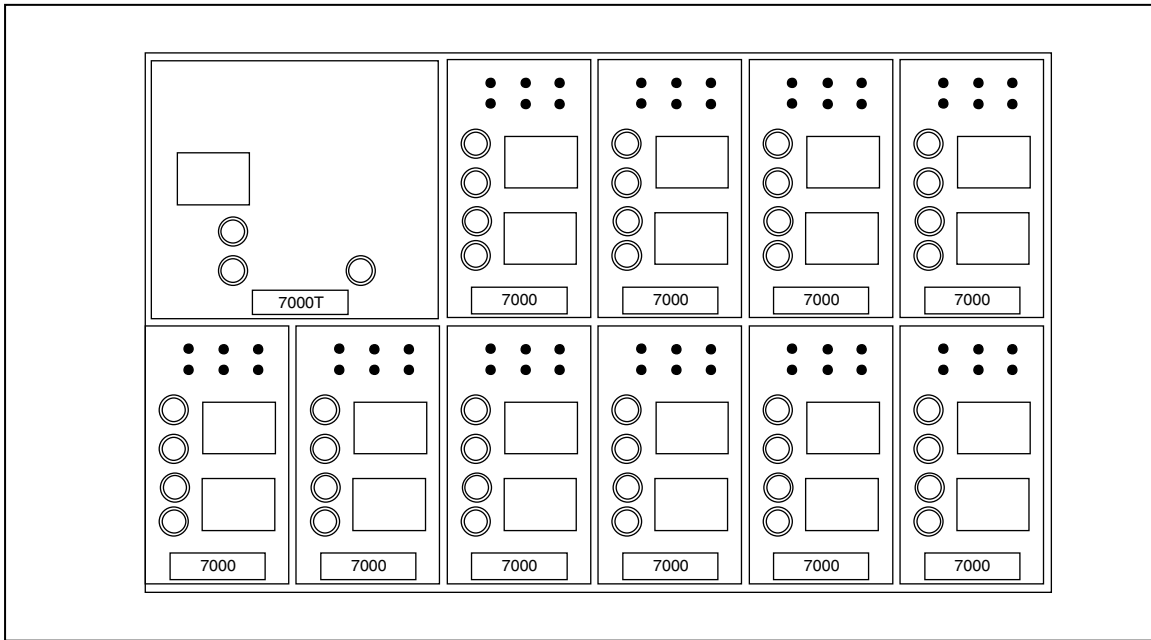
1571661 Module Extraction Tool with handle

The accessory 7004-65, a Ruggedized Transit Case with Min-Max Thermometer, is also available. It may be used to transport the Model 7004T when it is sent to an external standards laboratory for recalibration. The Min-Max Thermometer records the upper and lower temperature extremes experienced inside the case during transportation.

**Model 7010T**

The Model 7010T is a 6U high rack supplied with a pre-installed 7000T Transref Module and an external 12 V DC Power Supply. The rack has ten spare slots, each of which can accommodate either a Model 7000 Reference Module or a Model 7000S Scan Module. Unused slots are covered by blanking plates.

If the Model 7010T is being used as a Transfer Standard, the rack must contain at least one Model 7000 Reference Module to provide the System Average output. If the 7010T is only being used as an Extension Rack to a 7000-Series Nanoscan System it need not contain a 7000 Reference Module. It could be entirely populated by 7000S Scan Modules. (Note: If the 7010T only contains 7000S Scan Modules, there will be no 10 V Average Output on the 7000T Module.)



**Figure 1-4. Model 7010T**

aho04f.eps

As standard, Model 7010T is supplied with the following accessory:

1571661 Module Extraction Tool with handle

No transit case is available for the Model 7010T.

## Model 7001

The Model 7001 comprises a single Model 7000 Reference Module housed in a stand-alone enclosure and is supplied with an external 12 V DC Power Supply.

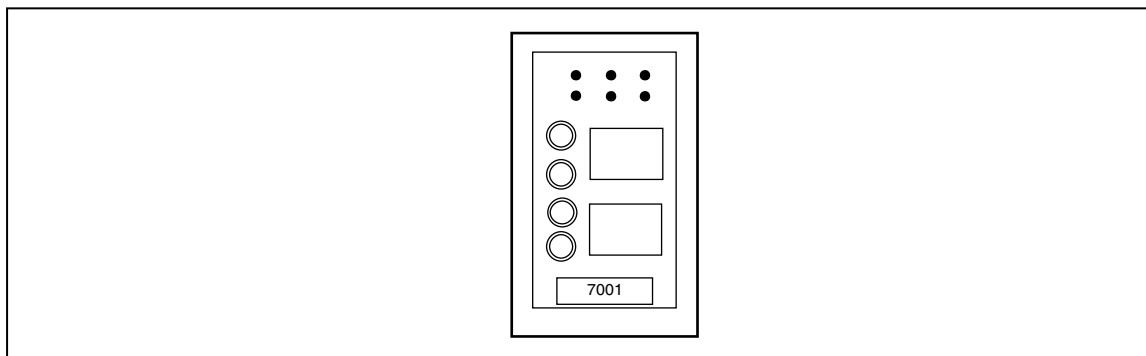


Figure 1-5. Model 7001

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The Model 7000 Reference Module is removable and may be interchanged with another Model 7000 Reference Module from a 7000-Series Nanoscan or Transref system. This provides a convenient way of transporting single reference modules.

The accessory 7004-65, a Ruggedized Transit Case with Min-Max Thermometer, is also available. It may be used to transport a Model 7001 when it is sent to an external standards laboratory for recalibration. The Min-Max Thermometer records the upper and lower temperature extremes experienced inside the case during transportation.

See the "7000 Series Accessories and Spare Parts" section of this chapter for a list of available accessories.

## Model 7050 Volt Maintenance Software

The 7050 Volt Maintenance Software contains two separate software modules.

The first is a National Instruments CVI application that allows the user to initiate automatic measurement scans and data capture in either a 7004N or 7010N Nanoscan system.

The second software module is a Microsoft Excel "Add In" that stores captured data, appends it to an Excel spreadsheet and performs data analysis. These data analysis functions include verification of basic system integrity and prediction of the value of the System Average output. It also allows importation of calibration data for the purposes of calibrating a 7000-Series Volt Maintenance System. A succession of such imports can be used to establish a history and a drift rate for the System Average. In conjunction with the most recent calibration data and the elapsed time since recalibration, this information can be used to predict the value of the System Average output for a period of up to 1 year into the future. The 7050 Software may also be used to Export calibration to other references.

## 5700 Series Artifact Calibration Support

The 7000 Volt Maintenance System can provide "Voltage Artifact" support of Fluke's 57XX Multifunction Calibrators. The addition of the 742A Resistance Standards completes the necessary Artifacts support package. Two values, 1  $\Omega$  and 10 k $\Omega$  both fit within the option 65 Transit Cases to form a single, portable unit.



## 7000-Series System Modules

7000-Series Systems are constructed around four modules.

### Model 7000 Reference Module Plug-in

The Model 7000 Reference Module forms the heart of all 7000-Series Volt Maintenance Systems, providing a self-contained 10 V reference and support circuitry. It incorporates the zener reference diode, a temperature controlled oven for the zener diode, 10 V output scan multiplexing and reversal switching, "In Average" and "Out of Average" switching and a battery back up supply. For compatibility with Weston Cells, a 1.000/1.018 V (switchable) output is also provided.

The low-temperature oven minimizes aging of the zener reference diode while still maintaining a very low temperature coefficient for the 10 V reference. When incorporated into a 7004N or 7010N Nanoscan system, the oven temperature and module status can be interrogated by the 7050 Software.

A patented low-noise DC/DC converter built into the Model 7000 module ensures very low common mode current on the output terminals. As a result, the 10 V output can be directly measured against a Josephson System while still being powered from a line supply. Model 7000 Reference Modules can therefore be calibrated under exactly the same conditions in which they will be used.

For convenience when moving the unit within a laboratory, or between a calibration laboratory and an adjacent shop-floor environment, and for protection against line supply failures, each Model 7000 Reference Module contains its own battery backup supply. However, the 7000 Reference Module is not solely dependent on its batteries to maintain calibration during transportation. If battery power is lost during extended periods of transit a patented zener reference conditioning technique will recover the output from any hysteresis that may have been introduced by exposure to low temperatures. As a result, unpredicted delays during shipment do not mean loss of calibration. For the best possible performance, however, 7000 Reference Modules should remain permanently powered by a combination of their line supply adapter (or an external 12 V DC supply) and their internal battery.

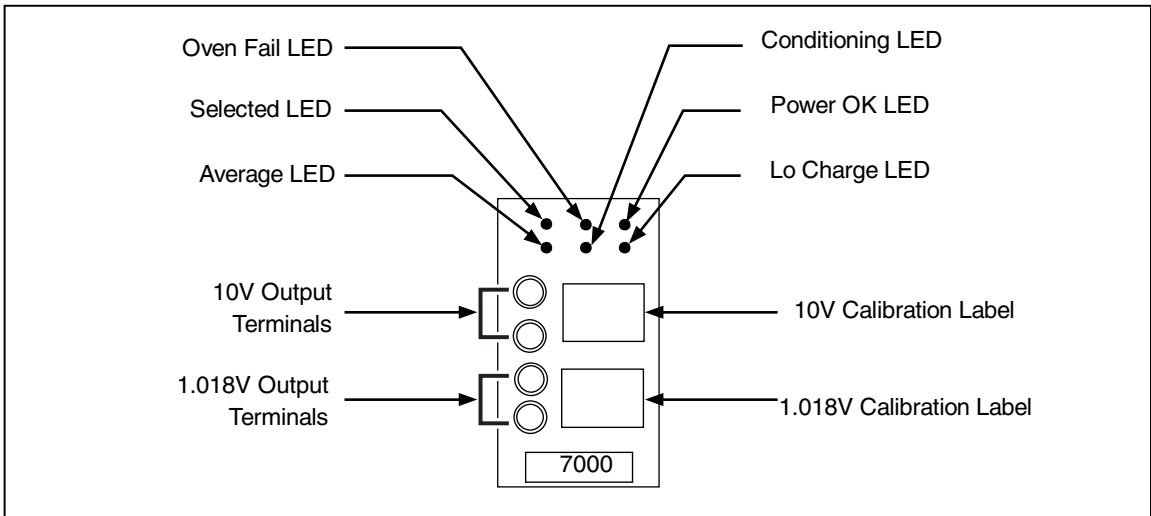


Figure 1-6. 7000 Reference Module Plug-in

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### 7000S 10 V Scan Module

The 10 V Input Scan Module is used for connecting an existing 10 V Reference into the system. This enables an established history to be incorporated into the 7000 System. Over a period of time this will assist in building the history of the 7000 System.

The 7000S module contains the necessary scan and reversal switching.

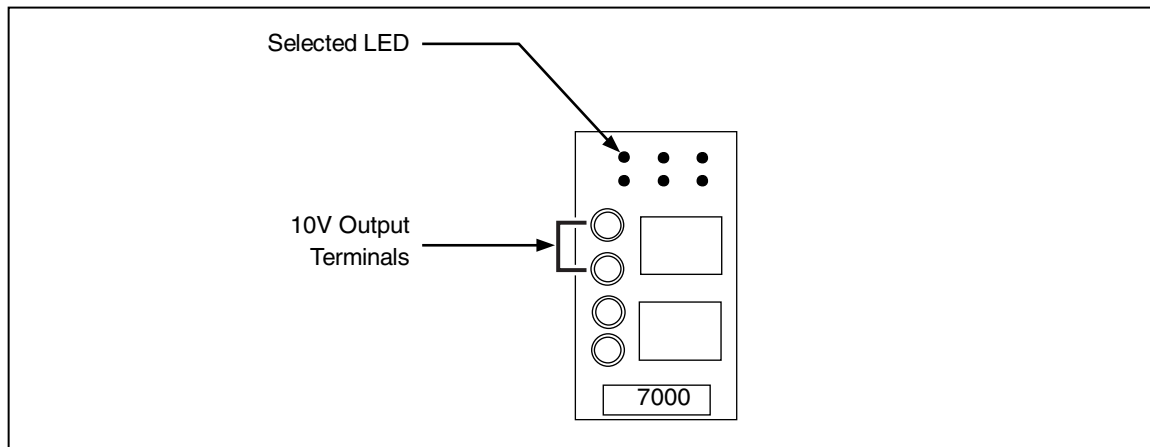


Figure 1-7. 7000S 10 V Scan Module

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### 7000N Nanoscan Module

The 7000N Nanoscan Module generates the 10 V System Average Output, 1 V Divided Output and 10 V 4-wire Buffered Output; provides an External Standard Input; and incorporates Scan Control, Voltage Reversal, Null Detector, Status Display, and Optically Isolated RS232 Interface functions.

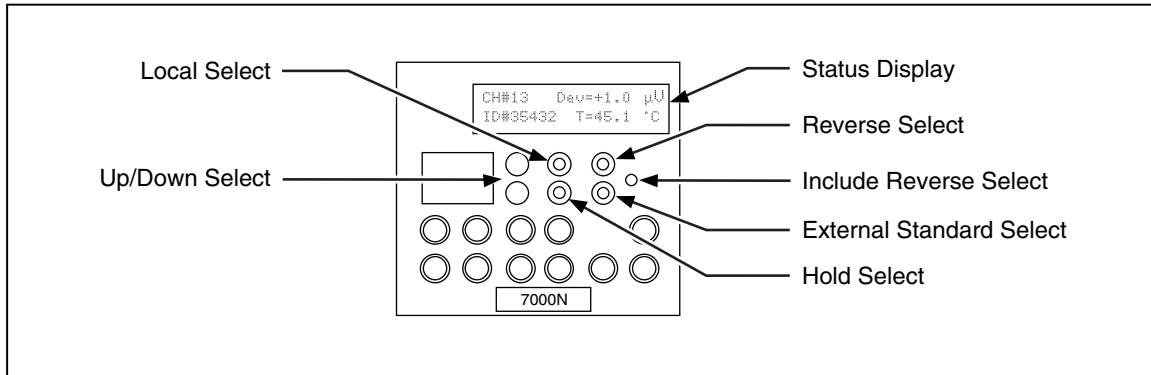
The 10 V System Average Output is derived from the output of any 7000 Reference Modules in the rack that set to their "In Average" mode. Reference Modules contained in an extension rack are not included in the System Average, because the second rack is unlikely to be a permanent feature (for example, it may only be used as a means of importing calibration).

The 7000N Nanoscan Module routes 12 V DC power across the backplane to the 7000 Reference Modules or 7000S Scan Modules. Provided that the 7000 Reference Modules selected as "In Average" are successfully operating from their batteries, the 10 V System Average Output is maintained during line supply failures.

The 10 V 4-wire Buffered Output is provided to drive loads such as a Kelvin Varley divider. The source resistance of the System Average output is unsuitable for driving such loads.

The External Standard Input is intended for connection of an external reference standard for the purposes of either importing or exporting calibration.

The module being scanned and compared against the 10 V System Average by the Null Detector can be controlled directly from the 7000N's front panel or remotely via a PC. The measured difference is indicated on the Scan Status display and is also available over the optical RS232 interface. The optical interface ensures isolation between the 7000-Series systems and the PC, eliminating interference and noise problems associated with the PC.



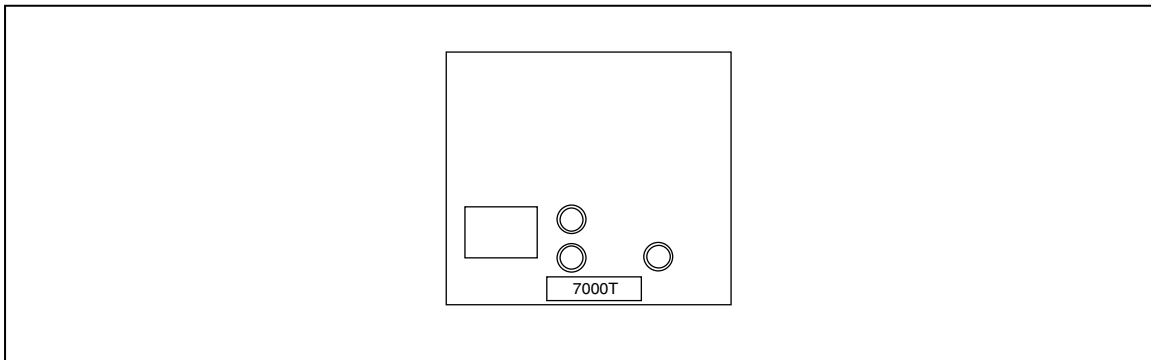
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**Figure 1-8. 7000N Nanoscan Module**

**7000T Transref Module**

The 7000T Transref Module generates a 10 V System Average Output from any 7000 Reference modules in its rack that are set to their "In Average" mode.

It also routes 12 V DC power across the backplane to the 7000 Reference Modules or 7000S Scan Modules. Provided that the 7000 Reference Modules selected as "In Average" are successfully operating from their batteries, the 10 V System Average Output is maintained during line supply failures.



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**Figure 1-9. 7000T Transref Module**

**Operating Modes**

**Model 7004N and 7010N Nanoscan Systems**

The Model 7004N and 7010N Nanoscan Systems can be operated manually from their front-panel controls, or automatically using a PC running the 7050 Volt Maintenance Software. Automatic operation offers the advantages of increased repeatability and freedom from operator error, and frees personnel to perform other tasks.

**Model 7004T and 7010T Transref Systems**

When used as stand-alone systems, the Model 7004T and 7010T Transref Systems can only be operated manually. However, Model 7000 Reference Modules and Model 7000S Scan Modules contained in a Model 7004T or 7010T Transref System can be scanned automatically if the 7004T/7010T system is connected to a Model 7004N or 7010N Nanoscan System (typically to import/export calibration to/from the Nanoscan System).

### **Model 7001**

The Model 7001 can only be used manually to provide a 10 V and 1.000/1.018 V DC Reference.

## **7000 Series Accessories and Spare Parts**

7000 System racks do not necessarily need to be full of modules. Additional 7000 or 7000S modules may be added or removed as required. A 7000 Reference Module may be removed from its host rack and put into a 7001-CASE Enclosure for transportation.

### **Accessories**

The following accessories are available to extend an existing system.

<b>Model No.</b>	<b>Description</b>
7000-M	Module Extraction Tool with handle
7001-CASE	7001 Enclosure for housing a single 7000 Reference Module. Supplied with 12 V DC Power Supply
7001-65	Ruggedized transit case with min max thermometer
7004-PWR	12 V DC Power Supply IEC Switched Input for 7001/7004
7004-65	Transit case 3U ruggedized with min max thermometer
7010-PWR	12 V DC Power Supply IEC Universal Input for 7010
Y7004	7004N and 7004T Rack Mounting Kit
Y7010	7010N and 7010T Rack Mounting Kit

### **Spare Parts**

The following spare parts are available.

<b>Part No.</b>	<b>Description</b>
1571587	9-pin male D-type to 25-way female D-type Adapter for PC
1571593	RS232 to Fiber Optic Adapter for PC
1571623	0.75m Lemo Lead extends Backplane Signal Bus into another rack
1571638	0.75m 15 way D Type Lead extends Backplane Control Bus into another rack
1571645	1.5m Low Thermal Lead Set gold spade to spade lead for general purpose signal connections
1571650	10m Fiber Optic Cable
1575982	Thermometer, Min/Max Thermometer
1573990	Replacement Battery Assembly

## 7000 System General Specifications

### Line Power Supply Adapter

The 7000 Systems require a 12 V DC Power Supply. This specification relates to the Line Power to 12 V DC Adapter supplied: 7000, 7001/7004 Part No. 2403609 or 7010 Part No. 2403889.

Line Supply Connector	IEC 270
Line Voltage	7001/7004: 115 V or 230 V $\pm$ 5 %, Switch Selectable 7010: 93 V – 264 V, Universal
Overvoltage	Installation Category II
Line Frequency	48 to 63 Hz
Consumption	< 90 VA
Power Fuse	Internal
Output Connector	5 pin 180° DIN plug Pin Assignments: 1 & 4 = 0 V, 3 & 5 = +12 V, 2 = Functional Earth
Lead length	1.0 m min.
Voltage Output	+12.25 V to 13.5 V DC
EMC and ESD Radiated Emissions	EN50081-1, EN55022, EN55011, Level B
Conducted Immunity	EN50082-1
Conducted Noise	EN55022, EN55011, FCC, Level B
Electrostatic Discharge	EN61000-4-2, Level 4
Electrical Fast Transients/bursts	EN61000-4-4, Level 3
Surge Susceptibility	EN61000-4-5, Level 3
Safety	Power supply to EN60950, UL3111 CE and UL Marked (7000 system to EN61010:1993/A2:1995)
Height	58 mm max
Width	79 mm max
Depth	128 mm max, excludes output lead
Weight	1 kg max

### 12 V DC Power Supply

The 12 V DC Power Supply Input is located on the rear of the 7000N or 7000T Module.

Power Supply Input	11.8 V to 14.5 V DC
Power Input Connector	5 pin 180° DIN socket Pin Assignments: 1 & 4 = 0 V, 3 & 5 = +12 V, 2 = case
Power Consumption	7001 < 3.5 W, with 1 x 7000, 12 V DC, 23 °C 7004N, 7004T < 15 W, with 4 x 7000, 12 V DC, 23 °C 7010N, 7010T < 35 W, with 10 x 7000, 12 V DC, 23 °C
Power Supply Protection	-60 V < Vin < 0 V, 15 V < Vin < 75 V via self resetting 500 mA, 60 V thermal fuse

### Mechanical (Excluding Line Power Adapter)

#### Models 7004N, 7004T

Height	133 mm (5.24 inches) (3U)	
Width	449 mm (17.7 inches)	
Depth	369 mm (14.6 inches)	including carrying handles, terminals.
Weight	9.6 kg (21 lbs)	with 4 x 7000

#### Models 7010N, 7010T

Height	266 mm (10.48 inches) (6U)	
Width	449 mm (17.7 inches)	
Depth	369 mm (14.6 inches)	including carrying handles, terminals.
Weight	20.0 kg (44 lbs)	with 10 x 7000

### Environmental Conditions

Temperature Range	+15° C to +35° C	Operating
	-18° C to +45° C	Transit
	0° C to +45° C	Storage
Maximum Relative Humidity (non condensing)	< 90%	Over Operating temperature range
	< 95%	Over Storage temperature range
Altitude	0 to 2,000 m (6,562 ft)	Operating
	0 to 12,000 m (40,000 ft)	Non Operating
Shock	MIL-T-28800, type III, class 5, style E	
Vibration	MIL-T-28800, type III, class 5, style E	
Enclosure	MIL-T-28800, type III, class 5, style E	
EMC and ESD	EN55011:1991	Emissions
	EN50082-1:1992 CE Marked	Generic Immunity
Safety	EN61010-1-1: 1993/A2:1995 CE and CETL Marked	

### Miscellaneous

Isolation (per Module)	10 GΩ // 1 nF	Any terminal to Earth/Chassis
	20 GΩ // 3pF	Any terminal to Line, Chassis ground
Max applied voltage	100 V	Any terminal to Earth/Chassis
	100 V	Any 7000 terminal to any terminal of another module, 7000 Out of Average and Not Selected
	10 V	Any 7000 terminal to any terminal of another module, 7000 In Average or Selected

## 10 V Average Output

Models 7004N, 7004T assumes 4 x 7000 fitted, 4 In Average. Models 7010N, 7010T assumes 10 x 7000 fitted, 10 In Average. Statistically predicted from individual 7000 Module performance.

	7004N, 7004T	7010N, 7010T	
Stability ± ppm	0.5	0.5	30 days, ± 1° C, constantly energized
	0.8	0.7	90 days, ± 1° C, constantly energized
	1.2	1.0	1 year, ± 1° C, constantly energized
Predictability (1)	± 0.3 ppm/year typical	± 0.2 ppm/year typical	After 1 <sup>st</sup> year, ± 1° C, constantly energized
	± 0.2 ppm / year typical	± 0.2 ppm / year typical	After 2 <sup>nd</sup> year, ± 1° C, constantly energized
TC	< 0.02 ppm/°C	< 0.01 ppm/°C	+15 to +35° C
Noise	± 0.05 ppm RMS	± 0.03 ppm RMS	0.01 to 10 Hz
	± 0.06 ppm	± 0.04 ppm	Standard deviation of a 90 day regression
Hysteresis (after battery discharge)	< 0.1 ppm	< 0.05 ppm	Power On 23° C, Off 23° C, On 23° C, 1 conditioning cycle
	< 0.1 ppm	< 0.07 ppm	Power On 23° C, Off 10° C, On 23° C, 1 conditioning cycle
	< 0.1 ppm	< 0.07 ppm	Power On 23° C, Off 40° C, On 23° C, 1 conditioning cycle
	< 0.15 ppm	< 0.1 ppm	Power On 23° C, Off 0° C, On 23° C, 1 conditioning cycle
	< 0.3 ppm	< 0.2 ppm	Power On 23° C, Off -18° C, On 23° C, 1 conditioning cycle
Output Resistance	125 Ω ± 1%	50 Ω ± 1%	
Average Error	< ± 2 μV	< ± 2 μV	Relative to the mathematical average of the front terminals
Notes: (1) Assumes previous year's history available, containing at least 5 points taken no more than 3 months apart from each other.			

## 1 V Divided Output

Relative to 10 V Average Output

7004N, 7010N only		
Initial Value	± 100 ppm	see certificate for value and uncertainty
Stability	< ± 0.5 ppm	30 days, ± 1° C
Predictability (1)	± 0.6 ppm typical	1 year ± 1° C
TC	< 0.2 ppm/°C	+10 to + 35° C
Output Resistance	1 k Ω ± 1 Ω	
Warm Up Time	< 20 minutes	to ± 0.1 ppm of 24 hour value.
Notes: (1) Assumes previous year's history available, containing at least 5 points taken no more than 3 months apart from each other.		

## 4 Wire Buffer

Relative to 10 V Average Output

Models: 7004N, 7010N		
Offset	< $\pm 4 \mu\text{V}$	Over Operating Temperature Range
Output Current	> 12 mA	
Load Regulation	< 0.1 ppm < 2.0 ppm	0 to 2 mA 2 to 10 mA
Warm Up Time	< 20 minutes	to $\pm 1 \mu\text{V}$

## External Standard Input

Models: 7004N, 7010N		
Nominal Range	+ 9.990 to +10.010 V	Cannot be selected outside this range. Selectable Reversal.
Input Impedance	100 M $\Omega \pm 1\%$ , in parallel with 10 pF	
Input Protection	100 V	Hi to Lo, Channel not Selected

## Null Detector

Assumes Offset removal using Channel 00 measurement.

Models: 7004N, 7010N		
Measurement Range	- 9999.9 to + 9999.9 $\mu\text{V}$	Relative to Average
Measurement Error	$\pm 0.1\% \pm 0.5 \mu\text{V}$	Selected channel rel to Average, Channel Out of average
	$\pm 0.3\% \pm 0.5 \mu\text{V}$	Selected channel rel to Average, Channel In average
	$\pm 0.05\% \pm 0.5 \mu\text{V}$	Ext. Std. relative to Average, < 100 $\Omega$ source
Relative Errors	$\pm 0.1 \mu\text{V}$	Channel to Channel errors
Noise	< 200 nV pk-pk	Channel 00
Measurement Period	5 s	Difference and Temperature Reading

## Temperature Monitor

Excludes accuracy of 7000 Oven Temperature Output

7004N, 7010N		
Measurement Error	$\pm 1^\circ \text{C}$	Selected channel
Stability	$\pm 0.1^\circ \text{C}$	over 1 year and operating temperature range
7000N Ambient Monitor	$\pm 2^\circ \text{C}$	



## 7000 Reference Module

### 7000 Module - 10 V Output

Initial Value	± 2 ppm from nominal	See certificate for value and uncertainty. Output adjustable in 0.2 ppm steps.
Stability ± ppm	0.6	30 days, ± 1° C, constantly energized
	0.9	90 days, ± 1° C, constantly energized
	1.8	1 year, ± 1° C, constantly energized
Predictability (1)	± 0.5 ppm / year typical	After 1 <sup>st</sup> year, ± 1° C, constantly energized
	± 0.3 ppm / year typical	After 2 <sup>nd</sup> year, ± 1° C, constantly energized
TC	< 0.03 ppm/° C	+15 to +35°C
Noise	± 0.10 ppm RMS	0.01 to 10 Hz
	± 0.10 ppm	Standard deviation of a 90 day regression
Hysteresis (after battery discharge)	< 0.1 ppm	Power On 23° C, Off 23° C, On 23° C, no conditioning cycle
	< 0.1 ppm	Power On 23° C, Off 10° C, On 23° C, 1 conditioning cycle
	< 0.2 ppm	Power On 23° C, Off 40° C, On 23° C, 1 conditioning cycle
	< 0.5 ppm	Power On 23° C, Off 0° C, On 23° C, 1 conditioning cycle
	< 0.5 ppm typical	Power On 23° C, Off -18° C, On 23° C, 1 conditioning cycle
Output Current	> 12 mA	
Output Resistance	< 5 mΩ ± 1%	
Line Regulation	< 0.05 ppm	Over full operating range of 12 V DC power supply and battery.
Output Protection (between Hi and Lo terminals)	Indefinite short circuit	
	220 V DC	DC Voltage applied up to 50 mA continuous
	1100 V DC	DC Voltage applied up to 25 mA continuous, or up to 0.6 J
Notes: (1) Assumes previous year's history available, containing at least 5 points taken no more than 3 months apart from each other.		

### 7000 Module - Divided Output

Operator selectable 1 V or 1.018 V. Factory set to 1.018 V. Relative to 10 V Output.

Initial Value	± 100 ppm	
Stability	< 0.6 ppm	30 days, ± 1° C, constantly energized
	< 1 ppm	90 days, ± 1° C, constantly energized
	< 2 ppm	1 year, ± 1° C, constantly energized
	< 1 ppm	During 2 <sup>nd</sup> year, ± 1° C, constantly energized
Predictability (1)	± 0.6 ppm / year typical	After 1 <sup>st</sup> year, ± 1° C, constantly energized
TC	< 0.2 ppm/°C	Over Operating Temperature range
Output Resistance	1 kΩ ± 1 Ω	

### **7000 Module - General**

Battery Type (2)	NiMH	Nickel Metal Hydride, 12 V, 1600 mAH
Battery Support Life (2)	> 24 hours	from fully charged, 23 ± 5 °C, < 0.1 mA from 10 V Output
Battery Recharge Time (2)	< 2.5 hours	Initial recharge, Output unavailable during this period
	< 14 hours (Boost)	To reach 100% charge, 12 V DC Power constantly applied.
Battery Capacity Half Life (2)	> 5 years	Time taken for battery capacity to half.
Conditioning Time	between 8 and 9 hours	After initial battery recharge, manually or automatically triggered
Warm Up Time (after battery re-charge)	< 20 minutes	After initial battery recharge, after conditioning (if enabled), to ± 0.1 ppm of 24 hour value, at constant temperature
Oven Temperature Output Module	± 3 °C	Only available to 7000N
Common Mode Current	< 10 nA RMS	Lo terminal to Earth, 40 Hz to 10MHz, into 1 k Ω //15 pF, using supplied 12 V DC power supply and case to Earth.
Notes: (1) Assumes previous year's history available, containing at least 5 points taken no more than 3 months apart from each other. (2) All battery specifications are derived from the Battery Suppliers specifications.		

### **7000S 10 V Scan Module**

Input Range	10.000 V ± 10 mV	10 mV Deviation from Hardware Average
Scan Uncertainty	< 500 nV	
Input Resistance	> 10 GΩ	
Input Bias Current	< 1 nA	
Max Applied Voltage	100 V	Either terminal to Earth/ Chassis
	100 V	Hi to Lo, Module not Selected

### **Contacting Fluke**

Call Fluke using any of the phone numbers listed below:

USA: 1-888-44-FLUKE (1-888-443-5853)  
 Canada: 1-800-36-FLUKE (1-800-363-5853)  
 Europe: +31 402-675-200  
 Japan: +81-3-3434-0181  
 Singapore: +65-738-5655  
 Anywhere in the world: +1-425-446-5500

Or, visit Fluke's Web site at [www.fluke.com](http://www.fluke.com).

For software-related issues, see "Software Support" in Chapter 6.

## **Chapter 2**

# **Installing the 7000 Series**

<b>Title</b>	<b>Page</b>
Introduction.....	2-3
Lifting and Carrying the 7000 Series.....	2-3
Lifting and Carrying from Bench Height.....	2-3
Lifting and Putting Down at Low Level.....	2-3
Unpacking and Inspection.....	2-3
Storage.....	2-3
Preparation for Shipment.....	2-4
Preparation for Operation.....	2-4
Rack Mounting.....	2-4
Power Input.....	2-4
Line Power Adapter.....	2-4
Initial System Configuration and Calibration.....	2-5
Connectors and Pin Designations.....	2-6
7000N Rear Panel Connections.....	2-6
Optical RS232.....	2-6
12 V DC Power Input.....	2-7
Control Bus Out.....	2-8
Control Bus In.....	2-8
Signal Bus.....	2-9
Reverse.....	2-9
7000N Front Panel Connections.....	2-10
1 V Output.....	2-10
10 V Average Output.....	2-10
10 V 4 Wire Buffered Output.....	2-10
Case Terminal.....	2-11
External Standard Input.....	2-11
7000T Rear Panel Connections.....	2-12
Control Bus Input.....	2-12
12 V DC Power Input.....	2-12

Signal Bus .....	2-12
7000T Front Panel Connections .....	2-13
10 V Average Output .....	2-13
Case Terminal .....	2-13
Adding 7000 or 7000S Modules .....	2-14
Removing 7000 or 7000S Modules .....	2-14

## **Introduction**

This chapter contains information and instructions for unpacking and installing a 7000 System.

## **Lifting and Carrying the 7000 Series**

### **Caution**

**The Model 7010N and 7010T when populated with ten Model 7000 Reference Modules weigh approximately 20kg. Take special care when lifting and carrying these units.**

### **Lifting and Carrying from Bench Height**

1. Disconnect and remove any cables from the front and rear panels.
2. Tilt the unit so that it is standing on its rear panel.
3. Carry the unit by the handles built into the rack.
4. Place the unit down vertically on its rear panel and tilt the unit back onto its feet.

### **Lifting and Putting Down at Low Level**

Always bend your knees, not your back, when lifting or lowering the unit. Keep your back as straight and as vertical as possible.

## **Unpacking and Inspection**

Every care is taken in the choice of packing materials to ensure that your equipment will reach you in perfect condition.

If the equipment has been subject to excessive mishandling in transit, this fact will probably be visible as external damage to the shipping container and inner carton. In the event of damage, the shipping container, inner carton and cushioning material should be kept for the carrier's inspection.

Carefully unpack the equipment and check for external damage to the case, sockets, controls, etc. If the shipping container and cushioning material are undamaged, they should be retained for use in subsequent shipments. If damage is found, notify the carrier and your sales representative immediately.

Standard accessories (associated products and spares) supplied with the unit should be as described in Chapter 1 and on the delivery note.

## **Storage**

The instrument should be stored under cover. The shipping container provides the most suitable receptacle for storage, as it provides the necessary shock isolation for normal handling conditions.

Place the instrument, together with an active desiccant sachet, inside a sealed bag. Fit the bag into the cushioning material inside the inner carton, place this within the outer shipping container, and locate the entire package within the specified storage environment.

## Preparation for Shipment

If a Model 7004N, 7010N, 7004T, 7010T or 7001 System is to be transported, please consider using the appropriate Ruggedized Transit Case.

The instrument should be transported under cover. The original shipping container should be used to provide shock isolation for normal handling operations. The following transport cases are available:

- Ruggedized transit case with min max thermometer, Accessory 7001-65, Part Number: 1571554
- Transit case 3U ruggedized with min max thermometer, Accessory 7004-65, Part Number: 1571568

Place the instrument, together with an active desiccant sachet, inside a sealed bag. Fit the bag into the cushioning material inside the transit case, place this within the outer shipping container, and secure the entire package.

## Preparation for Operation

### Note

*Refer to 7000 Series General Specifications, including Environmental Conditions located in Chapter 1.*

Before preparing the 7000 System for operation, note the following:

### Caution

**If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.**

## Rack Mounting

The instruments may be fitted into a standard 19-inch rack.

Front handles with rack-mounting brackets are supplied as optional accessories, Y7004 for the 7004N/7004T and Y7010 for the 7010N/7010T. Use a 3 mm hex key to remove the four screws securing the existing handles, then fit the rack-mounting handles in their place. Spare fixing screws are provided with the kit. The feet may be removed by first removing the two screws securing the bottom cover and corner moldings at the rear of the case. Slide and lift off the cover then remove the feet-locking pegs by pushing them through from the bottom of the feet. Compress the cruciform on the top of the feet to remove them, then replace the cover and secure using their fixing screws through the corner moldings.

## Power Input

All models in the 7000 Series operate on 12 V DC power. Each model is supplied with a line supply to 12 V DC adapter.

### Line Power Adapter

The detachable line supply cable, comprising two meters of 3-core PVC sheath cable permanently molded to a fully-shrouded 3-pin socket, fits in the IEC standard power input plug recess of the line power adapter and should be pushed firmly home.

The supply lead must be connected to a grounded outlet ensuring that the ground lead is connected. If the line power adapter has a line voltage switch, ensure that it is set to the correct operating voltage.

### **Caution**

**For the 7001 and 7004 Models, the supplied switched line power adapter must be correctly adjusted to local line voltage before connection to supply. Failure to correctly adjust the recessed switch beneath the IEC inlet socket to either "230V" or "115V" could result in damage to the line power adapter.**

The 12 V DC output lead from the adapter should be connected to the 5 pin DIN socket on the rear of the 7000N Nanoscan or 7000T Transref Module. Before applying power, refer to the System Configuration section below.

## ***Initial System Configuration and Calibration***

Before switching the power on for the first time, it is necessary to consider the configuration of the system and any 7000 Reference Modules fitted.

As supplied from the factory all 7000 Reference Modules are; 1) set to Auto Condition at power up, 2) set to be "In Average" mode 3) set to generate a 1.018 V low voltage output

The calibration supplied with the system applies to these settings only.

If either the green **Power OK** or red **Lo Charge** LEDs on the front panel are flashing the module is still being powered from its internal batteries and external power may be applied without any due concern regarding the state of calibration.

However, if neither the green **Power OK** or red **Lo Charge** LEDs on the front panel are flashing the internal batteries are discharged and the module is powered off. When external power is applied the batteries in each 7000 Reference Module will be recharged. Within the first 2 hours, the batteries will have received an initial charge and the module will power up and subsequently enter a "BOOST" and if enabled, a Conditioning cycle. Once finished, the modules will be ready for use and form part of the System Average. The calibrated value of the System Average is not valid until all the 7000 Reference Modules fitted are indicating that they are In Average.

See the "Condition Enable" section in Chapter 3 for details as to how to disable conditioning.

See the "In Average" section in Chapter 3 for details on how to set the In Average or Out of Average modes.

See the "1.018 or 1 V Output Selection" section in Chapter 3 for details of how to set the low voltage output to give 1 V output.

See "Installing the 7050 Volt Maintenance Software" in Chapter 3 for details of how to install the 7050 Volt Maintenance Software.

## Connectors and Pin Designations

### 7000N Rear Panel Connections

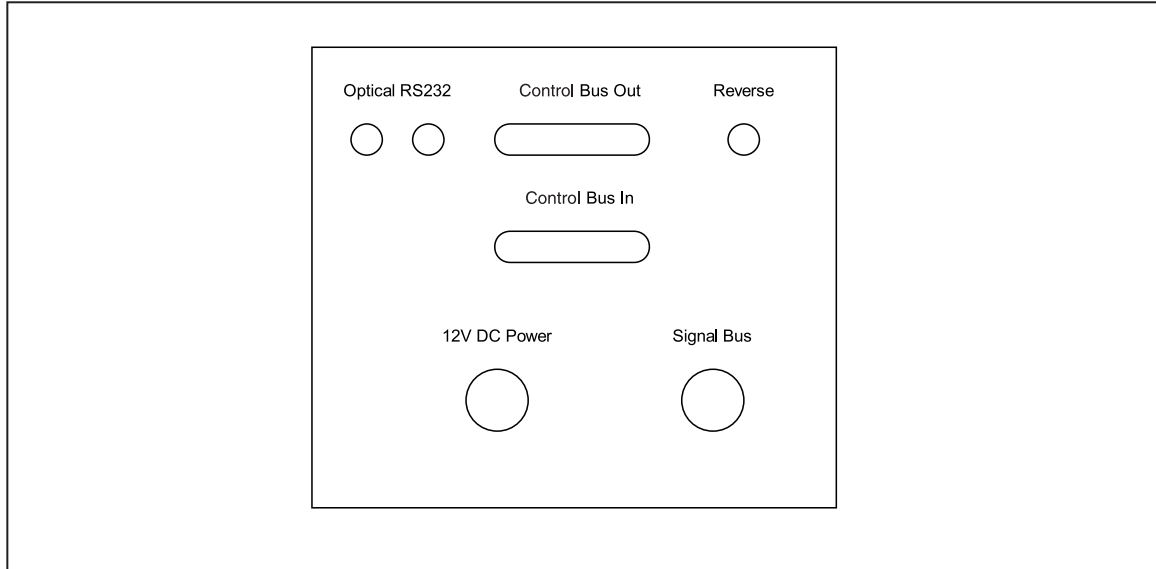


Figure 2-1. 7000N Rear Panel

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### Optical RS232

The optical RS232 interface connects the 7000N Nanoscan Module to the PC via a 10 m twin fiber optic cable (Part No. 1571650). To make the proper connections, use the following procedure:

1. It is necessary to attach the Fiber Optic Adapter (Part No. 1571593) to any available serial port on the PC. If necessary, use the 9 pin to 25 pin D type adapter (Part No. 1571587) to interface between the adapter and the serial port on the PC.
2. Slacken off the locking screw (counter clockwise), push the fiber optic cables firmly into the connectors and tighten the locking screw (clockwise). Be careful not to over tighten the locking screws.
3. Connect the white Tx Output from the 7000N to the Rx Input of the adapter. Connect the black Rx Input of the 7000N to the Tx Output of the adapter. To aid identification one of the cables is marked with white dots.

It is suggested that the optical interface is made first.

As standard, a 7004N or 7010N is supplied with 10 m of Fiber Optic Cable. If necessary, this may be shortened using a standard hot blade fiber cutting tool or sharp knife. Longer lengths are available.

Do not bend the fiber cable with a radius of less than 5 cm.

There is no safety hazard associated with the supplied Optical Interface as no laser diodes are used.



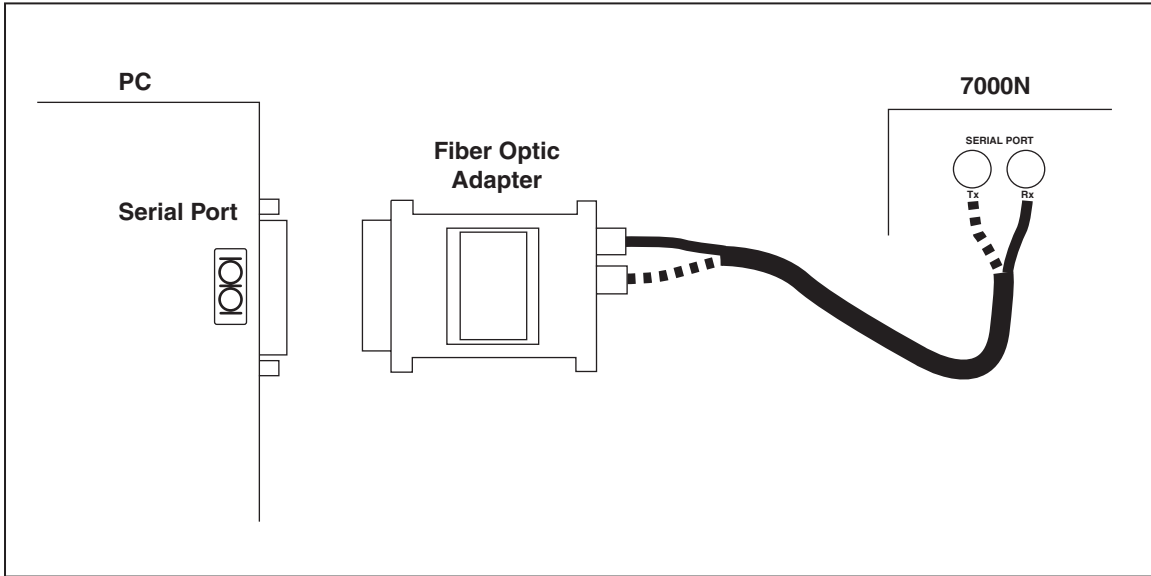


Figure 2-2. Optical RS232 Interface Connections

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**12 V DC Power Input**

The 12 V DC Power Input of the 7000N Nanoscan Module is via a 5 pin 180° DIN socket. The connections are as designated in Table 2-1.

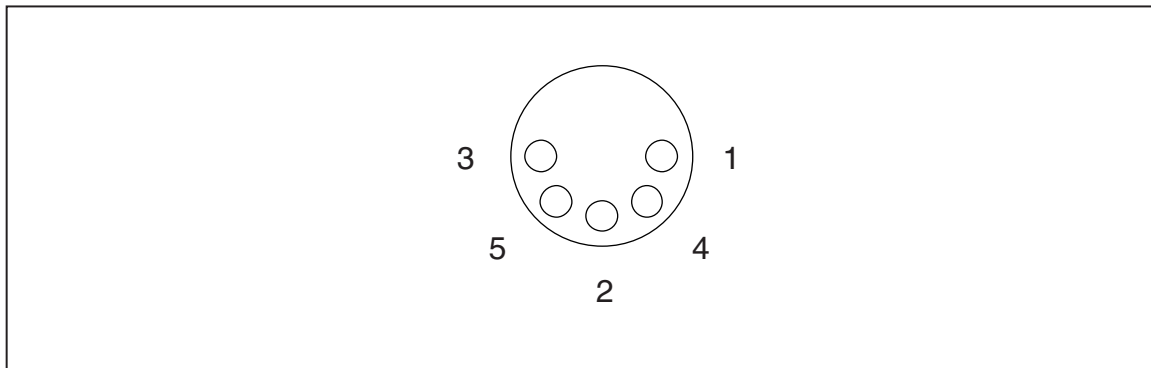


Figure 2-3. 12 V DC Power Input DIN Socket Connector

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Table 2-1. 7000N Nanoscan Module Connections

7000N Pin No.	Function
1	0 V
2	Case. (Connected to ground via the line supply adapter).
3	+12 V DC
4	0 V
5	+12 V DC

### Control Bus Out

The Control Bus Out connector on the 7000N Nanoscan Module is intended to drive a second extension rack such as a 7004T. It carries all the required control information to select channels and read back status information from 7000 or 7000S modules in such an extension rack. The two racks should be joined using the 15 way D Type lead (Part No. 1571623).

The connector is a 15 way D type plug. The connections are as designated in Table 2-2.

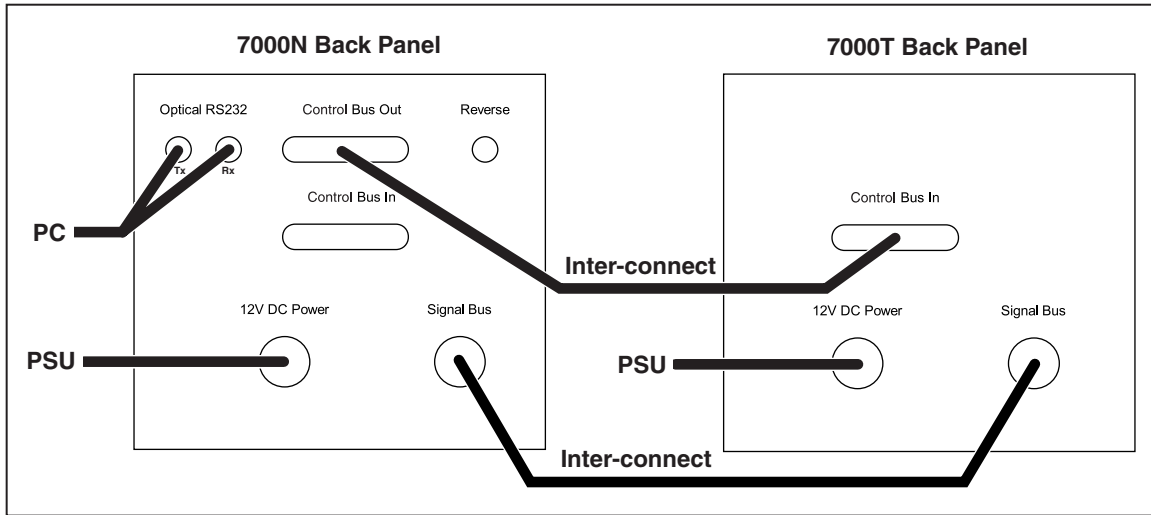
**Table 2-2. Extension Bus Out Connections**

7000N Pin No.	Function
1	Channel 11 Select_H
2	Channel 13 Select_H
3	Channel 15 Select_H
4	Channel 17 Select_H
5	Channel 19 Select_H
6	Reversal_L
7	Clock_L
8	Not used
9	Channel 12 Select_H
10	Channel 14 Select_H
11	Channel 16 Select_H
12	Channel 18 Select_H
13	Channel 20 Select_H
14	Data_H
15	Nanoscan 0 V

### Control Bus In

The Control Bus In connector on the 7000N Nanoscan Module is intended to be driven from a master Nanoscan Rack. It carries all the required control information to select channels and read back status information from 7000 or 7000S modules in a second rack. The two racks should be joined using D-Type lead Part No. 1571623.

The connector is a 15 way D-type socket.



**Figure 2-4. 7000N and 7000T Back Panel Connections**

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**Signal Bus**

The Signal Bus connector on the Nanoscan is intended for connecting the 10 V Reference and temperature signals of a secondary rack to the main rack using the Lemo Lead Part No. 1571638. Table 2-3 shows the signal bus connector pins.

**Table 2-3. Signal Bus Connector Pins**

7000N Pin No.	Function
1	0 V
2	Channel Lo
3	Channel Lo
4	Channel Hi
5	Channel Hi
6	Channel Temperature

Note that the connections are cross-coupled for added thermal emf cancellation.

**Reverse**

The Reverse connector is used to indicate to external equipment, such as a Josephson Array when the 7000 System is in its Reverse Mode.

The connector is a 3.5mm stereo jack socket. During Normal mode the tip and ring are open circuit. During Reverse mode the tip and ring are shorted together by a opto MOSFET. The contacts are therefore optically isolated from the 7000 System.

Table 2-4. Reverse Connector Pins

7000N Pin No.	Function
Tip	Reverse A
Ring	Reverse B
Sleeve	No connection

### 7000N Front Panel Connections

All the front panel connections to the 7000N Nanoscan Module are made via gold plated 4mm terminals. These can either take standard 4mm plugs or spade connections. For optimum performance, the supplied gold plated spade lead Part No.1571645 is recommended. All the terminals are floating with respect to the case terminal.

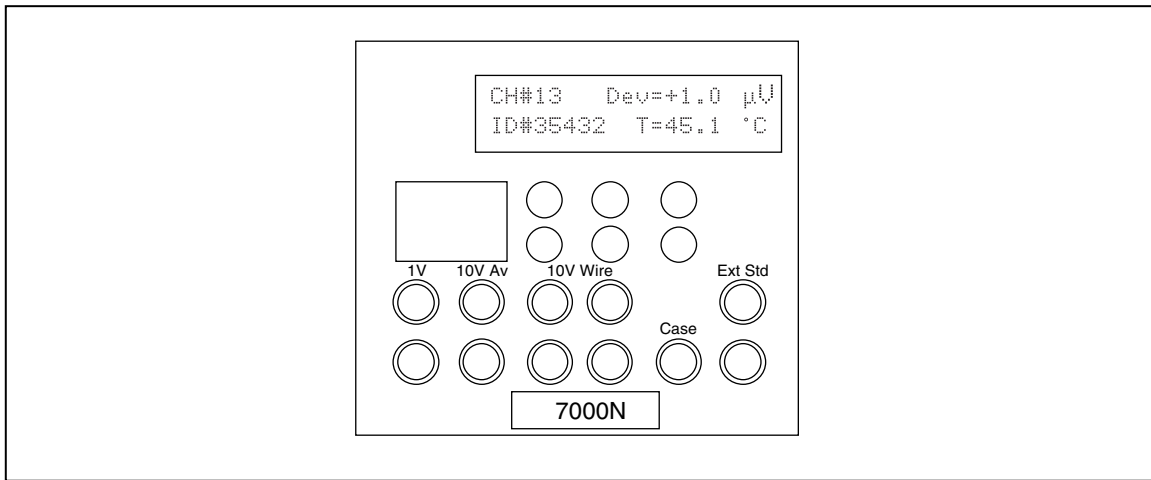


Figure 2-5. 7000N Front Panel Connections

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### 1 V Output

This is a passive resistively-divided output derived from the 10 V System Average. The red terminal is high with respect to the lo black terminal. During Reverse Mode the red terminal is negative with respect to the black terminal.

### 10 V Average Output

This is the 10 V System Average. It is the hardware average of all the 7000 Reference Modules that are selected to be in the System Average. The red terminal is high with respect to the lo black terminal. During Reverse Mode the red terminal is negative with respect to the black terminal.

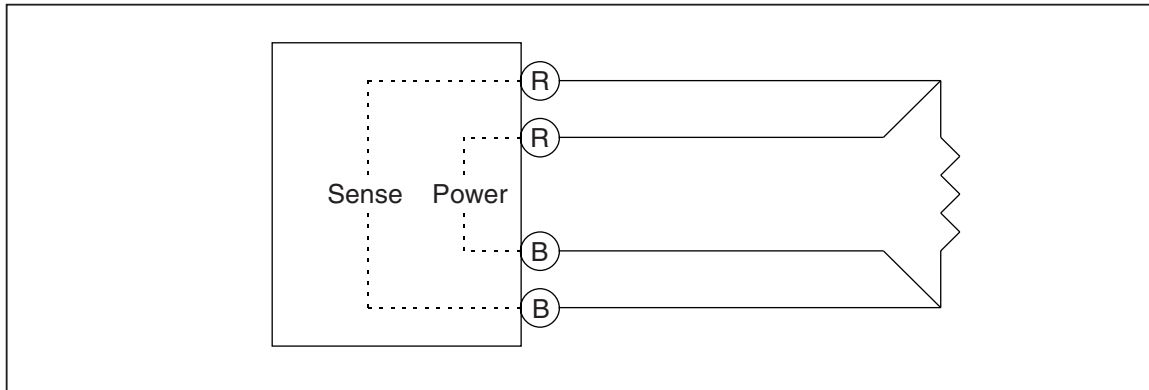
Depending on how many 7000 Reference modules are in the System Average, the performance will vary.

See the "System Average" section in Chapter 4 for an explanation of the 10 V System Average. See the "Specifications" section in Chapter 1 for full details of the Specification.

### 10 V 4 Wire Buffered Output

This is a 4 wire buffered version of the 10 V System Average output, described above. As the System Average output has a finite output resistance it is unsuitable for driving finite

loads such as a Kelvin Varley divider, without introducing errors. The 4 wire buffer is capable of sourcing up to 12 mA with negligible errors. The right hand pair of "current" terminals drive the load, the left hand pair of "sense" terminals control the voltage at the point of connection to the load, thus eliminating any errors caused by the load and any interconnecting lead resistance.



**Figure 2-6. 10 V 4-wire Buffered Output**

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### **Case Terminal**

This terminal is connected to the case of the 7000N Nanoscan Module and hence to the rack itself. It is intended that the screens of interconnecting leads would be attached to this to assist in preventing interference pick up.

It is connected to supply ground by the supplied line to 12 V DC power adapter (Part No. 1571579).

#### *Note*

*The case terminal is not a safety earth.*

### **External Standard Input**

This pair of terminals is intended for connecting to an external standard for either importing or exporting calibration. The External Standard may be a Normal or Reversible standard.

## 7000T Rear Panel Connections

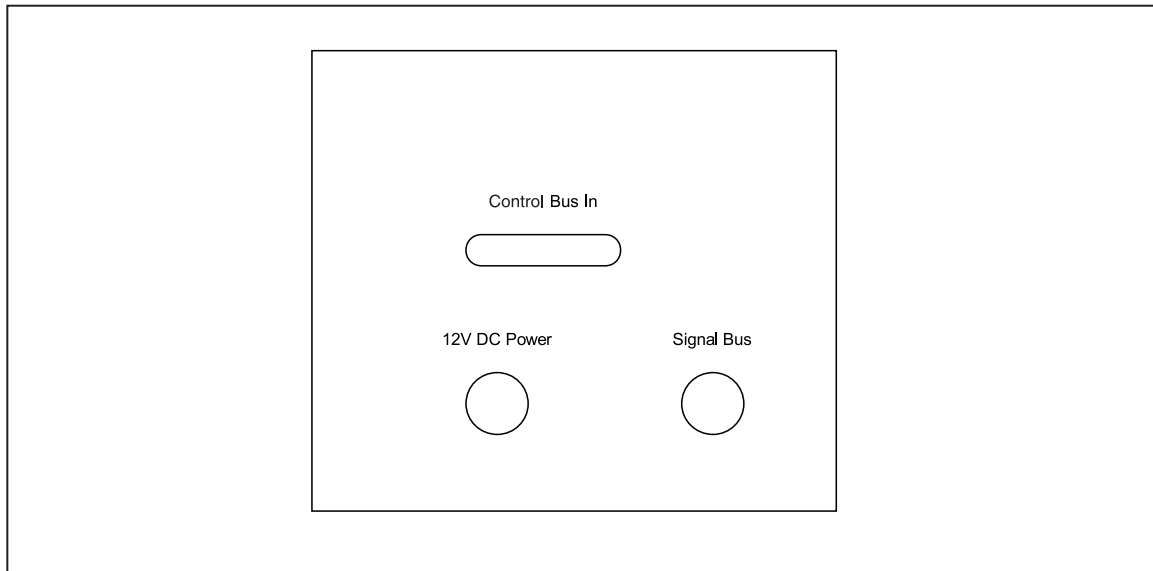


Figure 2-7. 7000N Rear Panel Connections

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### *Control Bus Input*

This is functionally the same as the 7000N Control Bus Input. See "Control Bus In" in this chapter.

### *12 V DC Power Input*

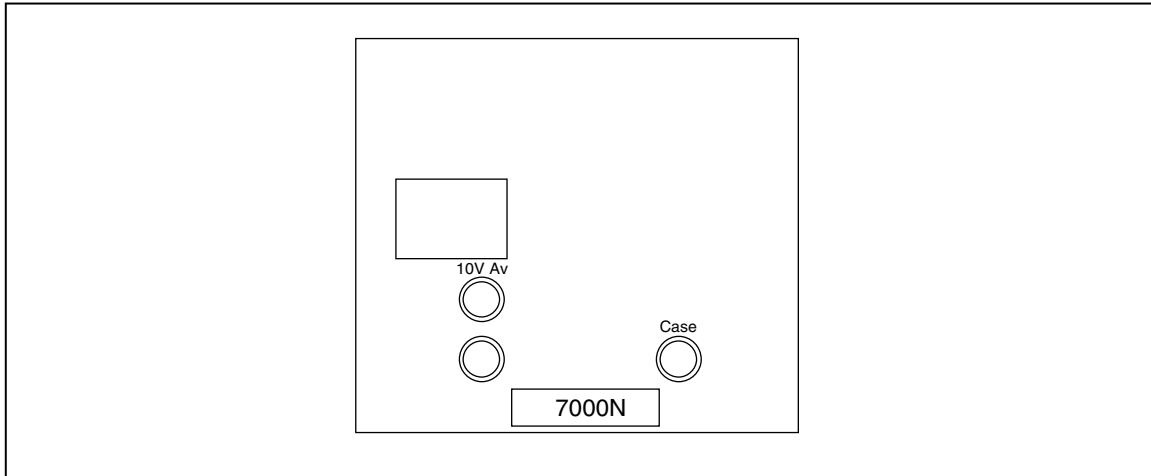
This is functionally the same as the 7000N 12 V DC Power Input. See "12 V DC Power Input" in this chapter.

### *Signal Bus*

This is functionally the same as the 7000N Signal Bus. See the "Signal Bus" section of this chapter.

### 7000T Front Panel Connections

All the front panel connections to the 7000T Transref Module are made via gold plated 4mm terminals. These can either take standard 4mm plugs or spade connections. For optimum performance the gold plated spade lead (Part No. 1571645) is recommended. All the terminals are floating with respect to the case terminal.



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**Figure 2-8. 7000T Front Panel Connections**

### 10 V Average Output

This is the 10 V System Average. It is the hardware average of all the 7000 Reference Modules that are selected to be in the System Average. The red terminal is high with respect to the lo black terminal. **During Reverse Mode the red terminal is negative with respect to the black terminal.**

Depending on how many 7000 Reference modules are in the System Average the performance will vary.

See the "System Average" section in Chapter 4 for an explanation of the 10 V System Average. See "Specifications" in Chapter 1 for full details of the Specification.

The 10 V Average Output of a 7000T would typically be connected to the External Standard Input of a 7000N System to Import Calibration, but can be used in isolation.

### Case Terminal

This terminal is connected to the case of the 7000T Transref Module and hence to the rack itself. It is intended that the screens of interconnecting leads would be attached to this to assist in preventing interference pick up.

It is connected to supply ground by the supplied line to 12 V DC power adapter (Part No. 1571579).

*Note*

*The case terminal is not a safety earth.*

## **Adding 7000 or 7000S Modules**

Additional 7000 Reference or 7000S 10 V Scan modules may be added to a 7000 System at any time. It is not necessary to disturb other modules by powering the system down.

### **Caution**

**If the new module is a 7000 Reference Module and the batteries have become discharged, it will go through the power up sequence described in Initial System Configuration and Calibration, when it is inserted into the powered rack. If a conditioning has been enabled the 7000 may undergo a conditioning cycle. Please check whether this is intended.**

See section "Enabling Conditioning".

Consider carefully whether the 7000 Module should be included in the System Average.

1. Remove blanking plate. Retain with fixing screws.
2. Insert new module into rack taking care to align the module with the guides.
3. Push fully home until the front panel is flush with other modules.
4. Using the supplied knurled fixing screw secure the module into the rack.

## **Removing 7000 or 7000S Modules**

7000 Reference or 7000S 10 V Scan modules may be removed from a 7000 System at any time. It is not necessary to disturb other modules by powering the system down.

### **Caution**

**If the module being removed is a 7000 Reference Module that is In Average, the value of the System Average will be affected. It will be necessary to determine the new value of the System Average by performing a Virtual Import. See section "Value of HAV (Hardware Average)" in Chapter 4.**

1. Remove the knurled fixing screw securing the module into the rack.
2. Insert the extraction tool into the hole and slide to the left to engage the tip behind the slot.
3. Pull the module out using the extraction tool. Do not remove modules by pulling on their terminals.
4. Fill empty slot with a blanking plate, securing with the screws provided.



# **Chapter 3**

## **7000 Series Module**

### **Controls and Indicators**

<b>Title</b>	<b>Page</b>
Introduction.....	3-3
7000 Reference Module Front Panel .....	3-3
Front Panel Controls.....	3-3
In Average.....	3-3
Conditioning Enable.....	3-4
1.018 V or 1 V Output Selection.....	3-5
10 V Output Adjustment.....	3-5
Boost Charge.....	3-5
7000 Reference Module Indicators.....	3-6
Power OK.....	3-7
Lo Charge.....	3-7
Oven Fail.....	3-7
Conditioning.....	3-8
In Average.....	3-8
Selected .....	3-8
Indicator Summary Table.....	3-8
7000S 10 V Scan Module Front Panel Controls .....	3-9
7000S Front Panel Controls.....	3-9
7000S Front Panel Indicators .....	3-9
7000N Nanoscan Module Front Panel Controls .....	3-10
Front Panel Controls.....	3-10
Local.....	3-10
Hold.....	3-10
Up Down Channel Select.....	3-11
External Standard Select .....	3-11
Reverse.....	3-11
Include Reversal Switch.....	3-11

Front Panel Scan Status Display.....	3-12
Channel Field .....	3-12
Deviation Field.....	3-12
ID Number Field .....	3-12
Temperature Field .....	3-12
Miscellaneous Display Messages.....	3-13
7000T Transref Module Front Panel Controls.....	3-13
7001 Rear Panel- Earth Terminal .....	3-14

## Introduction

This chapter is a detailed description of the front panel controls and indicators on the various 7000 Series Modules.

## 7000 Reference Module Front Panel

### Front Panel Controls

The 7000 Reference Module contains front panel controls for setting whether the module is included in the System Average, Conditioning is Enabled and 1.018 V or 1.000 V Output selected.

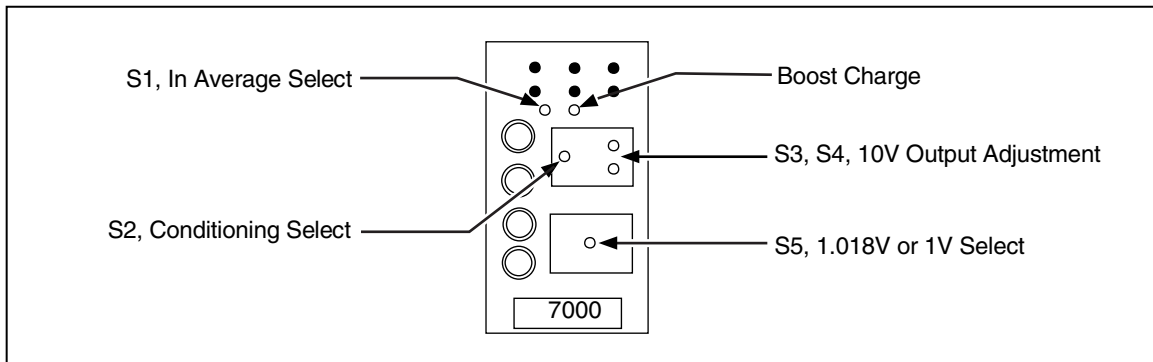


Figure 3-1. 7000 Reference Module Front Panel Controls

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### In Average

The front panel recessed switch, S1, sets whether the 7000 Reference Module is either "In" the System Average or "Out" of the System Average.

The switch is recessed to avoid accidental adjustment therefore potentially changing the System Average. It is recommended that the switch be covered by a tamper proof label. The switch is a rotary switch and is best adjusted using a small (3mm) flat bladed screwdriver.

Table 3-1. S1 Adjustment

Position	Function
Clockwise	Module Out of Average
Counter Clockwise	Module In Average (Factory Default)

With the Module In Average, the green Average LED above the switch is illuminated.

A module would be excluded from the System Average and switched Out of Average if it was felt by the operator that its performance was erratic and affecting the quality of the System Average. A module would be returned to being included in the System Average and switched to In Average if the operator decided that the module was behaving adequately to enhance the performance of the System Average.

A new module added to the system with the intention of enhancing the System Average would initially be used Out of the System Average, until its behavior was assessed. Once the operator is satisfied with the new module it may be included in the System Average.

Switching a module In or Out of Average will affect the value of the System Average. If a module is to be removed from the system and dispatched for calibration, it should be removed from the System Average. On return from calibration, the calibrated module's 10 V output should be connected to the Nanoscan external input.

Note that the 7050 Software detects whether a given channel is In or Out of the System Average, and warns the operator of any changes. The 7050 Software can be used to recalculate the System Average as individual modules are switched In or Out of Average.

As supplied from the factory all 7000 Reference Modules pre-fitted into 7000 Systems are set to be "In" Average. They are therefore part of the calibration of the System Average Output.

### Conditioning Enable

The front panel switch, S2, sets whether the 7000 Reference Module is set to automatically condition upon the restoration of module power.

Table 3-2. S2 Adjustment

Position	Function
Clockwise	Conditioning Disabled
Counter Clockwise	Conditioning Enabled (Factory Default)

The switch is a rotary switch and is best adjusted using a small (3mm) flat bladed screwdriver.

The switch is recessed and hidden behind the 10 V Calibration label to avoid accidental adjustment, as the Conditioning process may have a profound affect on the modules output and may also affect the System Average.

If Conditioning is enabled, every time power is restored and the batteries are sufficiently recharged, the Conditioning process will begin and recover the reference element from any stress that may have been acquired as a result of any low temperature thermal exposure during transit.

If power is already applied and the Conditioning switch is adjusted to "enable", a Conditioning cycle will be initiated. The conditioning process takes approximately 8 hours to complete. If the switch is accidentally adjusted to enable, there is a safety interval of about ten minutes to reset the switch to "disable" before anything happens.

If the Conditioning process is under way the red Conditioning LED will be illuminated. The LED extinguishes at the end of the cycle.

As supplied from the factory all 7000 Reference Modules are set with Conditioning Enabled and will Auto Condition at power on.

### Caution

**It is not recommended that Conditioning be disabled during a Conditioning cycle.**

Conditioning operates during the "Boost" mode (see "Boost Charge") if it is enabled but only if there has been a complete power failure. It is not triggered by a front panel commanded "Boost".

**1.018 V or 1 V Output Selection**

The low voltage output from the 7000 Reference Module may be set to give either a nominal 1.018 V or 1 V Output.

**Table 3-3. S5 Adjustment**

Position	Function
Clockwise	1 V
Counter Clockwise	1.018 V (Factory Default)

The switch is a rotary switch and is best adjusted using a small (3mm) flat bladed screwdriver. The switch is recessed and hidden behind the Lo Voltage Calibration label to avoid accidental adjustment. Changing the state of the switch will require the output to be calibrated.

As supplied from the factory all 7000 Reference Modules are set and calibrated with the low voltage output set to 1.018 V.

**10 V Output Adjustment**

Rotary switches S3 and S4 hidden behind the 10 V Calibration Label are used to adjust the 10 V Output.

**Boost Charge**

The 7000 series Reference Modules are enhanced with a new battery-charging system, called "Boost Charge" allowing users to better guarantee full-battery charge prior to self-powered use. This arrangement allows full charging to be triggered any time, whatever the starting battery state. These units are identified by the recessed front panel "Boost Charge" switch.

**Operation**

After the initial charge from a "flat" state which takes up to 2.5 hours, the unit automatically enters "Boost Charge" mode during which time precision operational use is not recommended. During this period of about 14 hours (overnight is suggested) the battery is charged at a rate of approximately C/12 where the batteries fitted have a capacity "C" of 1600 mA.H. Any external power interrupts during this time could result in less than full charge being achieved but it is then quite safe to repeat the Boost period (without the initial charge period of 2.5 hours) by depressing the recessed front panel "Boost" switch.

While in Boost mode, either entered automatically or front-panel triggered, the unit indicates this condition by holding the red "Lo Charge" LED ON even though the green "Power OK" LED is also ON. The green "Power OK" should be interpreted as meaning that the unit is operating functionally, with sufficient power supply voltage to operate internal circuits but not necessarily with a fully-charged battery. After "Boost" has finished the red "Lo Charge" LED turns OFF indicating that the battery is now charged. If starting from a near fully discharged state, a second "Boost" period is recommended.

Note that with the Power "Power OK" ON and "Lo Charge" OFF, this only indicates that the charge condition is at least adequate to run the internal Zener oven for an hour or so. Timing a full charge-on-demand ensures that the battery is fully charged just after its completion and then capable of battery operation for up to 36 hours. It is recommended that prior to critical use, under battery power, a full "Boost" period is triggered via the front panel. Repeating "Boost" periods will not shorten the battery life.

If Boost Charge is front-panel triggered when the unit is operating under battery power, a false but safe state is set with the red "Lo Charge" LED ON. If this happens, it is recommended to re-connect power and wait until the boost period has completed.

Shortly after power is removed, the "Power OK" LED flashes. If the battery is fully charged this may not happen immediately but flashing will start when the battery Voltage drops below its charging voltage, usually a matter of minutes at most.

### **Conditioning**

Conditioning operates during the Boost mode if it is enabled, but only if there has been a complete power failure. It is not triggered by a front panel commanded "Boost".

### **Specification for Boost**

This facility changes the external power requirements to higher current drive during Boost charging and also allows a wider range of input Voltage. Additionally, the battery fitting is of higher capacity.

Input Voltage Range (operational, charging):	11 V to 14.5 V
Input Voltage Range (preferred):	11.5 V to 13 V
Nominal input current:	100 mA
Nominal "Boost" input current:	250 mA

### **External Power Supply**

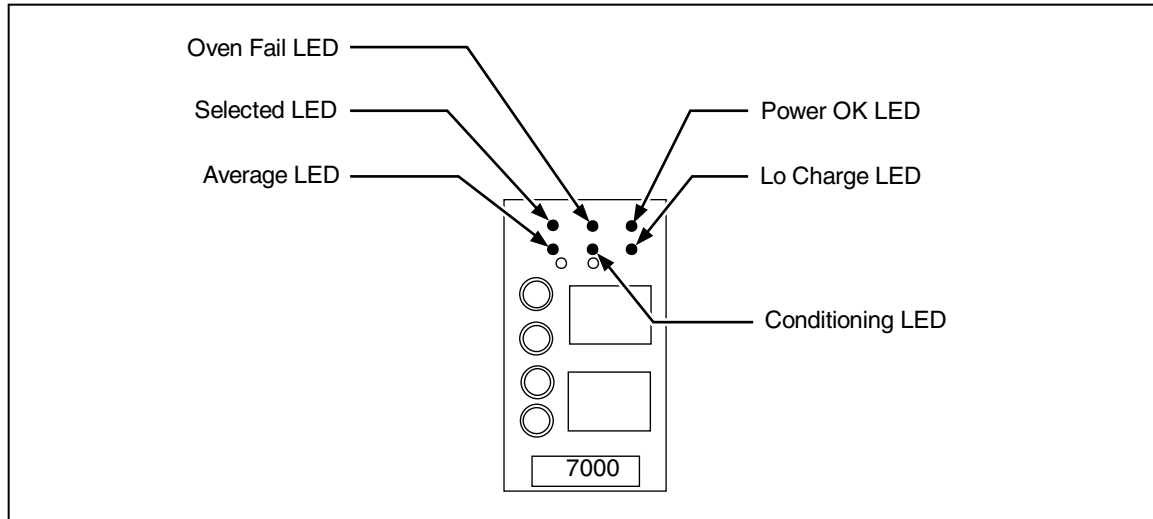
Extra power is required to support the boost charge, and certain configurations of 7004 and 7010 systems may be supplied with higher current external supply units. All units provide undetectable 7000 module output voltage differences between external power ON and OFF under worst case conditions. However, it is recommended, for good practice, that the following notes be considered:

#### *Notes*

- *The supply provided is connected to safety earth via the IEC 320 connector earth pin and a 3 pin plug lead should always be used. For best results the external lug of the 7001, 7004 or 7010 chassis should connect back to a "quiet" or reference earth. This provides a return path for HF interference coming from other equipment.*
- *It is recommended that a spacing of 0.5 m (18 ") is maintained between the power supply unit and any sensitive equipment to avoid residual electrostatic or magnetic Common Mode coupling effects.*

### **7000 Reference Module Indicators**

The 7000 Reference Module contains 6 front panel indicators that can be used to determine the state of the module.



**Figure 3-2. 7000 Reference Module Indicators**

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### **Power OK**

The green Power OK LED indicates the presence of power in the 7000 Module. A constant green indicates the presence of external 12 V DC power and that the battery is sufficiently charged. This is the normal operating state. The battery is being trickle charged.

A flashing green indicates that the 7000 module is running under battery power. This state would be expected during initial transit or if the unit was being deliberately run on batteries to avoid possible line power effects. New fully charged batteries will support this state for at least 24 hours.

### **Lo Charge**

A constant red Lo Charge LED indicates that there is insufficient charge in the battery and that it is being fast charged from the external 12 V DC supply, and there is no output from the 7000 Module. This state would be expected after shipment and will last for less than 1 hour. When there is sufficient charge in the battery, the Lo Charge LED will go out and the green Power OK LED will illuminate. The battery will now continue to be trickle charged indefinitely, taking up to 10 days to achieve full charge.

A flashing red indicates that the 7000 module is running under battery power but the charge is running low. This state warns the operator that there is approximately 1 hour of battery life remaining. External power should be re-applied to avoid any problems with control of the reference element's oven control and any possible hysteresis effects on the output voltage.

### **Oven Fail**

The red Oven Fail LED indicates that the reference element is not at the correct operating temperature, typically 47° C. This would be expected after power is restored and the battery recharged. This state should last for approximately 20 seconds.

During Conditioning, the temperature of the reference element is cycled up and down. It is possible that the LED will illuminate during a cooling cycle. This condition should be ignored.

**Conditioning**

The red Conditioning LED indicates that the Conditioning process is in progress. This state lasts for approximately 8 hours. This state would be expected after the restoration of external 12 V DC power and the initial recharging period of the battery.

**In Average**

The green In Average LED is illuminated when the 7000 Module is contributing to the System Average.

**Selected**

The green Selected LED illuminates when the 7000 Module is being scanned by a 7000N Nanoscan Module.

**Indicator Summary Table**

The following tables describes the various states of the indicators for typical power up and power down of the 7000 Module.

**Table 3-4. Power Up - Conditioning Enabled (as supplied from the manufacturer)**

<b>Lo Charge (Red)</b>	<b>Power OK (Green)</b>	<b>Oven Fail (Red)</b>	<b>Conditioning (Red)</b>	
OFF	OFF	OFF	OFF	Module is completely unpowered. No external power applied, battery is discharged.
ON	OFF	OFF	OFF	External 12 V DC power has been re-applied after battery discharge. Battery is being "fast" charged. Module disabled. This state lasts for less than 2.5 hours.
ON	ON	OFF	ON	Battery initially charged. Module enabled. Battery is being "Boost" charged. Conditioning and "Boost" Cycles are in progress. Conditioning lasts for approximately 8 hours during the "boost" period of 14 hours.
OFF	ON	ON	ON	Transitional state during Conditioning. Indicates the reference element is cooling.
OFF	ON	OFF	OFF	Conditioning and Boost have finished. Module is now ready for normal operation but a thermal stabilization wait period of ½ hour is advisable.



**Table 3-5. Power Up - Conditioning Disabled**

Lo Charge (Red)	Power OK (Green)	Oven Fail (Red)	Conditioning (Red)	
OFF	OFF	OFF	OFF	Module is completely unpowered. No external power applied, battery is discharged.
ON	OFF	OFF	OFF	External 12 V DC power has been re-applied after battery discharge. Battery is being "fast" charged. Module disabled. This state lasts for less than 1 hour.
ON	ON	ON for 20 secs then OFF	OFF	Battery initially charged. Module enabled. Battery is being "Boost" charged. Oven reaches temperature after 20 secs. Boost state lasts for approximately 14 hours.
OFF	ON	OFF	OFF	Boost Charge has finished and Module is now ready for normal operation but a thermal stabilization wait period of ½ hour is advisable.

**Table 3-6. Power Down**

Lo Charge (Red)	Power OK (Green)	Oven Fail (Red)	Conditioning (Red)	
OFF	ON	OFF	OFF	Normal operating state.
OFF	Flashing	OFF	OFF	External 12 V DC power has been removed. Battery is supplying the module power. Fully charged batteries will support this state lasts for at least 24 hours.
Flashing	Flashing	OFF	OFF	Battery charge is running low. Indicates approximately 1 hours battery life remaining.
OFF	OFF	OFF	OFF	Module is completely unpowered.

## **7000S 10 V Scan Module Front Panel Controls**

### **7000S Front Panel Controls**

The 7000S 10 V Scan Module has no front panel controls.

### **7000S Front Panel Indicators**

There is a single green Selected LED that illuminates to indicate that the module is being scanned by a 7000N Nanoscan module.

A 7000S may not contribute to the System Average.

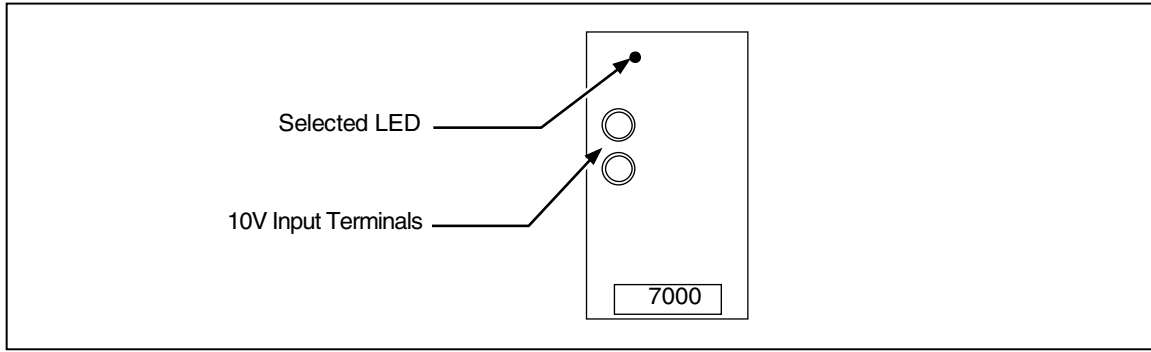


Figure 3-3. 7000S Front Panel Indicators

aho18f.eps

## 7000N Nanoscan Module Front Panel Controls

### Front Panel Controls

The 7000N Nanoscan Module offers front panel controls and a status display for manual operation of the 7000 System. These are described below.

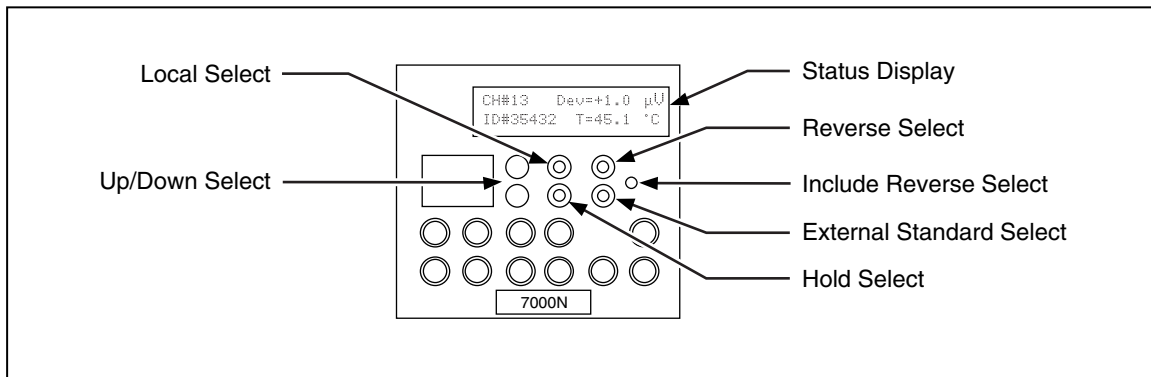


Figure 3-4. 7000N Front Panel Controls

aho08f.eps

### Local

The Local key and built-in LED control and indicate whether the 7000N Nanoscan module is under local or remote control:

- If the LED is illuminated the module is under local control and the rest of the controls on the front panel are active.
- If the LED is off, the module is under remote control. To return the unit from remote to local control, press the Local key and the LED will illuminate.

Do not set the module into Local control while the System is being remotely scanned as this may affect the integrity of the scan..

### Hold

The Hold key and built in LED control and indicate whether the 7000N Nanoscan Null Detector ADC is taking readings.

- If the LED is illuminated, the Null Detector ADC is held and not taking readings. To take a single reading, press the Hold key briefly. To set the ADC to take readings continuously, press the Hold key for 1 second. The Hold LED will then be off.
- If the LED is off the ADC is continuously taking readings of the selected channel. To stop or Hold the ADC press the Hold key and the LED will illuminate. Any reading in progress will be completed. Each reading takes approximately 4 seconds.

### *Up Down Channel Select*

The two keys marked  $\uparrow$  and  $\downarrow$  control which channel is to be measured by the Null Detector. They may be used to step between channels 00 and 20.

- Empty channels are skipped.
- Channel 00 is the Null Detector Zero or Offset.
- Channels 01 to 10 are in the main Nanoscan rack.
- Channels 11 to 20 are in a secondary extension rack.
- Channel 21 is the External Standard Input on the front of the Nanoscan.

### *External Standard Select*

The External Standard key selects Channel 21 - the External Standard Input to be measured by the Null Detector.

Its operation is such that it toggles between Channel 21 and the previously selected Channel. With the LED illuminated, Channel 21, the External Standard is selected.

### *Reverse*

The Reverse key and built in LED control and indicate whether the 7000 System is in the Forward or Reverse Mode.

- With the LED off, the system is in the Forward mode.
- With the LED illuminated the system is in Reverse Mode.

Pressing the key toggles between the two modes. If a Transref is connected, it will also reverse all modules, including the HAV output.

### *Include Reversal Switch*

This recessed rotary switch should be set according to the type of reference connected to the External Standard Input.

The Include Reverse switch is best adjusted using a small (3mm) flat bladed screwdriver.

When Reverse Mode is selected, the 7000 System flips the System Average to -10 V. As the Null Detector uses the System Average as its reference and it only has a full scale range of  $\pm 10$  mV, any applied External Standard must also flip to -10 V. Most traditional references cannot do this, and the 7000N module needs to internally reverse the terminals. However, a second 7000 System connected as an extension rack, can reverse at source, in which case the 7000N module does not need to reverse the terminals.

**Table 3-7. Include Reversal Switch Adjustment**

Setting	Mode	Typical References
cw	Internal Reversal for a non-reversing reference	Fluke 732A, 732B Wavetek 4910, 4911, 4912 Fluke 7001 Fluke 7000 System with NO Rear Panel Extension Bus connections made
ccw	No Internal Reversal for a reversing reference	Fluke 7000 System with Rear Panel Extension Bus connections made

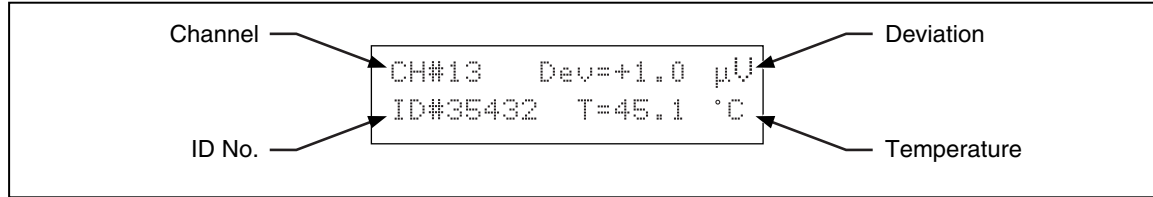
As supplied from the factory the default switch setting is clockwise.

### Front Panel Scan Status Display

The 7000N Nanoscan Module contains a two line by 20 character LCD to indicate the scan status. Normally, the Scan Status display will show four data fields as shown on the typical display below; A flashing cursor in the middle of the top line indicates that readings are in progress.

### Channel Field

This indicates the selected channel number between 00 and 21. Empty channels are skipped under front panel control.



**Figure 3-5. Channel Field Indicator**

aho20f.eps

### Deviation Field

This is the measured difference of the selected channel relative to the System Average. The Null Detector has a full scale range of -9999.9 to +9999.9 μV. Channels outside this range report OUT\_OF\_RANGE

When a channel is first being measured, there is no valid difference to display. This field therefore reports READING\_CH

### ID Number Field

If the selected channel contains a 7000 Reference Module that module's unique ID No. is reported. This ID No. is set during manufacture.

If the selected channel contains a 7000S 10 V Scan Module, the ID No. is replaced by S\_ ## where ## is the channel number.

### Temperature Field

If the selected channel contains a 7000 Reference Module, the oven temperature of the reference element is reported.

If the selected channel contains a 7000S 10 V Scan module, the field reports the internal temperature of the scan module.

Channels 00 and 21 do not have an oven temperature available to report. For these channels the ambient temperature, Ta, is reported.

This is the internal temperature of the 7000N Nanoscan module adjacent to the front panel. This enables changes in the ambient room temperature to be monitored. This may be of interest during any Import or Export process.

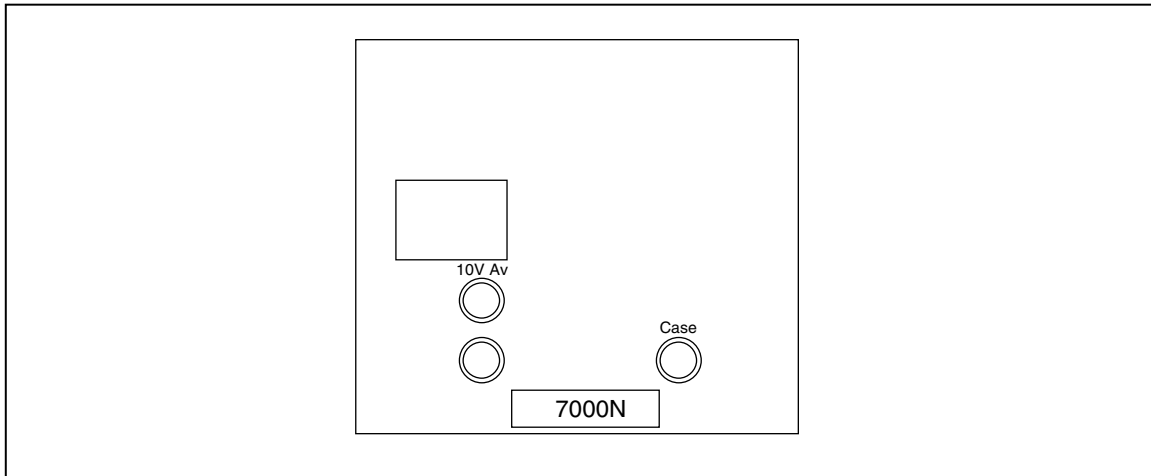
During Reverse Mode, the temperature output from a 7000 Reference Module cannot be measured by the Null Detector and the field reports NEG\_POL.

**Miscellaneous Display Messages**

Displayed Message	Description
NO_10 V_AVERAGE (NANOSCAN_FAULT)	No System Average present. All reference modules are set as being Out of Average. At least one must be In Average. This message typically occurs after transit while the batteries are initially being recharged. When at least one of the modules becomes active, the 7000N will re-initialize.
OUT_OF_RANGE	Channel Difference exceeds 10 mV.
NEG_POL	Indicates Reverse Mode selected and temperature information not available.
INPUT_FAULT	The External Standard is outside the range of 10 V $\pm$ 10 mV.
READING_CH	Deviation field, 1 <sup>st</sup> reading in progress
WAIT	Temperature field, 1 <sup>st</sup> reading in progress
CONDITIONING	7000 Reference Module is conditioning
REF_FAULT	Module has stopped responding
INVALID_CH	No module fitted in requested channel
FAULT	Temperature fault
HIGH	Temperature too high
LOW	Temperature too low

**7000T Transref Module Front Panel Controls**

The 7000T Transref Module has no front panel controls or indicators.



aho15f.eps

**Figure 3-6. 7000T Transref Module Front Panel Controls**

### ***7001 Rear Panel- Earth Terminal***

Not required due to double isolation of DC/DC converter and AC/DC converter.

# **Chapter 4**

## ***Volt Maintenance Terminology and Practices***

<b>Title</b>	<b>Page</b>
Introduction.....	4-3
Laboratory Reference Standard .....	4-3
Transfer Standard .....	4-3
System Average.....	4-4
Switching 7000s In and Out of Average .....	4-4
Reversal Measurements.....	4-5
Data Capture.....	4-6
Scanbase .....	4-7
Scan ID No. ....	4-7
Data Transfer .....	4-7
Pre and Post Import Scans.....	4-7
Volt Maintenance Practices .....	4-7
Basic Procedures.....	4-8
Basic Confidence .....	4-9
Import Calibration.....	4-9
Value of HAV (Hardware Average).....	4-10
Export Calibration.....	4-10





## **Introduction**

This chapter acts as a glossary of terms used in 10 V DC maintenance.

### **Laboratory Reference Standard**

The Laboratory Reference Standard would normally be expected to permanently reside in the laboratory.

A typical Reference Standard would be a 7010N System with ten 7000 Reference Modules.

Confidence in the Reference Standard is achieved by intercomparing the individual reference Modules against the System Average.

This intercomparison is made easy by the use of a 7000 System. The built in features of the 7000 Reference Module and 7000N Nanoscan module and rack, when combined with the 7050 Software, eliminate the need for separate references, interconnections, scanner, DMM and software.

### **Transfer Standard**

The Transfer Standard moves from laboratory to laboratory transferring calibration between installations.

Calibration is imported from a "higher" laboratory such as a National Laboratory. Calibration is exported to a "lower" laboratory.

The Import or Transfer Standard moves from the laboratory to an external laboratory for calibration.

Upon its return, calibration is imported or transferred to the resident Reference Standard. Such an external laboratory would be a National Standards Laboratory where the 7000 System could be directly calibrated against a Josephson Array.

Similarly, the Transfer Standard can be used to export or transfer calibration to a Reference Standard at another location.

A typical Transfer Standard would be a 7004T with four 7000 Reference Modules. Such a Transfer Standard does not necessarily need all features of the scanning system provided by a 7004N or 7010N Nanoscan System.

Using a 7000T (or 7000N) System as a Transfer Standard makes the process of importing and exporting calibration to another 7000N System simplicity itself, as the individual Reference Modules and the Average in the Transfer Standard may be included in the basic scanning process of the Laboratory Reference Standard. Using the 7050 Software makes it even easier.

Note that it is feasible to remove a 7000 Module from a system and use it as a Transfer Standard. However, care needs to be taken that it is not normally part of the System Average, otherwise the value of that average will change dependent on whether the module is fitted or not.

### **System Average**

The 10 V System Average available on either a 7000N or 7000T system is an average of all the 7000 Reference Modules fitted in that rack that are set to be In Average. The average is achieved by passive resistor averaging. The average of a group of references will exhibit better performance than a single reference and exhibit:

- lower noise
- lower temperature coefficient
- better predictability of the drift and hence lower uncertainty in the 10 V Average Output.

The system average is less prone to any erratic behavior of an individual reference, providing a greater degree of confidence.

The System Average of each rack is based only on the modules in that rack. As a typical system is expected to be a 7010N Laboratory Reference Standard with a 7004T Transfer Standard that is transported, it is undesirable to have the System Average changing every time the 7004T is connected or disconnected.

7000S 10 V Scan modules cannot be included in the System Average because variations in source resistance may upset the resistive average.

### **Switching 7000s In and Out of Average**

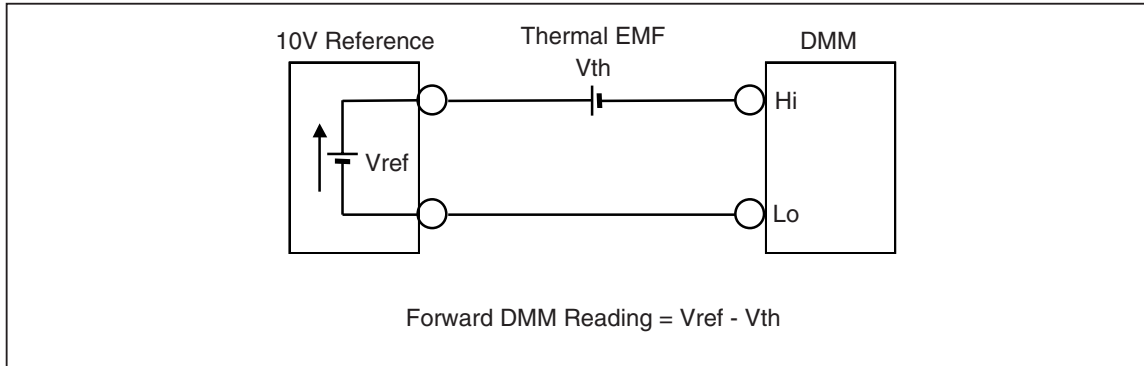
Individual 7000 Reference Modules may be In or Out of the System Average under operator control. Modules that are expected to be removed from the system for independent use would not normally be expected to be included in the average. Each time a module is included or excluded from the System Average, the value of the System Average and its drift rate will need to be reassessed.

Should a module show signs of erratic behavior such that it may be disturbing the performance of the System Average it may be excluded from the System Average. Such erratic behavior would be detected by the routine check scans. The 7050 Software is capable of performing a Virtual or Soft Import to help re-assign a value and a drift rate to the new System Average. Should the modules behavior subsequently be shown to be satisfactory it may be returned to the System Average and another Virtual Import performed.

The most common requirement to add a reference to the system average is when more modules are added to a system to enhance its performance and achieve lower uncertainty. For example, a 7010N System may initially only be populated with four 7000 Modules. At a later date, an enhanced performance may be required at which point up to a further six modules could be added. Each of these modules would be monitored Out of Average against the existing System Average to determine their value and drift rate. When these are satisfactorily known, they can then be included in the System Average.

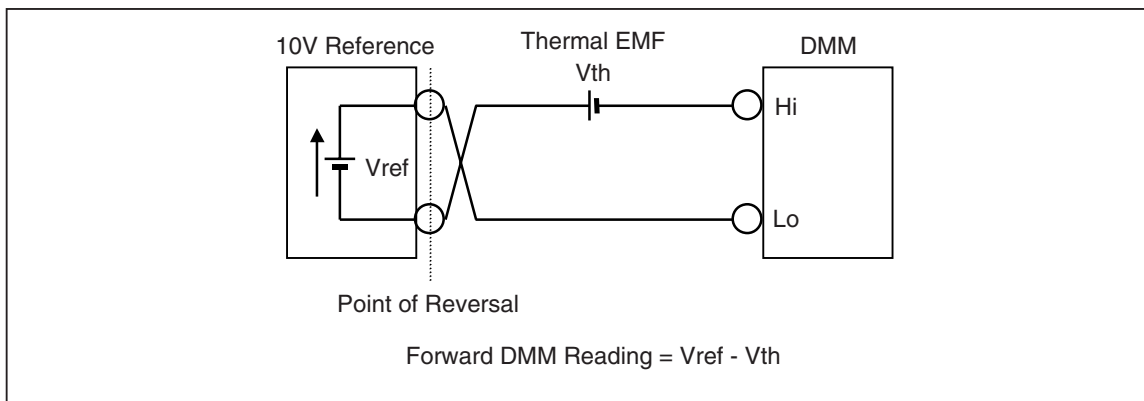
**Reversal Measurements**

Measurements are made using reversals to eliminate thermal emfs introduced by any interconnections.



**Figure 4-1. Forward (Normal) Measurement**

aho22f.eps



**Figure 4-2. Reverse Measurement**

aho22f.eps

Therefore

$$V_{ref} = (+ \text{Forward DMM Reading} - \text{Reverse DMM Reading}) / 2 \quad V_{th} = (- \text{Forward DMM Reading} - \text{Reverse DMM Reading}) / 2$$

Any thermal emf to the right, measurement side, of the point of reversal is removed. Any thermal emf to the left, source side, of the point of reversal is not removed. For example, any Internal thermal emfs inside the Reference just form part of the Reference.

The closer the point of reversal can be made to the reference element the better.

In the 7000 Series the reversal switching is included in the 7000 Reference Module. Therefore any thermal emfs generated by the backplane interconnections through into the 7000N Nanoscan module are removed.

Backplane connections sense direct to Front panel terminals.

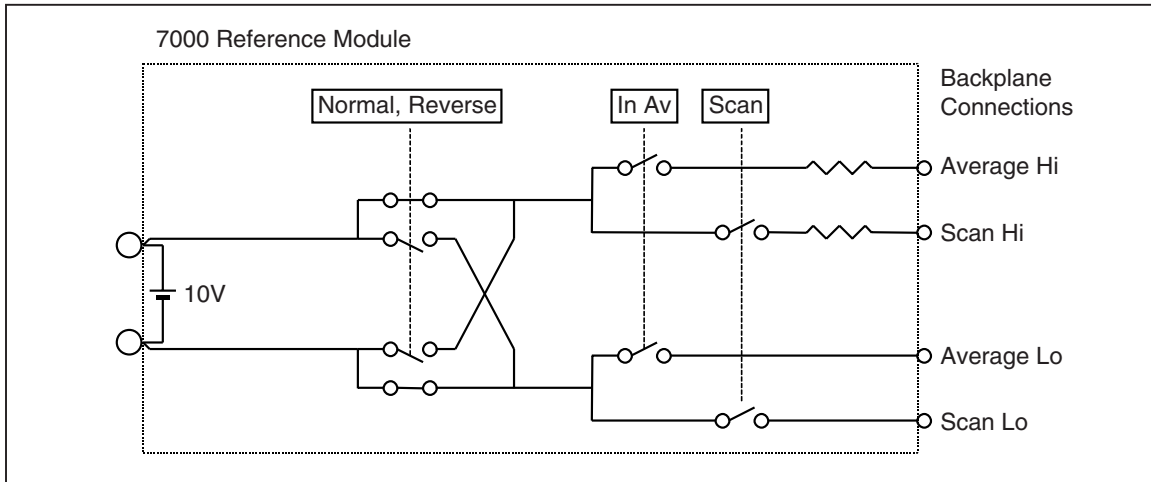


Figure 4-3. Backplane Connections

aho24f.eps

A 7000S 10 V Scan Module contains reversal switches

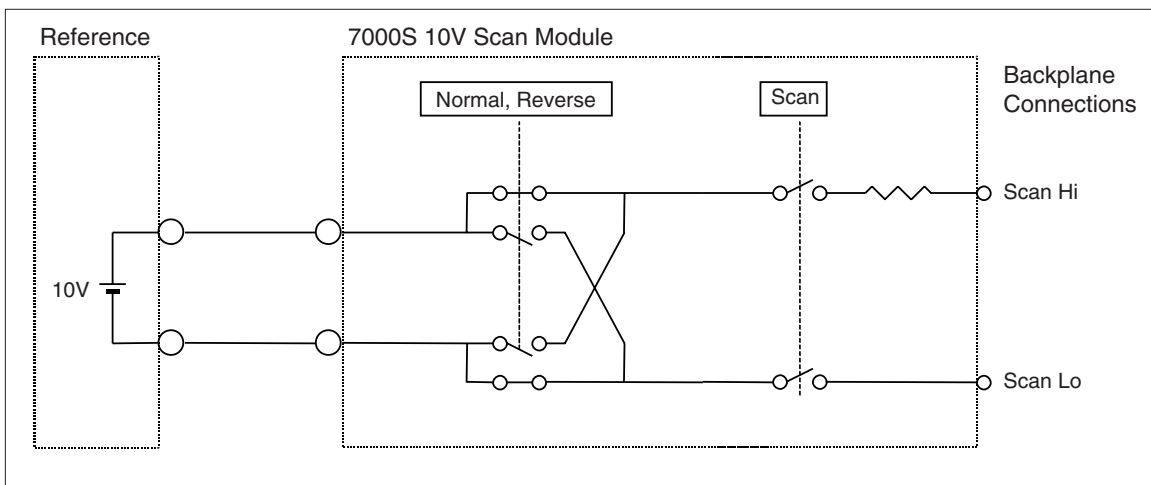


Figure 4-4. Reversal Switches in the 7000S Scan Module

aho25f.eps

It is intended for use with references that do not reverse. The red input terminal should therefore remain positive with respect to the black input terminal.

Thermal emfs in the 7000 system are removed as they are to the measurement side of the point of reversal. Any thermal emf in the interconnections between the reference and the 7000S scan module are not removed as they are to the source side of the point of reversal.

The External Standard Input of the 7000N Nanoscan Module also contains reversal switches. These may be disabled if a reversing reference is connected by setting the front panel Include Reverse switch appropriately. See the "Include Reversal Switch" section in Chapter 3 for details. If a reversing reference is used then thermal emfs in the 7000N Module and any interconnections back to the point of reversal will be removed.

### Data Capture

Automatic data capture of the differences and status information leads to greater repeatability, no operator to operator variations, and eliminates any transcription errors. The operator is also free to perform other tasks.

### **Scanbase**

A scanbase is a record of the measurement regime in each scan. It refers to the modules involved, the number of samples taken, the delay between channels and whether the mode was forward or included reverse measurements.

Typically different scanbases are needed for Routine, Pre and Post Imports or Export measurements as different hardware will be involved.

An Import scanbase will need to identify the use of channel 21 which would not be used in routine scans. Depending on the nature of the transfer standard used it may well have its modules scanned as well as its system average on channel 21.

### **Scan ID No.**

To ensure logical data cataloging and storage, each scan is given a unique ID number, which acts as a reference.

### **Data Transfer**

The data capture capability of the 7050 Software controls the scanning process and accumulates data in a temporary results file. This data then requires transfer into Excel for analysis.

### **Pre and Post Import Scans**

Before a Transfer Standard is shipped off for external calibration by a "higher" laboratory it is wise to check its value(s) against the Laboratory Standard. These Pre External Calibration scans are referred to as Pre-Import scans. When the Transfer Standard returns another set of scans would be performed. These Post External Calibration scans are referred to as Post Import scans. By comparing any differences between the Pre and Post scans it is possible to determine if the Transfer Standard has suffered in transit. If it has not suffered, its certified value may be Imported to the Laboratory Reference Standard. If the difference between the Pre and Post scans indicates a problem it may be investigated before any Import of a new value. Under extreme circumstances (such as damage during transit), or where incorrect data has been included on calibration certification, it may be necessary to return the Transfer Standard to the higher laboratory for recalibration.

## **Volt Maintenance Practices**

This section describes the basic operations required to maintain a working 10 V DC Reference Standard. Most operations required involve building confidence in the systems behavior.

As it is impractical to continuously import calibration every time a 10 V Reference is required, a permanently resident working reference standard is needed in the laboratory, the Laboratory Reference Standard. A method of achieving confidence in this reference is required. This is achieved by having multiple reference elements and intercomparing them on a regular basis. Observation of these measurements and verification that there are no unexpected changes leads to confidence that the system is behaving correctly. Aberrant behavior by a given reference can be identified and investigated. If after the regular intercomparison a problem is discovered, it is necessary to consider the effects on any work done with the standard since the last good intercomparison. The greater the performance required from the reference, the more frequent these routine intercomparisons should be.

A 7000N Nanoscan System intercompares the references by determining the difference between each 7000 Reference and the System Average. Under the control of the 7050

Software all the differences may be measured in an automatic scan. It is recommended that the routine scans checking system behavior be performed weekly. The recorded differences may then be studied by using the reporting mechanisms built into the 7050 Software.

The routine intercomparisons imply a degree of confidence in the Laboratory Reference Standard, but in themselves are unable to determine the actual drift rate of the system or any individual reference. This can only be achieved by regular calibration to an external reference, typically at the National Standards Laboratory. From a series of such imports over a period of time a drift rate may be established. As time progresses and more imports are performed, a better picture, and hence better prediction of the drift rate, will become possible. It is suggested that Imports be performed every three months.

As the Laboratory Reference Standard remains in the laboratory and the National Laboratory remains fixed a moving reference is required for transferring calibration from the National Laboratory to the laboratory. This achieved by the use of a Transfer Standard. This can be a single reference or, for enhanced performance, consist of a multiple reference group.

To transfer calibration from the Transfer Standard to the Laboratory Reference Standard, it is necessary to determine the difference between the two. This is a special scan as we only need to include the measurement of the External Standard Input terminals.

Further confidence in the Laboratory Reference Standard is achieved by comparing the value of the latest import with its predicted value. Unexpected errors would lead to elements of the import process being investigated - for instance, was the Transfer Standard incorrectly calibrated or has it suffered in transit etc.

Confidence in the import process is achieved by comparing the Transfer Standard against the Laboratory Reference Standard before and after it is transported for external calibration. By using these Pre and Post scans of the Transfer Standard it is possible to determine that it has not suffered in transit. By comparing its recently calibrated value with that expected for the Transfer Standard it is possible to determine if it was incorrectly calibrated.

Having established a drift rate for the Laboratory Reference Standard and determined that the latest import was successful, it is possible to safely predict the value for the Laboratory Reference Standard Average into the future until the next Import.

Although only post scans are required to establish the value and drift rate of the system, it is recommended that both pre and post scans are performed to provide increased confidence.

A succession of imports using the same Transfer Standard enables its drift rate and value to be determined.

The Laboratory Reference Standard can be constantly powered where as the Transfer Standard may be exposed to power failures and temperature variations.

## **Basic Procedures**

This section details the basic steps to be performed for each of the following tasks.

### **Basic Confidence**

1. Perform Routine Scan(s) of all channels:
  - a. Start Fluke 7050
  - b. Set up the Data Scan as required
  - c. Wait for Scan(s) to complete
2. Import data into Excel:
  - a. Start Excel
  - b. From the menu select Fluke 7050, then Data Capture Import
  - c. Complete Data Capture Import dialogue box
3. Check differences have not changed:
  - a. From the menu, select Fluke 7050, then Measurement Analysis, then Produce Report
  - b. Complete Report Output dialogue box
  - c. View results using the normal features available in Excel. Note that these reports also include oven temperatures and other status information.

### **Import Calibration**

1. Perform Pre-scans over several days for the required channels, specifically those relating to the Transfer Standard:
  - a. Start Fluke 7050
  - b. Set up the Data Scan as required
  - c. Wait for Scan(s) to complete
2. Import data into Excel:
  - a. Start Excel
  - b. From the menu, select Fluke 7050, then Data Capture Import
  - c. Complete Data Capture Import dialogue box
3. Ship Transfer Standard to the External Calibration Laboratory
4. Transfer Standard calibrated. Transfer Standard returns to base, allow to settle
5. Perform Post-scans over several days for the required channels, specifically those relating to the Transfer Standard:
  - a. Start Fluke 7050
  - b. Set up the Data Scan as required
  - c. Wait for Scan(s) to complete
6. Import data into Excel:
  - a. Start Excel
  - b. From the menu select Fluke 7050, then Data Capture Import
  - c. Complete Data Capture Import dialogue box

7. Perform Import:
  - a. Start Excel
  - b. From the menu select Fluke 7050, then Measurement Analysis, then Perform Import
  - c. Complete Import Details Entry dialogue box
  - d. View results presented in Import Results dialogue box
8. Transfer results to the HAV
  - a. From the menu select Fluke 7050, then Maintain HAV
  - b. Enter the new certified values into the dialogue box

### **Value of HAV (Hardware Average)**

Whenever the value of the HAV is required, access the HAV calculator by selecting Fluke 7050 from the menu select, then Measurement Analysis, then HAV Calculator.

### **Export Calibration**

1. Perform Scan(s) of required channels:
  - a. Start Fluke 7050
  - b. Set up the Data Scan as required
  - c. Wait for Scan(s) to complete
2. Import data into Excel:
  - a. Start Excel
  - b. From the menu select Fluke 7050, then Data Capture Import
  - c. Complete Data Capture Import dialogue box
3. Perform Export:
  - a. Start Excel
  - b. From the menu, select Fluke 7050, then Perform Export
  - c. Complete Export Details Entry dialogue box
  - d. View results presented in Export Results dialogue box
  - e. Select Generate Certificate (can be performed independently)
  - f. Select Certificate Format. Enter Certificate Filename Select Generate Certificate
  - g. View and Print Certificate
4. Independent generation of Certificate:
  - a. Start Excel
  - b. From the menu, select Fluke 7050, then Produce Certificate
  - c. Complete Certificate Output dialogue box
  - d. View and Print Certificate



# **Chapter 5**

## **Using the 7000 System - Manual Mode**

<b>Title</b>	<b>Page</b>
Introduction.....	5-3
Initial Settings.....	5-3
Explanation of Channels Numbers.....	5-3
Nanoscan Setup.....	5-3
Measuring Differences.....	5-3
Channel Difference - Forward Mode.....	5-4
Channel Difference - Reverse Mode.....	5-4
Import of Calibration.....	5-4
Drift Rate Calculation.....	5-5
Calculation of the HAV.....	5-5
Export of Calibration.....	5-5



## Introduction

This chapter is a guide to using a 7000 System manually to maintain a 10 V DC reference. It details how to make the measurements and perform the required calculations.

## Initial Settings

### Explanation of Channels Numbers

A 7000N Nanoscan Module scans up to 21 channels:

- CH00 is the 7000N Null Detector Zero
- CH01 to CH10 are in the same rack as the 7000N Module
- CH11 to CH20 are in any extension rack
- CH21 is the 7000N External Standard Input

If the extension rack contains a 7000N Nanoscan Module then the extension Nanoscan must be:

1. in Hold. If necessary press the Hold key until the Hold LED is illuminated.
2. not in Reverse. If necessary press the Reverse key until the Reverse LED is off.
  - Use the Step  $\uparrow$  key to increment to the next channel. Note that this will roll over from 20 to 00 (i.e. 18, 19, 20, 00, 01, 02 etc.)
  - Use the Step  $\downarrow$  key to decrement to the next channel. Note that this will roll under from 00 to 20 (i.e. 02, 01, 00, 20, 19, 18 etc.)

Empty channels are automatically skipped.

The External Standard key toggles between the currently selected channel and channel 21. CH21 is selected by pressing the External Standard key until the built-in External Standard LED illuminates. Pressing this key again will deselect CH21, indicated by the LED going out, which will return the Nanoscan to the channel previously selected.

### Nanoscan Setup

For manual operation, the 7000N Nanoscan Module must be in Local mode. If necessary press the Local key until the Local LED is illuminated.

For the measurements to be taken, the 7000N Module must be out of Hold. If necessary press the Hold key until the Hold LED is off.

If required, Reverse Mode can be selected by pressing the Reverse key until the Reverse LED is illuminated. Reverse Mode is cancelled by pressing the Reverse key until the Reverse LED goes out.

## Measuring Differences

All measurements made by the 7000N Null Detector are differences relative to the hardware system average.

Differences may be made in either Forward mode only or as a combination of Forward and Reverse modes. See "Front Panel Controls" in Chapter 3 for an explanation of Reversal Measurements.

### **Channel Difference - Forward Mode**

1. Select CH00 using the Step ↑, Step ↓ or External Standard keys and record the indicated deviation as the null detector zero, CH00\_F.
2. Select the required channel using the Step ↑, Step ↓ or External Standard keys and record the indicated channel deviation as CHxx\_F.
3. Calculate the Channel Difference using

$$\text{Channel Difference} = \text{CHxx\_F} - \text{CH00\_F}$$

### **Channel Difference - Reverse Mode**

1. Select CH00 using the Step ↑, Step ↓ or External Standard keys and record the indicated deviation as the null detector zero, CH00\_F.
2. Select the required channel using the Step ↑, Step ↓ or External Standard keys and record the indicated channel deviation as CHxx\_F.
3. Select Reverse.
4. Select CH00 using the Step ↑, Step ↓ or External Standard keys and record the indicated deviation as the null detector zero, CH00\_R.
5. Select the required channel using the Step ↑, Step ↓ or External Standard keys and record the indicated channel deviation as CHxx\_R.
6. Calculate the Channel Difference using

$$\text{Channel Difference} = ( \text{CHxx\_F} - \text{CH00\_F} + \text{CHxx\_R} - \text{CH00\_R} ) / 2$$

### **Import of Calibration**

Importing Calibration assigns a value from a Reference Standard to the HAV.

1. Connect the Reference Standard of known value to the External Standard Input on the 7000N Nanoscan Module.
  - If Reverse measurements are to be made, set the Include Reverse switch appropriately. See "Front Panel Controls" in Chapter 3.
  - If Forward only measurements are to be made, follow the instructions in "Channel Difference – Forward Mode" in this chapter to produce the Channel 21 Difference.
  - If Reverse measurements are to be included, follow the instructions in "Channel Difference – Reverse Mode" in this chapter to produce the Channel 21 Difference.

2. Calculate the value of the HAV from the following equation

$$\text{HAV} = \text{Reference Standard} - \text{Channel 21 Difference}$$

This value now becomes the Last Certified Value.

As time progresses and a history for the system is built up, it is possible to compare this new value to a predicted value based on the previous certified value and the established drift rate. If such a comparison is unfavorable the new value may be ignored and the reasons for any discrepancy investigated. Under these conditions the old value for the HAV is retained.

It is also possible to Import Calibration using a 7000S Scan Module, or a 7000 Module that has been sent away for calibration. If using a 7000S Scan Module, note that when Reverse mode is to be used, the 7000S requires a Non-Reversing Reference.

## **Drift Rate Calculation**

Over a period of time with regular imports it is possible to determine the drift rate of the HAV.

The nominal drift rate for a 7000 Reference Module is -0.8 ppm per year, equivalent to -22 nV per day.

## **Calculation of the HAV**

To calculate the value of the HAV on a particular day use the following equation:

$HAV = \text{Last Certified Value} + (\text{Drift Rate} \times \Delta T)$  where  $\Delta T$  is the elapsed time since the Last Certified Value was determined.

Example:

Last Certified Value: 10.000 010 000 V, on 6<sup>th</sup> November 1998. Drift Rate: -0.75 ppm per year Today: 20<sup>th</sup> December 1998

therefore

$$\Delta T = 44 \text{ days}$$

$$\text{Drift Rate} = (-0.75 \times 10^{-6} \times 10) / 365 = -20.5 \times 10^{-9} \text{ V per day}$$

$$HAV [ 20^{\text{th}} \text{ December } 1998 ] = 10.000 \ 010 \ 000 + (-20.5 \times 10^{-9} \times 44)$$

$$HAV [ 20^{\text{th}} \text{ December } 1998 ] = 10.000 \ 009 \ 096 \text{ V}$$

## **Export of Calibration**

Exporting Calibration assigns a value from the HAV to a specified channel. To calculate the actual value of a channel use the following equation:

$$\text{Channel Value} = HAV + \text{Channel Difference}$$



# **Chapter 6**

## **Using the 7050 Volt Maintenance Software**

<b>Title</b>	<b>Page</b>
Introduction.....	6-3
Installing the 7050 Volt Maintenance Software .....	6-3
Basic PC Requirements .....	6-3
Computer Hardware .....	6-3
Computer Software .....	6-3
Installing the 7050 Software.....	6-4
On Line Help .....	6-5
Uninstalling the 7050 Software .....	6-5
Software Dialogue Box Explanations.....	6-5
Data Capture Application .....	6-5
Starting the Data Capture Application .....	6-5
Communications Port Setup.....	6-6
PC COM Port Settings .....	6-6
Data Scan Setup.....	6-7
Delayed Start.....	6-8
Scan Status .....	6-9
Excel 'Fluke7050' Add-in (Accessing the Data Analysis Functions in Excel) .....	6-10
Captured Data Import.....	6-10
HAV Maintenance .....	6-10
Explanation of the Dialogue Controls.....	6-11
Calculate HAV .....	6-14
Drift Rate Calculator.....	6-15
Perform Export - Information Entry.....	6-15
Perform Export - Result .....	6-17
Perform Import - Information Entry.....	6-17
Perform Import - Result .....	6-20

Produce Certificate.....	6-20
Produce Report.....	6-21
Explanation of the Dialogue Controls.....	6-22
Produce Graph.....	6-23
Software Support .....	6-24
United States.....	6-25
United Kingdom .....	6-25



## **Introduction**

The 7050 Volt Maintenance Software comes complete with On Line Help. Other than the installation instructions, this chapter is a essentially a copy of the On Line Help and is a guide to using a 7000 System automatically to maintain a 10V DC Reference.

## **Installing the 7050 Volt Maintenance Software**

This section describes how to install the 7050 Volt Maintenance Software onto a PC.

### **Basic PC Requirements**

Before installing the 7050 Volt Maintenance Software onto a PC check that it meets the following hardware and software requirements;

#### **Computer Hardware**

<b>Computer Hardware</b>	<b>Minimum PC Specification</b>	<b>Recommended PC Specification</b>
	To run 7050, the computer must conform to the following minimum system specifications.	We recommend a computer that meets or exceeds these specifications for running 7050.
Host Computer:	100% IBM PC compatible with 80486 processor, 66MHz clock and 4Mbytes of memory.	100% IBM PC compatible with Pentium processor with 166 MHz clock and 16 Mbytes of memory.
Operating System:	Microsoft Windows 95	Microsoft Windows 95, 98 or NT 4.0
Hard Disk:	10 Mbytes unused capacity for the basic installation. More hard disk space may be required as the results spreadsheets expand.	10 Mbytes unused capacity for the basic installation. More hard disk space may be required as the results spreadsheets expand.
Floppy Disk:	One 3.5-inch 1.44 Mbytes drive.	One 3.5-inch 1.44 Mbytes drive.
Monitor:	VGA mono or color graphics.	SVGA color graphics.
Comm Ports:	One spare RS232 serial port with 9-way or 25-way D-type connector.	One spare RS232 serial port with 9-way or 25-way D-type connector.

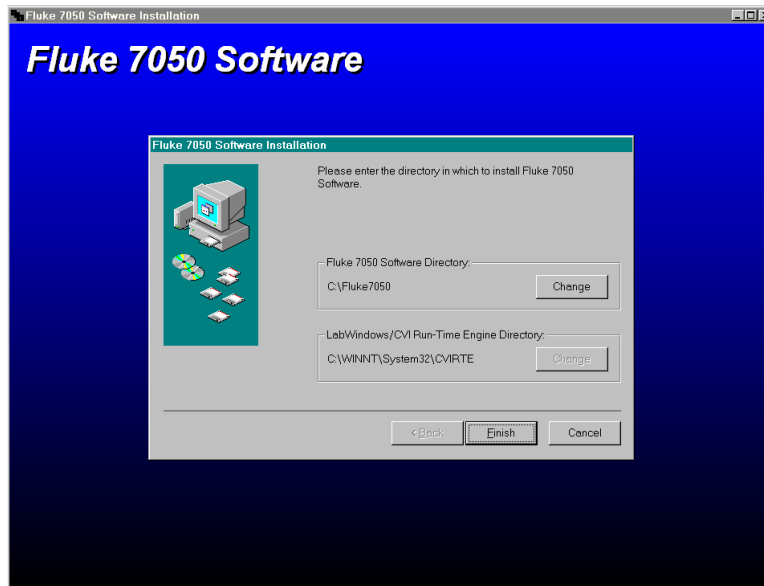
#### **Computer Software**

To run the data analysis part of the 7050 software, Microsoft Excel 97, Version 8 or later must be installed.

### Installing the 7050 Software

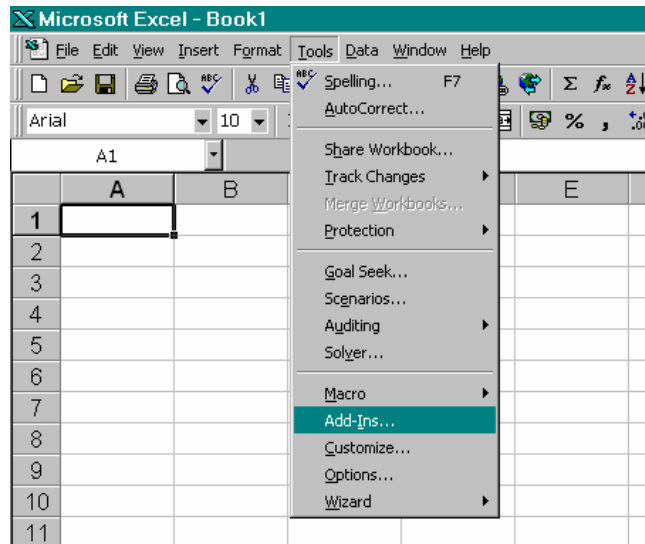
To install the 7050 Software follow the instructions below.

1. Insert disk 1 into the A: drive and from the Start Menu select...a:\setup.exe.
2. Follow the on-screen instructions and the software will be installed in the directory specified.



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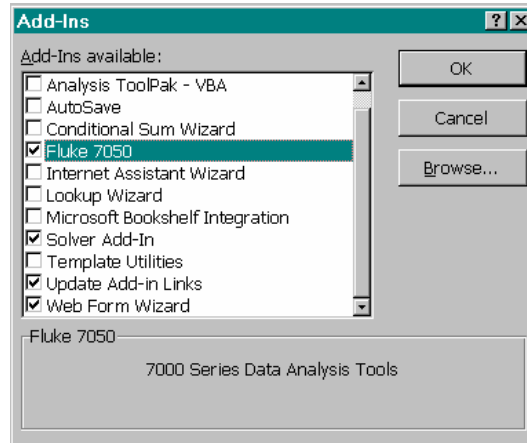
3. After installation, open Excel and from the "Tools" menu, select "Add-Ins".



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4. On the "Add-In" screen select "browse" and search for the file "Fluke7050.xla". This will be in the directory the 7050 software has just been installed.

5. Upon selecting the Fluke7050.xla add-in, it will be loaded into Excel, ready for use.



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### **On Line Help**

At any time during the use of the 7050 Volt Maintenance Software the On Line Help may be invoked by clicking on the Help button in each dialogue box. To invoke the On Line Help from Excel, select Fluke 7050, then Help from the drop down menu.

### **Uninstalling the 7050 Software**

Should it become necessary to uninstall the 7050 Software, follow the instructions below.

1. Open Excel and from the "Tools" menu, select "Add-Ins".
2. From the list of available Add-Ins, de-select the Fluke 7050 Add-In.
3. Click on the OK button and close Excel.
4. From the Windows Start Menu select "Uninstall Fluke 7050" from the Fluke 7050 program group.
5. Follow the on-screen instructions and the software will be uninstalled from your system.

### **Software Dialogue Box Explanations**

#### **Data Capture Application**

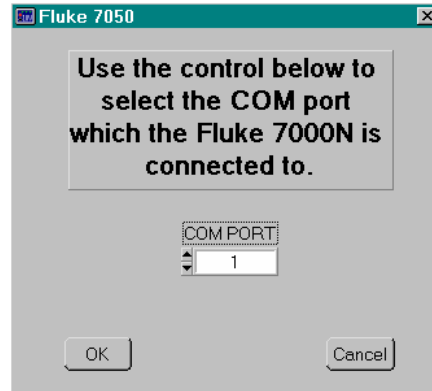
##### **Starting the Data Capture Application**

To start the Data Capture software:

1. Click on the Windows **Start** button
2. Select the programs folder
3. Select the Fluke 7050 folder and click on the Fluke 7050 icon. A splash screen will be displayed indicating where you have installed the software.
4. You will be presented with the Communications Port Setup dialogue, detailed in the next section of the help file.

### Communications Port Setup

Use the control in this dialogue to set the serial port on your PC that the 7000N is connected to.



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Click the **OK** button to attempt communication with the 7000N.

If connection is not made, check that the correct COM port has been selected and the PC's port settings are correct.

### PC COM Port Settings

The following com port settings must be set for the PC to communicate with the 7000N:

Baud Rate: 9600  
Data Bits: 8  
Parity: None  
Stop Bits: 1  
Flow Control: None

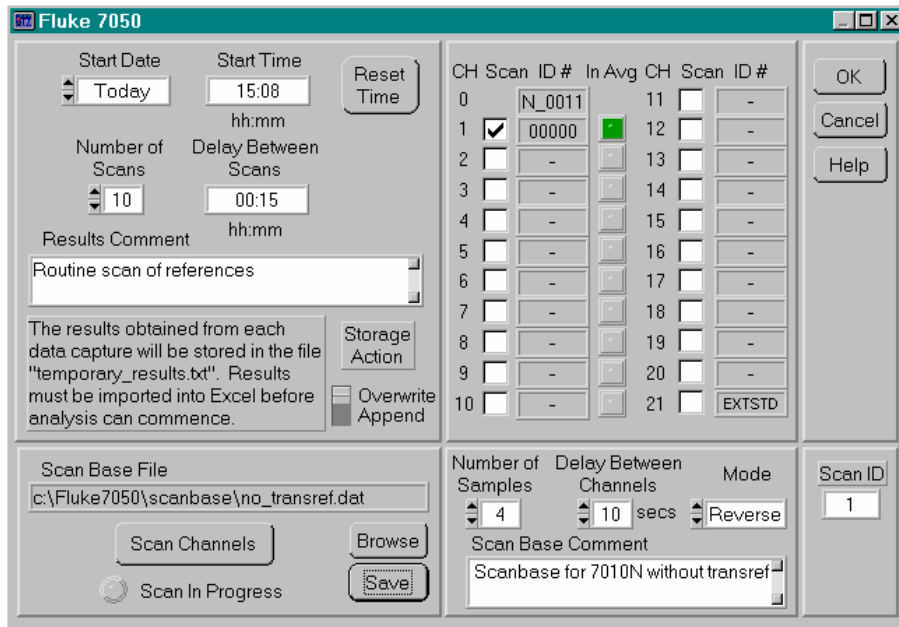
Also check that the 7000N is powered up and that the fiber optic cable is connected to the fiber adapter with the Tx of one end connected to the Rx of the other.

A quick and easy test to find out which fiber should be connected to the Rx on the fiber adapter is as follows:

1. Connect the fiber optic cable to the 7000N, set it to scan channel zero,
2. Press the **HOLD** button to start a measurement.
3. Looking at the ends of the fiber optic cable not connected to the 7000N, you should be able to see one of the fibers emit a red light as the measurement is completed. Connect this fiber to the Rx connection on the fiber adapter and the other to the TX connection.
4. Click the **Cancel** button to close this dialogue box and the data capture application.

## Data Scan Setup

This dialogue allows you to set-up a measurement scenario.



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The top left group of **controls** allows the following settings:

- Selection of the measurement **Start Date** and **Start Time**. The measurement can be set to commence up to seven days in the future. The **Start Time** is specified in hours and minutes in the format "hh:mm" For example say the current date and time were 13:45 on the 5<sup>th</sup> of August and you wanted to start a measurement at 02:15 on the 6<sup>th</sup> of August, you would set the date to be +1 day and the time to be 02:15.
- The **Reset Time** button replaces the displayed start time with the current time so that a scan will start as soon as you press the **OK** button.
- The **Number of Scans** control allows you to set how many scans of the selected modules will be taken.

(Minimum = 1, Maximum = 256)

- The **Delay Between Scans** control allows you to enter a period of time in hours and minutes (in the format "hh:mm") for which the system will wait between scans. A comment about the set of measurements can be entered in the **Results Comment** box. (Maximum of 200 characters) This comment will be stored on the summary sheet of the results workbook once the measurements have been imported into the Excel using the 7050 Data Analysis Add-In.
- The **Storage Action** control sets how the result information will be stored in the temporary results file. Results can be appended to existing measurements before being imported to Excel or all previous results can be over written.

The bottom of the display window is explained below:

- A **Scan Base** contains information relating to the measurements in each scan.
- The **Number of Samples** within each scan and on each channel may be set between 1 and 64.
- The **Delay between Channels** may be set between 0 and 60 seconds.

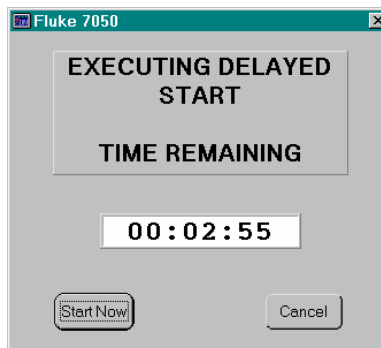
- **Mode** selects either Forward or Reverse measurements. Measurements made with "reverse" selected are used to remove thermal emfs and are made in both the forward and reverse connections, in the sequence Forward-Reverse-Reverse-Forward.
- The **Scan Base** also contains information about the modules fitted and which were in the scan.

A comment about the Scan Base can be entered in the **Scan Base Comment** box. (Maximum of 200 characters) This comment will be stored on the summary sheet of the results workbook. Details of the **Scan Base** may be saved for use again in the future.

- Use the **Browse** button to select already existing files.
- Use the **Save** button to save the current **Scan Base** settings.
- Click the **Scan Channels** button to perform a scan of all 21 possible channels. This will scan each channel in sequence to determine where and what type of modules are fitted. The data is displayed as it is gathered in the top right group of controls. While such a scan is in progress the green **Scan In Progress** indicator illuminates. If a module is fitted into a channel then a tick will be placed to the left of the module **ID #**. If the module is a 7000 it will return a unique **ID #**. If the module is a 7000S it will return an ID of S\_\_xx where xx is the channel number. The tick means that the module will be scanned (the default). If you do not wish to scan a module that is present then click the tick to remove it, click again to reinstate the tick. If the module is In Average (selected with S1 from the 7000 module front panel) the indicator (**In Avg**) to the right of the **ID #** turns green.
- The **Scan ID** box displays the next scan number. Each scan is allocated a unique number for cross referencing data.
- If a **Scan Channels** has not been performed it will be performed automatically when the **OK** button is clicked.
- If there is discrepancy between the hardware configuration and the Scan Base settings an error list is produced.
- Click the **Cancel** button to cancel the data capture process and close the measurement setup dialogue box.
- Click the **OK** button to start the scan using the settings selected.

### *Delayed Start*

This dialogue is displayed when a delayed start has been selected and indicates the time remaining before the measurements commence. The time is shown in hours, minutes and seconds.

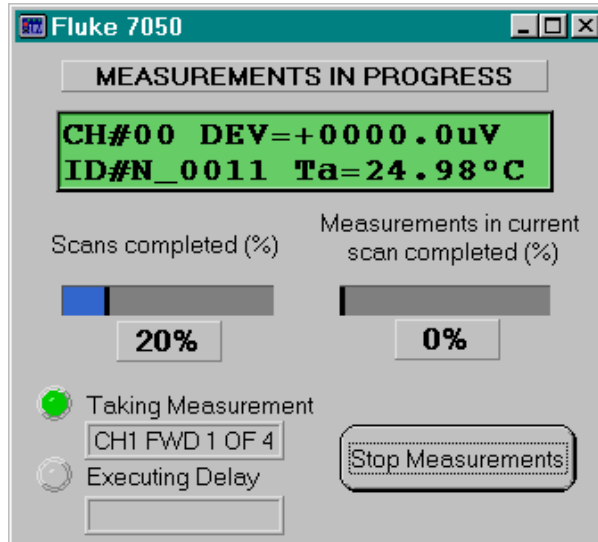


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- To cancel the delay and start immediately, click the **Start Now** button.
- To cancel the data capture and close the application, click the **Cancel** button.

**Scan Status**

This dialogue allows you to keep track of what measurement is currently being taken and how far the measurement scenario has gone.



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Once the data capture has been initiated and any start delay has expired, the scan status dialogue (shown above) will appear, allowing you to keep track of how many measurements have been completed.

The green window constantly updates with the latest scan information, echoing that which is shown on the LCD display of the 7000N.

The two bar graphs below that window indicate the amounts of measurements taken in the current scan (number of modules scanned so far i.e. 2 out of 5 modules scanned would indicate 40% complete) and the number of completed scans from the amount requested (3 out of 6 scans would indicate 50% complete).

At the bottom left of the dialogue box, two indicators and text boxes show what action is currently being performed.

If the **Taking Measurement** indicator is lit then the text box would contain a message about which channel is being scanned and the current sample information i.e. "CH2 FWD 2 of 4" would indicate that channel 2 was being scanned in forward polarity and that sample 2 of 4 was currently being taken.

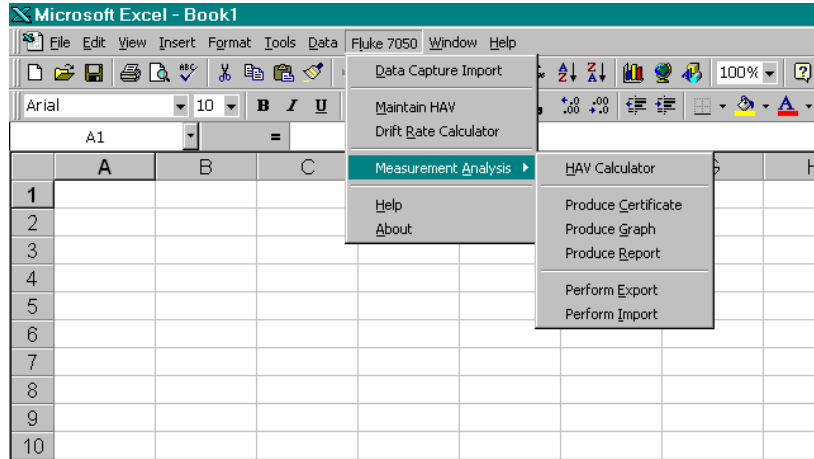
If the **Executing Delay** indicator is lit then a delay between channels or between scans is being executed and the time remaining is indicated in the text box.

If for any reason you want to stop the current set of measurements, click on the **Stop Measurements** button and a confirmation window will be displayed, asking if you really want to stop the data capture. If the data capture is stopped, the results already acquired will be stored in the results file.

Once the measurements are complete, a window indicating this will be displayed and the application will end.

### Excel 'Fluke7050' Add-in (Accessing the Data Analysis Functions in Excel)

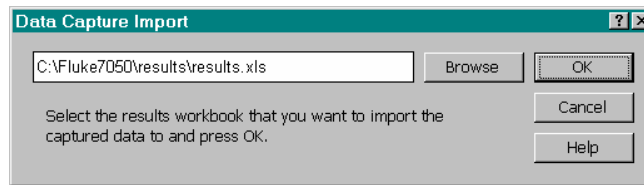
Once the Add-In has been installed in Excel, a menu option will appear on the Excel menu bar labeled **Fluke 7050**. From this menu you can access all of the data analysis functions (shown in the graphic below) by clicking on the highlighted title. Access to this help file can also be achieved by clicking on the **Help** title.



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### Captured Data Import

Once within Excel, the first task that needs to be done is to import results captured with the data capture application into a results workbook and this is done by selecting the **Data Capture Import** title from the Fluke 7050 menu in Excel.



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When presented with this dialogue you need to select a results workbook for where the new information is to be stored. This is done by clicking on the **Browse** button. A file selection dialogue will allow you to find an existing results workbook or enter the name of a new one.

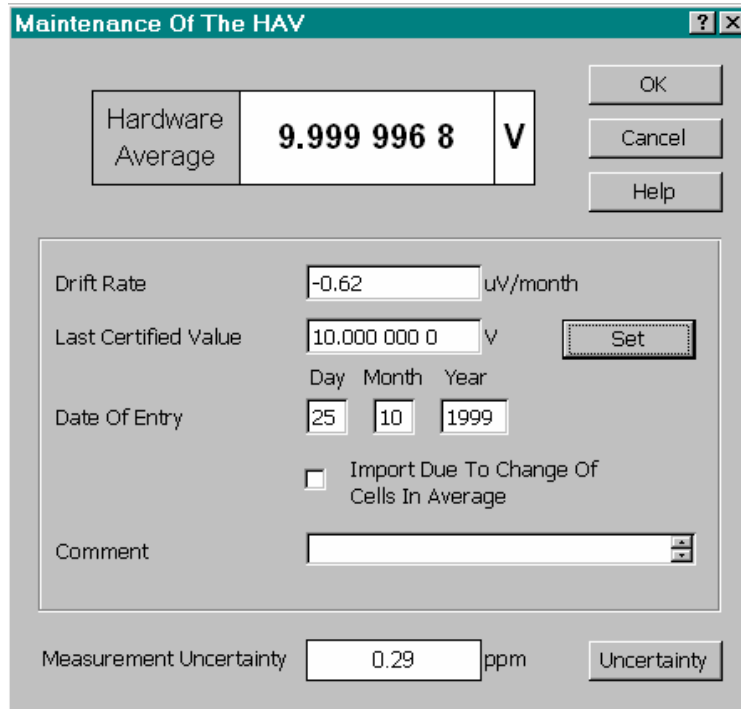
Clicking on the **OK** button starts the action of importing the results. This could take some time depending on how many results are to be imported.

The **Cancel** button closes the dialogue box.

### HAV Maintenance

This dialogue allows you to maintain the value of your **Hardware Average** by changing contributing factors such as the **Drift Rate** or **Last Certified Value**. Refer to Chapter 4 for a full explanation of the importance of maintaining the **HAV** (Hardware Average Value).





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### Explanation of the Dialogue Controls

#### Hardware Average

This is the current value of the **Hardware Average**.

It is calculated from the Last Certified Value, the Drift Rate and the Date Of Entry.

#### Drift Rate

This is the current drift rate of the HAV. A linear drift rate is assumed. It is established by analyzing the results of previous imports and certified values. This analysis is performed by selecting **>Measurement Analysis**, **>Produce Graph** from the Fluke 7050 menu bar, setting up to produce an import graph and selecting the import IDs that are to be used in the analysis.

This analysis calculates and reports the Drift Rate, which then must be entered in uV/day.

#### Last Certified Value

The Last Certified Value was established by the last import against an external standard or by a user calculation based on the analysis of removing a contributing module from the average. Enter the value in volts.

#### Date of Entry

The date that the Last Certified Value was updated needs to be entered so that the current value of the HAV can be established by using the current drift rate.

Enter the date using the day, month and year entry boxes.

### Comment

This box allows to add a comment which will be stored with the other values so that you can keep a note as to why the values have been changed.

### Import Due To Change Of Cells In Average

This tick box allows you to denote that a change to the **Drift Rate** and **Last Certified Value** has been made because a module has been removed or added to the Average. This piece of information is stored in the system log along with the new values entered.

### Set Button

To update the HAV value after altering the **Drift Rate**, **Last Certified Value** and/or **Date of Entry** values, click on the **Set** button. This will store the entered values, update the displayed HAV value and make an addition to the file "system\_log.XLS" found in the **Results** sub-directory. This file allows you to keep track of all the updates to the system's Hardware Average.

### Measurement Uncertainty

This displays the Measurement Uncertainty of the Last Certified Value based on the various system uncertainties. These may be viewed by selecting the **Uncertainty** button.

### OK Button

Selecting the **OK** button will recalculate the HAV, based on Last Certified Value, the Drift Rate and the date. Then this dialogue box will close.

### Cancel Button

Selecting the **Cancel** button will close this Maintenance of the HAV dialogue box.

### Uncertainty Button

Selecting the **Uncertainty** button will display the **System Uncertainty Calculation** dialogue box, where the various system uncertainties may be viewed and edited.

CONTRIBUTION	TYPE	ppm
Calibration	B	0.10
Coverage Factor k =		2.00
Transportation	B	0.10
Drift	B	0.20
Temperature	B	0.05
Noise*	A	0.02
Coverage Factor k =		2.00
Expanded Uncertainty		0.29

\* Includes scan repeatability and assumes t=k

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The Expanded Uncertainty is based on the various contributions listed below and is calculated in accordance with NIS3003. The magnitudes of the contributions listed need to be manually entered. All the uncertainties are in ppm.

**Type A** are the contributions that are evaluated by statistical methods and are attributable to random effects and an assumed normal distribution.

**Type B** are the contributions that are evaluated by other means and may be attributable to systematic effects. These contributions will either have a declared coverage factor or an assumed (rectangular) distribution.

### Calibration (Type B)

This is the uncertainty of the calibration of the external standard used for importation. It will be available on the Calibration Certificate of the External Standard issued by the certifying lab.

### Calibration Coverage Factor, k

This is the coverage factor for the above calibration uncertainty.

As a guide, for 95% confidence limits  $k=2$ , for 99% confidence limits  $k=2.58$

### Transportation (Type B)

This uncertainty allows for the fact that the external standard has physically moved since it was calibrated. It may have experienced temperature or mechanical stress or even battery failure in transit. Comparison of Pre and Post Scans may reveal any abnormal behavior.

### Drift (Type B)

This uncertainty allows for the fact that time has elapsed since the external standard was calibrated.

If the same external standard is repeatedly used then this can be determined from it's history and the time difference.

### Temperature (Type B)

This uncertainty takes into account the fact that the external standard may have been calibrated at a different temperature. Refer to the calibration certificate and compare with the laboratory temperature. The specification of the external standard will reveal it's temperature coefficient.

### Noise (Type A)

This is from the Sample Standard Deviation of the combined noise of the Import Standard, the HAV, scan repeatability and the 7000N Null Detector. It is assumed that  $t=k$ . It may be assessed by examination of the results for the Channel of the Import Standard.

### Coverage Factor, k

This is the required coverage factor for the expanded uncertainty.

As a guide, for 95% confidence limits  $k=2$ , for 99% confidence limits  $k=2.58$

### Expanded Uncertainty

This is calculated from the above uncertainties and coverage factor. If any of the contributions have been updated, select the Calculate button to update the Expanded Uncertainty. This value may now be transferred to the Maintenance Of The HAV dialogue by pressing OK.

### Calculate button

Selecting the Calculate Button calculates the Expanded Uncertainty based on the uncertainties and coverage factors entered above. This is necessary to update the Expanded Uncertainty if any of the contributions are changed.

### OK Button

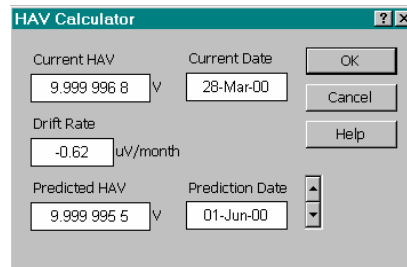
Selecting the OK button saves the values for the uncertainty contributions and closes the dialogue box, returning to the Maintenance of the HAV dialogue box.

### Cancel button

Selecting the Cancel button closes this System Uncertainty Calculation dialogue box and returns to the Maintenance of the HAV dialogue box.

### Calculate HAV

The **HAV Calculator** dialogue allows you to quickly predict the value of the HAV based on information entered into the system.



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### Current HAV, Current Date

This displays the current value of the system HAV and date. The current HAV is calculated from the Last Certified Value and the Drift Rate.

### Drift Rate

This displays the system HAV drift rate in uV/day.

### Predicted HAV

This displays the predicted value of the HAV on the date selected below.

### Prediction Date

Use the up and down buttons to select a date up to 1 year in the future to display the calculated HAV on that day.

### OK Button

Selecting **OK** will close this **HAV Calculator** dialogue box.

### Cancel Button

Selecting **Cancel** will close this **HAV Calculator** dialogue box.

### Drift Rate Calculator

This dialogue allows you to calculate the change in system drift rate based on 1) changing any of the drift rates of modules contributing to the average and/or 2) addition or removal of any modules to or from the average. This in turn is used to predict the impact it will have on the current HAV. Any values calculated from this can then be entered into the Maintenance of the HAV dialogue to update the HAV.

Channel	In Average	Drift Rate (uV/month)
Channel 1	<input checked="" type="checkbox"/>	-0.60
Channel 2	<input checked="" type="checkbox"/>	-0.44
Channel 3	<input type="checkbox"/>	-0.71
Channel 4	<input checked="" type="checkbox"/>	-0.69
Channel 5	<input type="checkbox"/>	0.00
Channel 6	<input type="checkbox"/>	0.00
Channel 7	<input type="checkbox"/>	0.00
Channel 8	<input type="checkbox"/>	0.00
Channel 9	<input type="checkbox"/>	0.00
Channel 10	<input type="checkbox"/>	0.00

Parameter	Value (uV/month)	Unit
Current Drift Rate	-0.62	
Current HAV	9.999 996 8	V
Average Drift Rate	-0.58	
New HAV	9.999 997 0	V

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The tick boxes for each channel are used to indicate whether or not the module in that channel is currently contributing to the average. The box below each tick box is used to enter the current calculated drift rate for that individual module. Drift rates for a module can be calculated by producing a graph in the same way you can produce a graph for predicting the system drift rate after an import of traceability.

The bottom left group of boxes indicate the **Current Drift Rate** and the **Current HAV** which are in use by the system. The bottom right group of boxes indicate the calculated **Average Drift Rate** and **New HAV** based on the information entered in the individual module **In Average** and **Drift Rate** boxes.

The **Calculate** button performs the calculations based on the currently entered data. Selecting the **OK** button will close this **Drift Rate Calculator** dialogue box. Selecting the **Cancel** button will close this **Drift Rate Calculator** dialogue box.

### Perform Export - Information Entry

The export process transfers calibration from the system HAV to an individual channel. If the channel has a 7000 Reference **Module** fitted it is the module that is being calibrated. If the channel is CH21, the 7000N External Input, or has a 7000S Scan Module fitted then an external standard is being calibrated.

The measurements have already been taken.

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### Result File

Select the results file that contains the measurement data with which the export is to be performed.

Use the **PREV** and **NEXT** navigation keys to view the worksheets of the selected results file.

Measurement data for each channel is recorded on its own worksheet.

Use the **UP** and **DOWN** navigation keys to scroll through the selected worksheet. This enables the required Scan ID numbers to be determined.

Enter the Export Channel Number, 1 to 21, this is the channel the external standard was connected to.

Enter the Scan ID numbers in the format shown.

Single ID	123
Contiguous Range of ID	123-126
Combination	123,125,126-128

The following data is optional and may be entered later onto the certificate:

Customer Name	J.W. Industries
Address1	Washington Drive
Address2	Austin
Address3	TX 78746-34421
Address4	
Address5	
Calibrated by	B. Harvey
Date of Receipt	20-Dec-99
Job/Order No.	10031

Manufacturer           Fluke  
 Instrument Type       7001  
 Serial Number         36521  
 1.018V Output Value (V)   -  
 1.018V Uncertainty (ppm)  1.00000123  
 1V Output Value (V)    -  
 1V Uncertainty (ppm)   0.29

**OK Button**

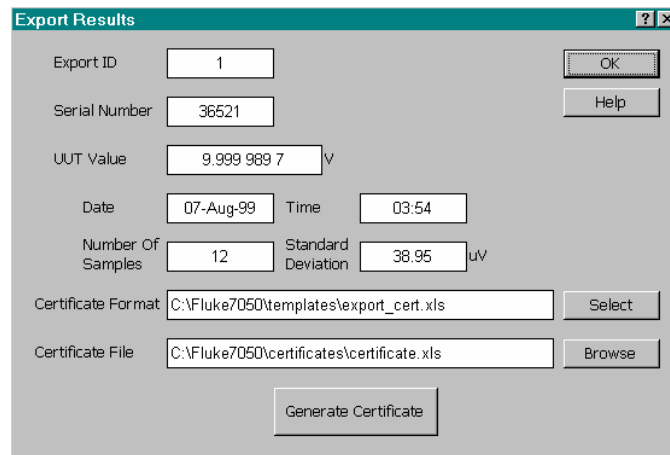
Selecting **OK** will cause the value of the channel to be calculated. The **Export Results** dialogue box will display the result of the export.

**Cancel Button**

Selecting **Cancel** will close this **Export Details Entry** dialogue box.

**Perform Export - Result**

This dialogue box contains the results of the export operation and acts as a visual confirmation of what has been stored on the export worksheet of the results workbook.



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From this dialogue, a certificate of the exportation can be produced directly. Clicking on the **Select** button brings up a file selection dialogue from where a certificate template can be selected. Then, by clicking on the **Browse** button, the destination file for the certificate can be selected.

Examples of Export certificates are supplied.

Once these selections have been completed, click the **Generate Certificate** button to produce the certificate.

Selecting the **OK** button will close this dialogue.

**Perform Import - Information Entry**

The import process transfers calibration from an individual channel to the system HAV. If the channel has a 7000 Reference Module fitted, the module is the external standard. If

the channel is CH21, the 7000N External Input, or the channel has a 7000S Scan Module fitted, then an external standard is being used.

The measurements have already been taken.

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### Result File

Select the results file that contains the measurement data with which the import is to be performed.

Use the **PREV** and **NEXT** navigation keys to view the worksheets of the selected results file.

Measurement data for each channel is recorded on its own worksheet.

Use the **UP** and **DOWN** navigation keys to scroll through the selected worksheet. This enables the required Scan ID numbers to be determined.

Enter the Import Channel Number, 1 to 21, this is the channel the external standard was connected to.

If Pre Scan data is to be included, tick the "Pre Scan Data Present Box". Enter the Pre Scan ID numbers. (see format below) Enter the Post Scan ID numbers. (see format below)

### Scan ID number format

Single ID	123
Continuous Range of ID's	123-126
Combination	123,125,126-128

The following data **MUST** also be entered for the calculations to be performed. The data is available from the External Standard's calibration certificate.

### Certified Value

Enter the certified value, in volts, for the external standard e.g. 10.000 001 123.



### Date

Enter the date of calibration for the external standard.

Use the left and write buttons in combination with the slide bar to select a date months previous.

### Uncertainty

Enter the uncertainty, in ppm, for the calibration of the external standard.

### Coverage Factor

Enter the Coverage Factor relating to the above Uncertainty. The following data is optional:

Cal Lab Name	e.g. Accucal lab
Calibrated by	e.g. P. Jerome
Certificate No.	e.g. 8774
Device Type	e.g. Fluke 7001
Serial No.	e.g. 35543
Temp (°C)	e.g. 20.6
Std. Dev. (uV)	e.g. 0.32
Sample	e.g. 8

### OK Button

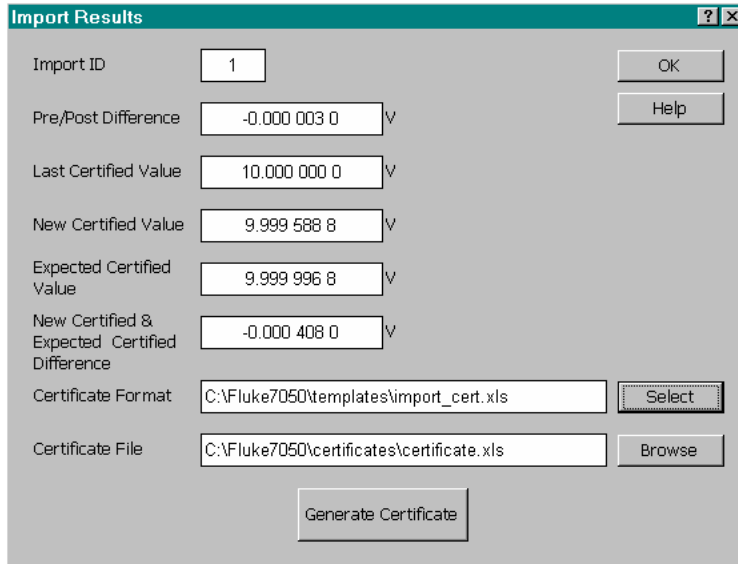
Selecting OK will cause the value of the HAV to be calculated. The Import Results dialogue box will display the result of the import.

### Cancel Button

Selecting Cancel will close this **Import Details Entry** dialogue box.

### Perform Import - Result

This dialogue box contains the results of the import operation and acts as a visual confirmation of what has been stored on the import worksheet of the results workbook.



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From this dialogue, a certificate of the importation can be produced directly. Clicking on the **Select** button brings up a file selection dialogue from where a certificate template can be selected. Then by clicking on the **Browse** button, the destination file for the certificate can be selected.

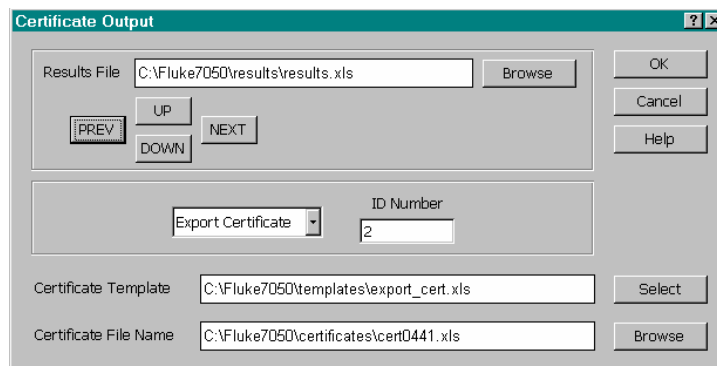
Once these selections have been completed, click the **Generate Certificate** button to produce the certificate.

Selecting **OK** will close this dialogue.

An example certificate template is supplied with the software.

### Produce Certificate

After completing an Export or Import of traceability, a certificate containing details of that operation can be generated using the **Produce Certificate** dialogue.



aho43s.bmp

Explanation of the dialogue controls:

### Result File

Select the results file that contains the Import or Export data from which the certificate is to be produced.

Use the **PREV** and **NEXT** navigation keys to view the worksheets of the selected results file. This enables switching between the Import and Export worksheets in particular.

Use the **UP** and **DOWN** navigation keys to scroll through the selected worksheet. This enables the required Import/Export ID numbers to be determined.

The selection box in the center is used to choose what the certificate is to be produced for (Import or Export). The box next to it is used to enter the Import or Export **ID Number**.

### Certificate Template

The selected template is shown in the **Certificate Template** box. To select an alternative click on the **Select** button and select the required template. Any number of templates can exist on the system and these can be modified in Excel to reposition the data fields which are filled with data from the results file when a certificate is produced.

### Certificate Filename

This is the filename that will be used for the resulting certificate workbook.

To see which certificate names have already been used or to enter another select the **Browse** button. Enter the new filename and then select Save.

### OK Button

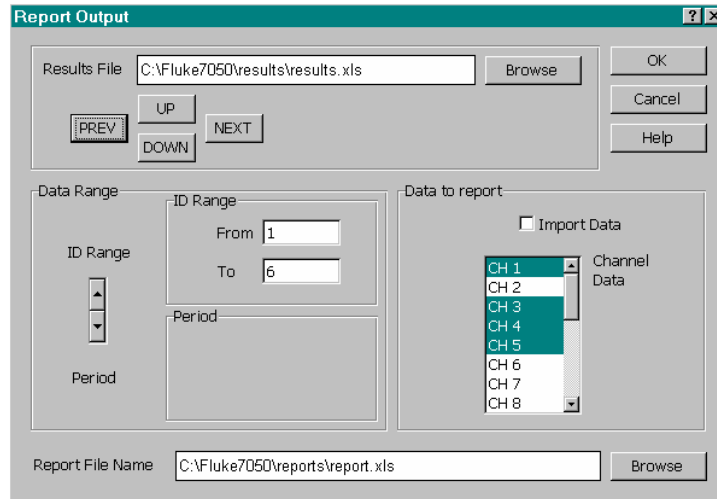
This will generate the certificate.

### Cancel Button

This will close this dialogue box without producing a certificate.

### Produce Report

The reporting facility allows you to list a series of data relating to either imports or a set of individual channels.



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### Explanation of the Dialogue Controls

#### Result File

Select the results file that contains the data from which the report is to be produced.

Use the **PREV** and **NEXT** navigation keys to view the worksheets of the selected results file. This enables switching between the Import and individual channel worksheets in particular.

Use the **UP** and **DOWN** navigation keys to scroll through the selected worksheet. This enables the required Scan ID numbers to be determined.

Using the spinner control in the **Data Range** group of controls, choose how the period of data to be reported will be selected, either by "to" and "from" ID's (**ID Range** group) or by a "to date" and a "from date" (**Period** group).

In the **Data to report** group, select what data is to be shown on the report. You can choose between reporting Importation data or scan data for a selection of channels.

For the importation report the following values for all the imports contained in the selected "data range" would be reported.

- New Certified Value
- Expected Value / New Value difference
- Present Certified Value Standard
- Deviation of the importation values
- Uncertainty of the importation value Temperature

To produce a report for importation data, the **Import Data** checkbox must be checked. What has been selected from the channel selection box bears no relevance.

For the channel data report the following values for all the selected channels contained in the selected "data range" would be reported.

- Difference from HAV value
- Forward-Reversal difference value
- Module Value (HAV + difference value)

- Standard Deviation
- Temperature

To produce a report for channel data, select the channels that you want to appear in the report from the **Channel Data** selection list and ensure that the **Import Data** checkbox is left un-checked.

### Report Filename

This is the filename that will be used for the resulting report workbook.

To see which report names have already been used or to enter another select the **Browse** button.

Enter the new filename and select **Save**.

### OK Button

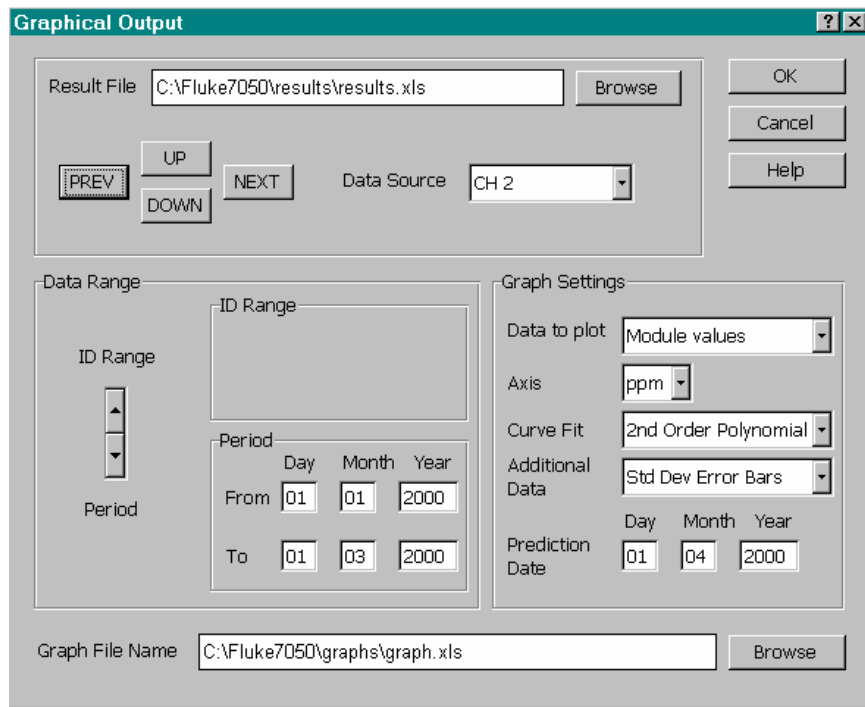
This will generate the report.

### Cancel Button

This will close this dialogue box without producing a report.

### Produce Graph

After completing an Import of traceability, a graph to plot a series of previous imports can be generated using the **Produce Graph** dialogue. This facility can also be used to plot a series of module values of differences for an individual module.



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Explanation of the dialogue controls:

### Result File

Select the results file that contains the data from which the graph is to be produced. Use the **PREV** and **NEXT** navigation keys to view the worksheets of the selected results file. This enables switching between the import and individual channel worksheets.

Use the **UP** and **DOWN** navigation keys to scroll through the selected worksheet. This enables the required ID numbers to be determined.

The **Data Source** selection box in the top group of the dialogue is used to select what the graph is to be produced for (import or individual channel).

Using the spinner control in the **Data Range** group of controls, choose how the period of data to be reported will be selected, either by "to" and "from" ID's (**ID Range** group) or by a "to date" and a "from date" (**Period** group).

In the **Graph Settings** group, make selections to set-up how the graph will appear.

Use the **Data to plot** drop-down to select whether to plot 1) HAV values or the external calibration values for an Import or 2) module values or difference from HAV values for an individual channel.

Use the **Axis** drop-down to select whether the difference from nominal 10 volts represented on the Y axis of the graph will be shown in micro-volts or parts-per-million.

Use the **Curve Fit** drop-down to select whether to apply a linear or second order polynomial curve fit to predict the future value of the HAV (or next external calibration value).

Use the **Additional Data** drop-down to select whether to show standard deviation or uncertainty error bars on the graph.

The **Prediction Date** controls allow entry of a date in the future to which the graph and curve fit will be extended to so that a predicted value of the HAV (or next external calibration value) can be returned as thus a predicted drift rate calculated.

### Graph Filename

This is the filename that will be used for the resulting graph workbook.

To see which graph names have already been used or to enter another select the **Browse** button.

Enter the new filename and select Save.

### OK Button

This will generate the graph.

### Cancel Button

This will close this dialogue box without producing a graph.

## Software Support

If you incur any problems with using the 7050 programs, you can obtain telephone hot-line support by contacting Fluke at the address given below.

Before you do so, however, please obtain your software version number by selecting the "About" option from the "Fluke 7050" menu located on the Excel menu bar.

For hardware-related issues, see "Contacting Fluke" in Chapter 1. For software support, use the following contact information to get in touch with Fluke:

**United States**

Fluke Corporation  
P.O. Box 9090  
Everett, WA 98206-9090  
U.S.A.

Telephone: 1-800-825-7411 (toll free)  
Fax: 1-425-356-5992  
E-mail: [metsupport@fluke.com](mailto:metsupport@fluke.com)

**United Kingdom**

Fluke Precision Measurement Ltd.  
Hurricane Way  
Norwich  
Norfolk  
NR6 6JB

Telephone: 01603-256-685  
Fax: 01603-256-688  
E-mail: [metsupport@fluke.nl](mailto:metsupport@fluke.nl)





# ***Appendix***

<b>Appendix</b>	<b>Title</b>	<b>Page</b>
A	Routine Maintenance and Test.....	A-1



# **Appendix A**

## **Routine Maintenance and Test**

### **Introduction**

This appendix contains information and instructions for any routine maintenance and testing.

### **Routine Maintenance**

The 7000 Series requires no routine maintenance.

### **Replacing the 7000 Module Battery**

According to the battery manufacturers data for the trickle charge current used, the battery in the 7000 should exhibit a half life of at least five years. This means that after five years of continuous trickle charge the capacity of the battery will be halved. Preventative maintenance procedures may require the battery to be changed more regularly. Should it be necessary to replace the battery for any reason follow the instructions below. It is advisable to have the replacement Battery Assembly ready to avoid powering modules up and down unnecessarily.

#### **⚠ Warning**

**The correct battery assembly is only available from Fluke by ordering Fluke Part No. 1573990.**

**Do not replace the battery with any other type. Wear eye protection.**

**Use extreme care not to short the battery terminals. The battery may explode if shorted.**

1. Remove the 7000 Reference Module from system;
  - a. Remove the knurled fixing screw securing the module into the rack.
  - b. Insert the extraction tool, part no. 1571661, into the hole and slide to the left to engage the tip behind the slot.
  - c. Pull the module out using the extraction tool. Do NOT remove modules by pulling on their terminals.

2. Undo the four screws securing the modules left hand side panel. This is the panel with the battery warning label.
3. Disconnect the Battery Assembly lead from the Side PCB Assy using the 4 way connector.
4. Undo the two large bolts securing the battery plate and battery pack to the rear panel.
5. Remove old Battery Assembly
6. Fit the new Battery Assembly
7. Feed the two large bolts through the battery assembly and secure into battery fixing plate.
8. Tighten bolts (take care not to over tighten)
9. Connect Battery Assembly lead to connector on the Side PCB Assy.
10. Re-attach the left hand side panel using the four screws.
11. Replace module into the system.
  - a. Insert module into rack taking care to align the module with the guides.
  - b. Push fully home until the front panel is flush with other modules.
  - c. Using the supplied knurled fixing screw secure the module into the rack.
12. Dispose of the old battery pack responsibly.