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DM 5110 Programmable Digital Multimeter

DM 511 Digital Multimeter

Operators

Instruction Manual

Tektronix, Inc.
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Product Group 76

Tektronix Part No. 070-7478-00

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INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert tag, or stamped on the chassis. The first number or letter designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument.Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B000000	Tektronix, Inc.Beaverton Oregon, USA
G100000	Tektronix Guernsey, Ltd., Channel Islands
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony / Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

TABLE OF CONTENTS

Page

LIST OF ILLUSTRATIONS iii

LIST OF TABLES iii

OPERATORS SAFETY SUMMARY iv

Section 1 SPECIFICATION

Introduction 1-1
Instrument Description 1-1
IEEE - 488.1 Function Capability 1-2
IEEE - 488.1 Interface Function Subsets 1-2
IEEE - 488.1 Bus Address and Terminator 1-2
Accessories and Options 1-2
Performance Conditions 1-2
Electrical Characteristics 1-3
Environmental Characteristics 1-13

Section 2 OPERATING INSTRUCTIONS

Introduction 2-1
Installation and Removal 2-1
Power Up Sequence 2-1
Repackaging for Shipment 2-2
Controls, Connectors and Indicators 2-4
Front Panel Operation 2-7
Front Panel Controls 2-7
Primary Level Functions 2-7
Secondary Functions 2-10
Summary of Keyboard Functions 2-13
Basic Measurements 2-15
Display Error Reporting 2-21

Section 3 PROGRAMMING

Introduction 3-1
IEEE-488.1 bus Address and Terminator 3-1
Message and Communication Protocol 3-2
Remote - Local Operation 3-7
Device Dependent Command Set 3-8
Detaled Command List 3-11

Page

Calibration Command List 3-29
Power - On / Initial Conditions 3-30
Status and Error Reporting 3-30
Detailed Error Listing 3-33

Section 4 MAINTENANCE

Introduction 4-1
Recalibration / Adjustment 4-1
Internal Fuse Replacement 4-1
Cleaning Instructions 4-1

Section 5 OPTIONS AND ACCESSORIES

Option 02 5-1
Standard Accessories 5-1
Optional Accessories 5-1

LIST OF ILLUSTRATIONS

Fig.		Page
2.1	Front Panel controls, connectors and indicators	2-3
3.1	ASCII and IEEE (GPIB) Code Chart	3-6
3.2	Definition of STB Bits	3-31

LIST OF TABLES

Table		Page
1-1	IEE - 488 Interface Subsets	1-2
1-2	Electrical Characteristics	1-3
1-3	Environmental Characteristics	1-13
2-1	Summary of Keyboard Functions	2-13
2-2	Resistance Ranges	2-17
2-3	Comparison of Average and TRMS Meter Readings	2-20
3-1	Function/ Range v.s. Range Number	3-24
3-2	Error Query and Status Information	3-32
3-3	Detailed Error Listing	3-33

Operators Safety Summary

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

TERMS

In this Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of live.

As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property including the instrument itself.

DANGER indicates a personal injury hazard immediately as one reads the markings.

SYMBOLS

In This Manual

This symbol indicates where applicable cautionary or other information is to be found.

This symbol indicates static sensitive devices, that are subject to be damaged by static electricity.

As Marked on Equipment

DANGER - High voltage

Protective ground (earth) terminal.

ATTENTION - Refer to manual.

Safety Summary (cont.)

POWER CONDITIONS

Use the Proper Power Cord

Use only the power cord and connector as specified for the instrument.

Power Source

Use the proper power source. Before switching on, make sure the instrument is set to the voltage of the power source. This product is intended to operate from a power source that will not apply more than 250 Volts RMS between the supply connectors or between either supply connector and ground. A protective ground connection by way of the grounding connector in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding connector of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before making any connections to the product input or output terminals. A protective ground connection by way of the ground connection is essential for safe operation.

Danger Arising from Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulated) can render an electrical shock.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified for the instrument in the instrument part list. A replacement fuse must meet the type, voltage rating, and current rating specifications for the fuse that it replaces.

GENERAL

Do Not Operate in Explosive Atmospheres

To avoid explosions, do not operate this instrument in an atmosphere of explosive gasses.

Do Not Remove Covers or Panels

To avoid personal injury, the instrument covers or panels should only be removed by qualified service personnel. Do not operate the instrument without covers and panels properly installed.

SPECIFICATION

Introduction

This section of the manual contains a general description of the Tektronix DM 5110 Programmable Digital Multimeter and the DM 511 (Non Programmable) Digital Multimeter and complete electrical, mechanical, physical and environmental specifications.
Standard accessories are also listed.

Instrument Description

The Tektronix DM 5110 is a programmable six function autoranging digital multimeter. At 4 1/2 digit resolution, the LED display can present +/- 19,999 counts.

The DM5110 /DM 511 can make the following basic measurements:

- DC voltage measurements up to 1000 V with maximum resolution of 10 mV.
- Resistance measurements up to 20 MΩ with maximum resolution of 10 mΩ
- TRMS AC voltage measurements up to 500 V with maximum resolution of 10 mV.
- DC current measurements up to 2000 mA with maximum resolution of 10 nA.
- TRMS AC current measurements up to 2000 mA with maximum resolution of 10 nA.
- Temperature measurements from –62 to + 240 °C. (Tektronix P6602 temperature probe required.)

All measurement functions can be set to either manual or auto-ranging except for the temperature measurement having just one range.
Besides the led's showing the measured value, 5 additional indicators show NULL, HOLD and AUTO and the GPIB functions ADDR and REM.
The DM5110/ DM 511 has the following functions:

- Additional dBm and dBV ranges, which are software calculated versions of the AC voltage ranges.
- A NULL function to make measurements with an offset value.
- A HOLD mode and a TRIGGER function.
- A COMPARE mode, comparing the measurement with user selectable HI and LO LIMITS.
- A BEEPER mode, which sounds the beeper when a measurement is beyond user selectable HI and LO LIMITS.
- FAST and NORMAL mode measurement. (3.5 and 4.5 digit)
- 50 and 60 Hz measurement modes.

The settings of the GPIB address and terminator are initiated by the frontpanel keys.
A manually operated switch can select a front or rear connection to the LOW and Volts /Ω /Temp inputs.
This switch is not operated via the IEEE-488.1 bus, but a query is available in the command set to monitor the setting.

WARNING

The maximum voltage that can be applied to the rear-interface connection is limited because of safety requirements.

The DM511 has the same specs. as the DM5110, but is not GPIB programmable, so all items in this manual concerning the IEEE- 488.1 bus do not apply to the DM511.

CAUTION

Turn the power OFF before inserting the DM5110. Otherwise arcing may occur at the rear interface connectors and damage may be done to the plug-in circuitry.

WARNING

Do NOT operate this product without covers or panels installed.
Do NOT apply power to the plug-in via a plug-in extender.
Do NOT operate this product with distorted covers.
To avoid fire hazard, only use the fuse specified in the parts list.

The maximum frontpanel input voltage is 1000 V peak, so the input connectors, and therefore all mainboard circuitry and part of the GPIB board, may be floating up to 1000Volts.

IEEE 488 .1 Function Capability

The built- in IEEE- 488.1 interface makes the DM 5110 instrument remotely programmable via the IEEE- 488.1 bus as specified in :
IEEE Standard 488.1 - 1987, "Standard Digital Interface for Programmable Instrumentation".
In this manual the interface is called the General Purpose Interface Bus (GPIB).

IEEE - 488 .1 INTERFACE FUNCTION SUBSETS

IEEE Standard 488.1-1987 identifies the interface function repertoire of a device on the bus in terms of interface function subsets. These subsets are defined in the standard. The subsets that apply to the DM 5110 are listed below.

Table 1-1
IEEE- 488.1 INTERFACE FUNCTION SUB SETS

SH1	Source handshake. Complete capability.
AH1	Acceptor handshake. Complete capability.
T6	Untalk if MLA
L4	Unlisten if MTA
SR1	Service request. Complete capability.
RL1	Remote Local. Complete capability including local lockout.
PP0	Parallel Poll. Does not respond to parallel poll
DC1	Device clear. Complete capability.
DT1	Device trigger with GET
C0	Non controller function
E1	Open collector drivers

IEEE- 488.1 BUS ADDRESS AND TERMINATOR

The GPIB address and terminator are stored in EEPROM.
The address and terminator are set via the front panel, as described in chapter 2.

Accessories and Options

Standard Accessories Included :

1 DM5110 Operators Manual 070-7478-xx
1 Pair of test leads 196-3212-xx
1 GPIB Reference Guide DM5110 .....070-7559-xx
1 Instrument Interface Guide
DM 5110 .....070-7560-xx

Note :
The test leads PL260 (196-3212-xx) are rated for 1000 V , based on UL evaluation.

Optional Accessories include:

Temperature Probe P6602
High Voltage Probe 010-0277-xx
RF Probe P6420
Service Manual.....070-7479-xx

Option :

Option 02 : DM5110 (or DM511) calibrated with a temperature probe P6602.

Performance Conditions

The characteristics in this specification are valid with the following conditions:

- The instrument must have been calibrated at an ambient temperature between + 22 °C and +24 °C.
- The instrument must be in a non-condensing environment whose limits are described under Environmental.
- Allow 30 minutes warm-up time for operation to the specified accuracy, and 1 hour after exposure to or storage in high humidity (condensing) environment.
- Specifications are valid only with those connections to the instrument that are required to verify each specification.

Items listed in the Performance Requirement column of the following tables are verified by completing the Performance Check in the Service Manual.
Items listed in the Supplemental Information column may not be verified in the manual; they are explainatory notes for which no limits are specified.

ELECTRICAL CHARACTERISTICS

Table 1–2
Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
DIRECT VOLTAGE (DV) (4.5 digit, front and rear panel inputs) [For specifications of the 3.5 digit mode, add +/- 1 display count.]		
Accuracy for 200 mV, 2 V, 20 V, 200 V, and 1000 V ranges		Automatic or manual ranging
+18 to +28 °C		
200 mV range 2 V range 20 V range 200 V range 1000 V range	± (0.05% of reading +0.015% of F.S.) ± (0.05% of reading +0.01% of F.S.) ± (0.05% of reading +0.015% of F.S.) ± (0.05% of reading +0.01% of F.S.) ± (0.05% of reading +0.02% of F.S.)	
0 to +18, +28 to +50 °C.		
200 mV range 2 V range 20 V range 200 V range 1000 V range	± (0.15% of reading +0.04% of F.S.) ± (0.1% of reading +0.02% of F.S.) ± (0.15% of reading +0.025% of F.S.) ± (0.1% of reading +0.02% of F.S.) ± (0.1% of reading +0.02% of F.S.)	
Common Mode Rejection Ratio	≥ 100 dB at DC ≥ 80 dB at 50 or 60 Hz	With a 1 kΩ unbalance
Normal Mode Rejection Ratio	≥ 50 dB at 50 or 60 Hz (± 0.2 Hz)	
Maximum Resolution		10 µV
Step Response Time		< 50 msec. to 0.05 % of step
Input Resistance		10 MOhm ± 0.5%

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
Maximum Input Voltage		
Front-panel inputs:		
VOLTS /Ω /TEMP to LOW		1000 V peak
VOLTS /Ω /TEMP to GND		1000 V peak
LOW to GND		1000 V peak
Rear interface Conn.:		
Pin 28B (Hi) to pin 28A (Lo)		60 V (DC plus pk AC)
Pin 28B (Hi) or pin 28A (Lo) to Chassis		60 V (DC plus pk AC)

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
ALTERNATING VOLTAGE (AC coupled) (True RMS) (4.5 digit, front and rear panel inputs) [For specifications of the 3.5 digit mode, add +/- 1 display count.]		
Accuracy for 200 mV 2V, 20 V, 200 V and 500 V ranges		Automatic or manual ranging
+18 to +28 °C		
200 mV to 200V Range		
20 Hz to 100 Hz	± (0.8% of reading +0.05% of F.S.)	Input > 200 counts
100 Hz to 10kHz	± (0.3% of reading +0.05% of F.S.)	Input > 200 counts
10 kHz to 20kHz	± (0.6% of reading +0.05% of F.S.)	Input > 500 counts
20 kHz to 50kHz	± (1.0% of reading +0.05% of F.S.)	Input >2000 counts
500V range		
20 Hz to 100 Hz	± (0.8% of reading +0.05% of F.S.)	Input > 50 counts
100 Hz to 10 kHz	± (0.3% of reading +0.05% of F.S.)	Input > 50 counts
10 kHz to 20 kHz	± (0.6% of reading +0.05% of F.S.)	Input > 250 counts
20 kHz to 50 kHz	± (1.0% of reading +0.05% of F.S.)	Input > 500 counts
0 to +18 , +28 to +50 °C		
200 mV to 200V Range		
20 Hz to 100 Hz	± (1.1% of reading +0.075% of F.S.)	Input > 200 counts
100 Hz to 10 kHz	± (0.6% of reading +0.075% of F.S.)	Input > 200 counts
10 kHz to 20 kHz	± (0.9% of reading +0.075% of F.S.)	Input > 500 counts
20 kHz to 50 kHz	± (1.3% of reading +0.075% of F.S.)	Input >2000 counts
500V range		
20 Hz to 100 Hz	± (1.1% of reading +0.075% of F.S.)	Input > 50 counts
100 Hz to 20 kHz	± (0.6% of reading +0.075% of F.S.)	Input > 50 counts
10 kHz to 20 kHz	± (0.9% of reading +0.075% of F.S.)	Input > 250 counts
20 kHz to 50 kHz	± (1.3% of reading +0.075% of F.S.)	Input > 500 counts

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
Common Mode Rejection Ratio	≥ 60 dB at 50 or 60 Hz	With a 1 kΩ unbalance
Maximum Resolution		10 µV
Step Response time		< 0.3 sec. to 1% of step
Maximum Input Voltage		
Front-panel inputs: VOLTS / Ω /TEMP to LOW VOLTS / Ω / TEMP to GND LOW to GND		 500 V rms or 600 V DC 1000 V peak 1000 V peak
Rear interface Conn.: Pin 28B (Hi) to pin 28A (Lo) Pin 28B (Hi) or pin 28A (Lo) to Chassis		 60 V (DC plus pk AC) 60 V (DC plus pk AC)
Crest Factor		3 : 1 for 0.1% add. error

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
DECIBELS (AC coupled) (True RMS) (4.5 digit, front and rear panel inputs) [For specifications of the 3.5 digit mode, add +/- 1 display count.]		
Accuracy for dBV/dBm	00.00 dBm= 1 mWatt in a 600 Ω load 00.00 dBV =1 V RMS	Automatic or manual ranging
+18 to +28 °C		
Accuracy for dBV (autoranging)	± 0.3 dB from –34 dBV to +54 dBV ± 0.6 dB from –54 dBV to –34 dBV ± 1.0 dB from –60 dBV to –54 dBV	Frequency 20 Hz to 20 kHz Frequency 20 Hz to 10 kHz Frequency 20 Hz to 10 kHz
Accuracy for dBm (autoranging)	± 0.3 dB from –32 dBm to +56 dBm ± 0.6 dB from –52 dBm to –32 dBm ± 1.0 dB from –58 dBm to –52 dBm	Frequency 20 Hz to 20 kHz Frequency 20 Hz to 10 kHz Frequency 20 Hz to 10 kHz
0 to +18, +28 to +50 °C		
Accuracy for dBV (autoranging)	± 0.4 dB from –34 dBV to +54 dBV ± 0.8 dB from –54 dBV to –34 dBV ± 1.5 dB from –60 dBV to –54 dBV	Frequency 20 Hz to 20 kHz Frequency 20 Hz to 10 kHz Frequency 20 Hz to 10 kHz
Accuracy for dBm (autoranging)	± 0.4 dB from –32 dBm to +56 dBm ± 0.8 dB from –52 dBm to –32 dBm ± 1.5 dB from –58 dBm to –52 dBm	Frequency 20 Hz to 20 kHz Frequency 20 Hz to 10 kHz Frequency 20 Hz to 10 kHz
Maximum Resolution		0.01dB
Step Response time		< 0.3 sec. to 1% of step
Input Impedance		2 MΩ ±1% paralleled by < 50 pF
Maximum Input Voltage		
Front-panel inputs: VOLTS / Ω / TEMP to LOW VOLTS / Ω / TEMP to GND LOW to GND		 500 V RMS or 600 V DC 1000 V peak 1000 V peak
Rear interface Conn.: Pin 28B (Hi) to pin 28A (Lo) Pin 28B (Hi) or pin 28A (Lo) to Chassis		 60 V (DC plus pk AC) 60 V (DC plus pk AC)

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
OHMS (4.5 digit, front and rear panel inputs) [For specifications of the 3.5 digit mode, add +/- 1 display count.]		
Accuracy for 200 Ω, 2kΩ, 20 kΩ, 200 kΩ, 2 MΩ and 20 MΩ ranges		Automatic or manual Ranging
+18 to +28 °C		
		Source cur. V max. at full scale
200 Ω range	± (0.05% of reading +0.02% of F.S)	1.0 mA 0.2 V
2 kΩ range	± (0.05% of reading +0.01% of F.S)	1.0 mA 2.0 V
20 kΩ range	± (0.05% of reading +0.02% of F.S)	10 µA 0.2 V
200kΩ range	± (0.05% of reading +0.01% of F.S)	10 µA 2.0 V
2 MΩ range	± (0.1% of reading +0.02% of F.S)	0.1 µA 0.2 V
20 MΩ range	± (0.1% of reading +0.01% of F.S)	0.1 µA 2.0 V
0 to +18 , +28 to +50 °C		
		Source cur. V max. at full scale
200 Ω range	± (0.25% of reading +0.04% of F.S)	1.0 mA 0.2 V
2 kΩ range	± (0.25% of reading +0.03% of F.S)	1.0 mA 2.0 V
20 kΩ range	± (0.25% of reading +0.04% of F.S)	10 µA 0.2 V
200 kΩ range	± (0.25% of reading +0.03% of F.S)	10 µA 2.0 V
2 MΩ range	± (1 % of reading + 0.04% of F.S)	0.1 µA 0.2 V
20 MΩ range	± (1 % of reading + 0.03% of F.S)	0.1 µA 2.0 V
Step Response Time		< 0.2 sec 200 Ω to 2 MΩ ranges < 2 sec in 20 MΩ range
Maximum input voltage any range (front)		300 V peak
Maximum input voltage any range (rear)		60 V peak
Maximum Resolution		10 mΩ
Maximum open circuit voltage		< 11 V

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
DIRECT CURRENT (DC) (4.5 digit, front panel inputs only) [For specifications of the 3.5 digit mode, add +/- 1 display count.		
Accuracy for 200 µA, 2 mA, 20 mA, 200 mA and 2000 mA ranges		Automatic or manual ranging
+18 to +28 °C	± (0.1 % of reading +0.01 % of F.S.)	
0 to +18 , +28 to +50 °C.	± (0.3 % of reading +0.025 % of F.S.)	
Step Response Time		< 50 msec. to 0.05 % of step
Input resistance		Range Approx.Res. 200 µA 1.0 kΩ 2 mA 100.0 Ω 20 mA 10.2 Ω 200 mA 1.2 Ω 2000 mA 0.26 Ω
Maximum Open Circuit Input Voltage (mA to LOW)		250 V peak
Maximum Input Current		2 A any range
Maximum floating voltage mA to GND LOW to GND		 1000 V peak 1000 V peak
Maximum resolution		10 nA

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
ALTERNATING CURRENT (AC coupled) (True RMS) (4.5 digit, front panel inputs only) [For specifications of the 3.5 digit mode, add +/- 1 display count.]		
Accuracy for 200 µA, 2 mA, 20 mA, 200 mA and 2000 mA ranges		Automatic or manual ranging
+18 to +28 °C		
20 Hz to 100 Hz 100 Hz to 10kHz	+/-(0.8% of reading +0.05% of F.S.) +/-(0.3% of reading +0.05% of F.S.)	Input > 200 counts Input > 200 counts
0 to +18, +28 to + 50 °C		
20 Hz to 100 Hz 100 Hz to 10kHz	+/-(1.1% of reading +0.075% of F.S.) +/-(0.6% of reading +0.075% of F.S.)	Input > 200 counts Input > 200 counts
Crest Factor		3 : 1 for 0.1% add. error
Step Response Time		< 0.3 sec. to 1 % of step
Input Impedance		Range Approx. Imp. 200 µA 1.0 kΩ 2 mA 100.0 Ω 20 mA 10.2 Ω 200 mA 1.2 Ω 2000 mA 0.26 Ω
Maximum Open Circuit Input Voltage (mA to LOW)		250 V peak
Maximum Input Current		2 A any range
Maximum floating voltage mA to GND LOW to GND		 1000V peak 1000V peak
Maximum Resolution		10 nA

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
TEMPERATURE (4.5 digit, front panel inputs) [For specifications of the 3.5 digit mode, add +/- 1 display count.]		
Temperature range		–62 °C. to + 240 °C.
+18 to +28 °C ambient		
Instrument calibrated to P6602 probe	± 0.6 °C from –62 °C to +150 °C ± 1.6 °C from +150 °C to +240 °C	
Any P6602 Probe	± 3.5 °C from –62 °C to +150 °C ± 6 °C from +150 °C to +240 °C	
0 to +18, +28 to +50 °C ambient		
P6602 Probe calibrated to instrument	± 1.5 °C from – 62 °C to +150 °C ± 2.5 °C from +150 °C to +240 °C	
Any P6602 Probe	± 4.5 °C from –62 °C to +150 °C ± 7 °C from +150 °C to +240 °C	

Table 1–2 (Cont.)

Characteristics	Performance Requirements	Supplemental Information
	MECHANICAL	
Net Weight DM5110 DM511		 2.45 lbs. (1.1 kg) 2.2 lbs. (1.0 kg)
Size		2.63 in. (66.8 mm) W x 11.240 in. (285.3 mm) D x 4.961 in. (125.9 mm) H.
	MISCELLANEOUS	
Power Consumption		Less than 10 watt
Reading Rate 4.5 digit (NORMAL) 3.5 digit (FAST)		 > 3 times per second > 25 times per second except 20MOhm range (10 times per second)
Over-range Indication		blinking display
Warm-up Time		30 minutes (60 minutes after storage in high humidity environment)

ENVIRONMENTAL CHARACTERISTICS

Table 1–3
Environmental Characteristics (With power module.)

Characteristics	Description	Supplemental Information
	TEMPERATURE	
Operating	0 °C to +50 °C	Meets or exceeds MIL-T-28800D, class 5. with exceptions.
Non-Operating	– 55 °C to +75 °C	
	HUMIDITY	
Humidity	≤ 95% RH, 0 °C. to 30 °C ≤ 75% RH 30 °C to 40 °C ≤ 45% RH above 40°C	Meets or exceeds MIL-T-28800D, class 5, non-condensing.
	ALTITUDE:	
Operating	4.6 km (15,000 ft.)	Meets or exceeds MIL-T-28800D, class 3.
Non-Operating	15 km (50,000 ft.)	
	VIBRATION	
Vibration	0.64 mm (0.025") peak-to-peak, 5 Hz to 55 Hz, 75 minutes.	<Refer to TM500 (DM511) or TM 5000 (DM5110) power module specifications.> Meets or exceeds MIL-T-28800D, class 3, when installed in power module.

Table 1–3 (cont.)

Characteristics	Description	Supplemental Information
	SHOCK	
Shock	30 g's (1/2 sine) 11 ms. duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets or exceeds MIL-T 28800D.
Bench Handling <Without power module.>	12 drops from 45 degr., 4" or equilibrium, whichever occurs first.	Meets or exceeds MIL-T 28800D.
	TRANSPORTATION	
Transportation		Qualified under National Safe Transit Association Preshipment. Test Procedures 1A-B-1 and 1A-B-2.
EMC (System performance subject to exceptions of power module and/or other plug-ins.)		Within limits of F.C.C. Regulations Part 15, Subpart J, Class A ; VDC 0871 category B and MIL-461B (1980) for RE01, RE02, CE01, CE03, RS01, RS03, CS01, CS02, and CS06. 30 Hz - 1 GHz
	ELECTRICAL DISCHARGE	
Electrical Discharge Operating	Operating Maximum Test Voltage: 20 kV, 150 pF through 150 Ω.	No MIL-T-28800 equivalent. Charge applied to each protruding area of the front-panel except the input connectors.

OPERATING INSTRUCTIONS

Introduction

This section provides installation and operating instructions for the DM 5110 / 511 and describes the functions of the front-panel controls and connectors.
The information in this section assumes the instrument is not connected to the GPIB.
Complete information for programming the DM 5110 via the GPIB (General Purpose Interface Bus) is in the Programming section of this manual. (see section 3)

Installation and Removal

NOTE

The DM 5110 is designed to operate in aTM 5000 - series power module.
The DM 511 is designed to operate in a TM 500- series module and also in a TM 5000 - series power module.

The DM 5110 / DM511 are calibrated and ready for use when received. It operates in one compartment of a power - module (TM 5000 or TM500 is depending on the type of instrument, DM 5110 or DM 511).
Refer to the manual of your power module for line voltage requirements and power module operation.

CAUTION

To prevent damage to the DM 5110 / DM 511 , turn the power module off before installation or removal.
Do not use excessive force to install or remove.

Before installing the instrument in the power module, align the instrument chassis with the upper and lower guides of the selected compartment. Press the instrument in and firmly seat the circuit board in the interconnecting jack.

To remove the instrument, pull the release latch (located in the lower left corner of the front panel), until the interconnecting jack disengages and the instrument slides out.

Check that the instrument is fully inserted in the power module.

Power Up Sequence

When powered on, the DM 5110 / 511's microprocessors perform a diagnostic routine (self test) to check the functionality of the EEPROM and the DM5110 tests the communication between the GPIB board microprocessor and the microprocessor of the mainboard.
The instrument will start in the DC Voltage, autoranging, 4.5 digit accuracy mode.
The LO LIMIT and HI LIMIT are set to zero.
The NULL, BEEPER and COMPARE mode are off.
If no EEPROM errors are found, the microprocessor goes on to check the functionality of the other instrument hardware.

If an EEPROM error is found, an error code "EErr" is displayed in the front-panel display for about a second. In that case, the IEEE address is then set to 15 and the line frequency to 60 Hz.

If the internal microprocessor communication test fails, the instrument reacts like a DM511. This can be checked by pressing the INST ID key; a DM511 will not show a GPIB address. Also the internal diagnostic LED on the GPIB-board of a DM5110 will not blink in a constant rate with a one second repetition time.

When errors like described above occur, send your instrument to the nearest Tektronix Service Center.

WARNING

Dangerous arcs of an explosive nature in a high energy circuit can cause severe personal injury or death.
If the meter is connected to a high energy circuit when set to a current range, low resistance range or any other low impedance range,the meter is virtually shorted.
Dangerous arcing can also result when the meter is set to a voltage range if minimum voltage spacing is reduced, or if maximum input voltages are exceeded.
The maximum input common- mode voltage(the voltage between the LOW , V/Ω/TEMP, mA - input and chassis ground) is1000 V peak. Exceeding this value may create a shock hazard.

Repackaging for Shipment

It is recommended that the original carton and packing material be saved in the event it is necessary for the instrument to be reshipped to a Tektronix Service Center, using a commercial transport carrier. If the original material is unfit or not available, then repackage the instrument using the following procedure :

1. Use a corrugated cardboard shipping carton having a test strength of at least 125 kilo and with an inside dimension of at least fifteen cm larger than the instrument dimensions.

2. If the instrument is going to be shipped to a Tektronix Service Center, enclose the following information:

   - The owners address, name, phone number of a contact person.

   - Type, option number and serial number of the instrument, reason for returning and a complete description of the service required.

3. Completely wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of harmful substances into the instrument.

4. Cushion the instrument on all sides using eight cm of padding material or urethane foam, tightly packed between the carton and the instrument.

5. Seal the carton with an industrial stapler or shipping tape.

6. Mark the address of the Tektronix Service Center and also your own address on the shipping carton in two prominent locations.

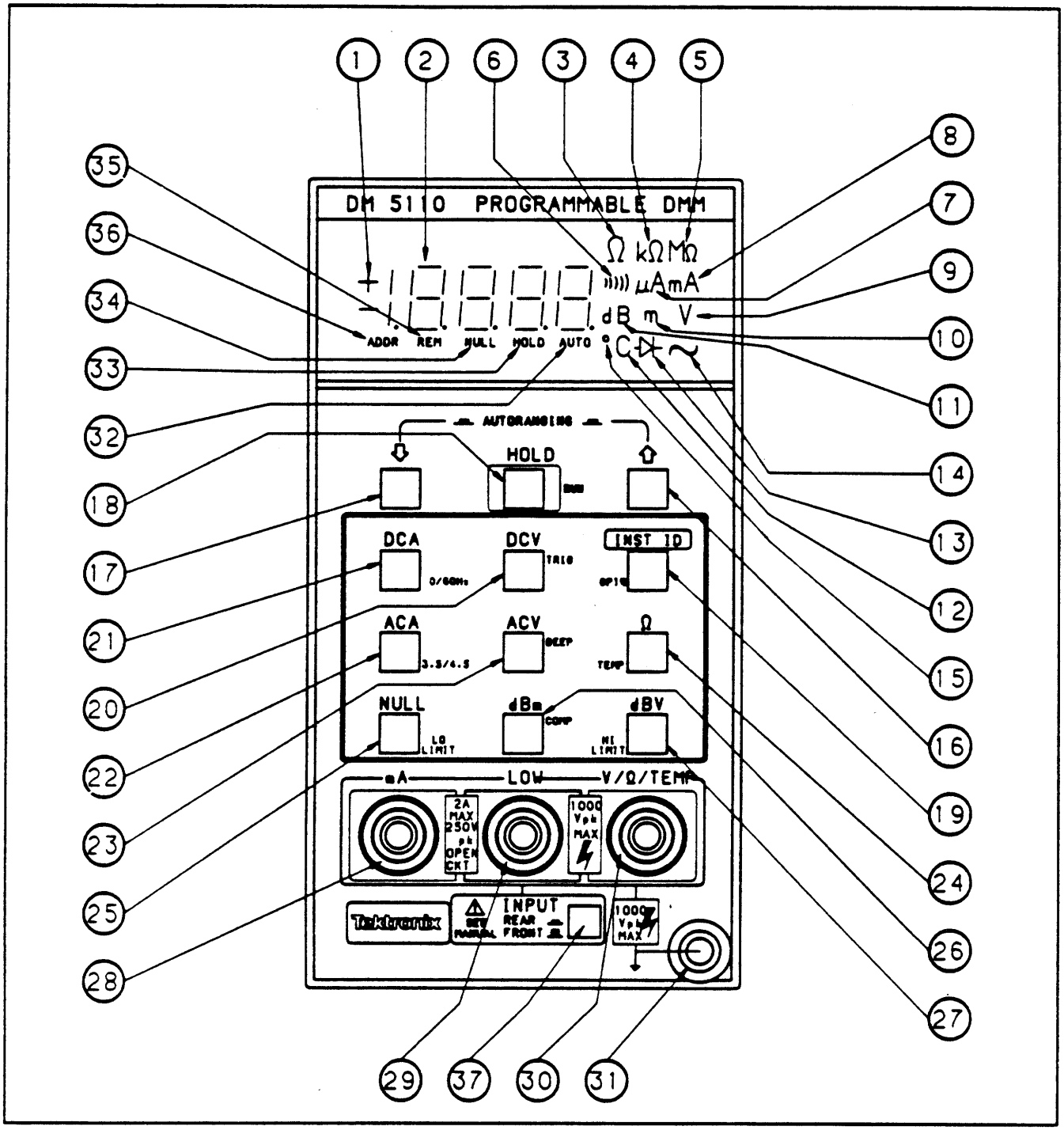


Fig. 2-1 Front Panel controls, connectors and indicators.

Controls, Connectors and Indicators

All controls, connectors and indicators required for operation of the instruments are located on the front panel. Fig 2.1 shows the location of all controls, connectors and indicators.

(1) **Polarity**

LED readout indicating the polarity of the measurement.

(2) **Display**

4 1/2 - digit LED readout with properly positioned decimal point.

(3) Ω

Illuminated when units are in Ohms.

(4) **kΩ**

Iluminated when units are in kiloOhms.

(5) **MΩ**

Illuminated when units are in MegaOhms.

(6) **Beeper**

Illuminated when the instrument is in the Beeper mode.
Beeper sounds when the measurement is below the LO limit or above the HI limit.

(7) **µA**
Illuminated when units are in µA.

(8) **mA**
Illuminated when units are in mA.

(9) **V**

Illuminated when units are in Volts or combined with dB for dBV.

(10) **m**

Illuminated when units are in mVolts (10^{-3}) or combined with dB for dBm.

(11) **dB**

Illuminated when units are in deciBells.

(12), (15) **°C**

Illuminated when units are in degrees Celsius.

(13) ⊣▷⊢ (Diode)

Illuminated in 2 kΩ, 200 kΩ and 20 MΩ ranges, indicating diode measurement capabilitity in these ranges .

(14) **~ (Sinewave)**

Illuminated in AC measuring modes.

(16) **Up**

Primary level:
Selects the next higher measurement range. Pushing UP and DOWN simultaneously selects autoranging.
Secondary level:
Changing settings.

(17) **Down**

Primary level:
Selects the next lower measurement range. Pushing UP and DOWN simultaneously selects autoranging.
Secondary level:
Changing settings.

(18) **HOLD**

Primary level:
Pressing the key sets the instrument in the HOLD mode. The HOLD led is on. Also indicating that the secondary functions functions can be used.
Secondary level:
Pressing the key sets the instrument in the RUN mode and returns the keyboard functions to the primary level.

(19) **INST ID**

Primary level:
Pressing the key makes the instrument show his primary address on the display. Releasing the key makes the instrument return to the original state.
Secondary level:
Pressing the key sets the instrument in the GPIB settings mode.

(20) **DCV**

Primary level:
Pressing the key sets the instrument in the DC voltage mode.
Secondary level:
Pressing the key triggers the instrument

(21) **DCA**

Primary level:
Pressing the key sets the instrument in the DC current function.
Secondary level:
Pressing the key will set the instrument in the 50 or 60 Hz setting mode.

(22) **ACA**

Primary level:
Pressing the key sets the instrument in the AC current function.
Secondary level:
Pressing the key sets the instrument in the 3.5 or 4.5 digit setting mode.

(23) **ACV**

Primary level:
Pressing the key sets the instrument in the AC voltage function.
Secondary level:
Pressing the key sets the instrument in the Beeper setting mode.

(24) **OHMS**

Primary level:
Pressing the key sets the instrument in the Ohms function.
Secondary level:
Pressing the key sets the instrument in the Temperature function.

(25) **NULL**

Primary level:
Pressing the key turns the NULL mode on or off.
Secondary level:
Pressing the key sets the instrument in the LO LIMit setting mode.

(26) **dBm**

Primary level:
Pressing the key sets the instrument in the dBm function.
Secondary level:
Pressing the key sets the instrument in the COMPare setting mode.

(27) **dBV**

Primary level:
Pressing the key sets the instrument in the dBV functon.
Secondary level:
Pressing the key sets the instrument in the HIgh LIMit setting mode.

(28) **mA (Input)**

Terminal used in conjunction with the LOW input connector for current measurements.

(29) **LOW**

Common terminal for all types of measurement.

(30) **V / Ω / TEMP (Input)**

Terminal used in conjunction with the LOW input connector for voltage, resistance and temperature measurements.

(31) **Ground Terminal**

Chassis ground terminal.

(32) **AUTO (led)**

Illuminated in AUTO ranging.

Note :
This led is blinking constantly, when the inter nal jumper is in the CAL position. TAKE CARE!! The instrument can now easily be recalibrated!!!! Contact qualified service personnel!

(33) **HOLD (led)**

Illuminated when the HOLD mode is on and also indicating secondary keyboard level.

(34) **NULL (led)**

Illuminated when the NULL mode is on.

(35) **REM (led)**

Illuminated when the instrument is in the GPIB remote state.

(36) **ADDR (led)**

Illuminated when the instrument is being GPIB addressed to talk or listen.

(37) **INPUT (switch)**

Selects the FRONT or REAR connection of the LOW and VOLTS /Ω /TEMP inputs. In the REAR position the front-panel mA, LOW and VOLT /Ω /TEMP - jacks are disconnected from the instrument.

FRONT PANEL OPERATION

General

In this section of the manual you will find a description of the front-panel operation of the DM 5110. (See Fig. 2-1)
The name of keys that are to be pressed are surrounded by square brackets [ ] wherever possible. Example: the Hold key would be written as [HOLD].

Display

The DM 5110 uses a 4.5 digit LED 7 segment display, combined with 17 separate LED's .
The display can have the following information:

- The current (or last) reading.
- If an error situation occurs, the display will show an error message for a short period of time.
- If the ID button is pressed, the GPIB address and terminator are displayed as described on page 2.9
- If one of the set modes is selected, the display will hold the value to be changed or other information /prompts, needed to complete the information transaction with the instrument.

GPIB Indicators

There are two GPIB indicators on the front panel:

- The remote indicator. This indicates when the instrument is in remote state (REM).
- The addressed indicator. This indicates when the instrument is being addressed to talk or listen (ADDR).

FRONT PANEL CONTROLS

General

The front-panel of the DM5110 has twelve "soft" - keys that enable the operator to select functions and ranges of the DM.
An additional switch below the LOW and Volts /Ω / TEMP jacks, selects the FRONT or REAR connection of the LOW and Volts/Ohms inputs.

In the REAR position of the switch, the mA - jack is disconnected from the instrument, but the diode bridge clamping circuitry, in series with the fuse, remains connected between the frontpanel LOW and mA - jacks. This prevents that pushing the FRONT/ REAR switch opens a circuit in which a current-measurement is taken. The switch can not be controlled by the GPIB - bus. A query in the IEEE- 488.1 instruction set is provided to read the status of the FRONT/REAR switch.
Most function and range settings of the DM5110 can be done by single key operations. (PRIMARY FUNCTIONS). These functions are indicated by a large black texture above the keys.
By selecting the "HOLD" mode, another set of functions becomes available to the operator. (SECONDARY FUNCTIONS). These functions are indicated by text beside the keys.

PRIMARY LEVEL FUNCTIONS

From the "RUN" mode the following functions can be selected by hitting just one key :

MEASUREMENT FUNCTIONS

Function	Key-sequence	Display
DCV	[DCV]	mV or V
DCA	[DCA]	µA or mA
ACV	[ACV]	~ and mV or V
ACA	[ACA]	~ and µA or mA
OHMS	[Ω]	Ω, kΩ or MΩ
dBV	[dBV]	dBV and ~
dBm	[dBm]	dBm and ~

In all the functions, a measurement can be done in the manual or the autoranging mode.
In the display, the autoranging mode will be indicated by the "AUTO"-led.

The first time an [UP] or [DOWN] key is hit in the autoranging mode, the DM will remain in the current range, but the autoranging mode is turned off.
In this manual ranging mode, the [DOWN] key selects a more sensitive range, and the [UP] key will make the DM change to a larger range.

Return to the autoranging mode is possible by pushing the [UP] and [DOWN] key simultaneously.
Overrange is indicated by blinking of the display.
At a reading of 20000 counts or more the display will show 19999.

DC Voltage [DCV]

In the DC Voltage (DCV) mode, five ranges , full scale, are available:

200 mV
2 V
20 V
200 V
1000 V

DC Current [DCA]

In the DC Current (DCA) mode, five ranges, full scale, are available:

200 µA
2 mA
20 mA
200 mA
2000 mA

AC Voltage [ACV]

In the AC Voltage (ACV) mode five ranges, full scale, (true RMS), are available:

200 mV
2 V
20 V
200 V
500 V

AC Current [ACA]

In the AC Current (ACA) mode, five ranges, full scale, (true RMS), are available:

200 µA
2 mA
20 mA
200 mA
2000 mA

Resistance [Ω]

In the Resistance (Ω) mode, six ranges, full scale, are available:

200 Ω
2 k Ω
20 k Ω
200 k Ω
2 M Ω
20 M Ω

In the 2 kΩ, 200 kΩ and 20 MΩ range, the output voltage at full scale is 2 Volts, enabling the user to make diode measurements. Therefore, the diode symbol is "on" in these three ranges.

DBV or DBM [dBV] / [dBm]

The DBV and DBM ranges are recalculated versions of the ACV measurements. Therefore, the five ranges are also 200 mV, 2 V, 20 V , 200 V and 500 V true RMS, full scale.
In the dBV mode these ranges are :

– 60.0	–13.98	dBV
– 40.0	+ 6.02	dBV
– 20.0	+26.02	dBV
0	+46.02	dBV
+20.0	+53.98	dBV

(00.00 dBV equals a voltage of 1 V RMS)
In the dBm mode these ranges are:

–57.78	–11.76	dBm
–37.78	+ 8.24	dBm
–17.78	+28.24	dBm
+2.02	+48.24	dBm
+42.22	+56.20	dBm

(00.00 dBm equals 1 mWatt in a 600 W load
(0.775 V RMS)).
It is advisable to use the dB ranges in autoranging mode, to insure measurements are taken in a range where the best accuracy is achieved.
If a measurement is less then 1 % of full scale, and a more sensitive range is available, the user is notified by blinking of the sign led. Overrange in the dB ranges is shown by the blinking maximum value of that range. A zero counts measurement is converted to a -199.99 reading.

NULL Mode

To provide the ability to make relative measurements, the NULL mode is made available in all functions.
To use the NULL mode, first select the desired function and range, then apply the offset measurement to the instrument, and press the [NULL] key.
The present reading will become the null value.
The "NULL" led will indicate that the display-value is relative.
A special situation exists, when the NULL mode is used in the dBV and dBm function.
The V or m led is blanked indicating that a relative measurement is made.
After selecting the NULL mode each range can be selected, even autoranging.

NOTE:

The absolute null value will be subtracted from the actual measurement. Blinking of the display, meant to show overrange, is still determined by the actual measurement value.

The NULL mode will not be accepted when the instrument is in overrange condition. (The display will briefly show "????")
When the present reading, pushing the [NULL] key, is zero, the NULL function will not react.
If the result of the NULL function calculation exceeds the 4.5 digit capabilities of that specific range, the decimal point will be shifted one position to the right, and the least significant digit will no longer be shown in the display.

Example:

Suppose the NULL mode was set in the 2000.0 mA DC Current range at +1900.0 mA.
When the same current in the opposite direction is measured, (–1900.0), the display will show –3800 mA

During the NULL mode the [HOLD] and [TRIG] mode will still function. Any key except [UP], [DOWN], [ID] or [HOLD] will make the instrument leave the NULL mode, and the null value will be lost.

INST ID

Pressing the [INST ID] key will make the DM show it's primary address on the display and, if USER has been enabled, generate a Service Request (SRQ) on the GPIB.
The far right decimal point lights if the LF/EOI message terminator is selected; decimal point does not light for EOI ONLY selection.
Releasing the key will make the DM5110 return to the original state. The DM511 will not react to the [INST ID] switch.

HOLD Mode

At power up the instrument will be measuring constantly.
By pressing the [HOLD] key once, the instrument stops measuring and displays the last measurement.
The "HOLD" - led will show that the instrument is in the HOLD mode.
Pressing the [HOLD] key a second time will make the instrument return to the RUN- mode. (secondary function [RUN])
The HOLD mode is also used as an entry to the SECONDARY LEVEL.
When a key, that is not defined as a secondary level, is pressed, the instrument will not react.

SECONDARY LEVEL FUNCTIONS

Introduction

Except for Trigger and the selection of the Temperature function, all secondary level keyboard functions are settings. In general, the function keys give the ability to show settings on the display. Changes to settings can only be made with the [UP] and [DOWN] keys.
Changing from one setting to another can only be done by leaving and re-entering the "HOLD" mode (with most of the functions).This is done to prevent settings to be changed erroneously.
An exception is made for the BEEPER, COMPARE, LO LIMIT and HI LIMIT settings. For ease of operation, it is possible to change from one of the settings mentioned above, to one of the other three immediately.

Trigger

When the instrument is in the HOLD mode, the user can make one measurement and return to the HOLD mode automatically, just by pressing the "TRIG" key once.

Limits

The DM5110 has an upper (HI LIMIT) and a lower limit value. (LO LIMIT)
At power-up, these will both be set to the zero position. (0.00 °C, 0.00 dBm or dBV).
Related to the " limits" are the BEEPER and COMPARE mode.

Note:

There is only ONE upper and ONE lower limit, which (once set) are related to the function in which they were set.

The settings remain stored in memory until, in a function other then the one in which the current limits were set, the limits are changed, or the COMPARE or BEEPER mode is chosen.

Example:

An operator wants to make measurements on 1% 10 kOhm resistors.
After selecting the 20 kOhms range the LO and HI limits can be set to 9.900 and 10.100 kOhms in the secondary functions LOLIM and HILIM.
After selecting the COMPARE mode, the [RUN] key will enable the operator to make measurements.
If an interruption occurs, he still can make other measurements like voltage, current, temperature or normal mode resistance measurements, without disturbing the limits, and afterwards return to measure 10 kΩ resistors immediately.

As soon as the limit setting, COMPARE or BEEPER on/off functions are selected in a function different then Ohms, both limits will be reset to their default value 0000.
It is possible to set the LO and HI limits in two different ranges of the same function and use the COMPARE or BEEPER mode in autoranging.

In DCV, DCA, dBV, dBm and TEMP the limits can have positive or negative polarity.
In ACV, ACA and OHMS the limits can only be positive.

Beeper Mode

If the instrument is in the BEEPER mode, indicated by the "))))) " led, the beeper will sound when the measurement is below the LO LIMIT or above the HI LIMIT. An exception is made in the Ohms mode, when the HI LIMIT is set at 19999 in the measurement range, and the instrument is in overrange.
Selecting the BEEPER mode can be done by first pushing the [BEEP] key , when in HOLD mode.The display will show "beep".

The Beeper-mode can be switched on or off, by pressing [UP] or [DOWN] key.
All the other keys except [UP], [DOWN] , [RUN], [COMP], HILIM] and [LOLIM] will be ignored.
The last measurement that was made before the HOLD mode was entered, will be recalculated.
If the BEEPER mode was turned on, and the value is beyond the limits the beeper will sound for a moment.
When the key - sequence has been completed, the instrument is still in the HOLD mode (indicated by the HOLD led).
Only after pressing [RUN] the instrument will make new measurements.
Selection of a different measurement function will automatically turn off the BEEPER mode.

Continuity Measurement.

When the limits are set in a function different from Ohms, and the Beeper mode is turned on while measuring Ohms, the limits will not return to the 0.0 settings. In that special case, the LOLIMIT will be set to 10.00 Ω and the HILIMIT to 19.999 MΩ.
This feature will only apply to keyboard commands while the instrument is not in the remote state. (applies to DM 5110 only)
From the power up condition, the continuity mode can be entered by pushing [OHMS], [HOLD], [BEEP], [UP],and [RUN]. In this setting the Beeper will sound when the measurement is less than 10 Ω.

Setting Limits

LIMIT setting can be done in the following way:

Press the [HOLD] key followed by the [LOLIM] key to reach the LO LIMITsetting mode.
The display will show the current LO LIMIT value.
The limit value will be in the same range and function in which the instrument was set before entering the HOLD mode.
If limits were available in memory of a completely different function, both limits will be reset to zero, the very moment the limit setting mode is entered.
By using the [UP]- and [DOWN]- keys, this value can be incremented or decremented.
The counting of the limit value will speed up as the user holds the [UP] - or [DOWN] - key.

The DM5110 will not allow the LO LIMIT above the HI LIMIT or the HILIMIT below the LO LIMIT.
When, for instance an "up" going LO LIMIT reaches the HILIMIT value, the HI LIMIT will also be incremented in the same rate as the LO LIMIT.
The user will be notified by a "beep" from the beeper.

Example:

If the limits are to be set from default value to 10 and 12 kΩ, it is efficient to set the lo-limit to 10 kΩ first. Then the HI-limit just has to be changed from 10 to 12 kΩ..
When the desired setting is reached, exit from the LO LIMIT function is possible by pressing:

[HILIM]	to set HI LIMIT,
[COMP]	to the COMPARE mode,
[BEEP]	to the BEEPER mode setting,
[RUN]	return to previously selected function.

Other keys do not react.

The user can also start with the HI LIMIT setting by pressing [HOLD] and the [HILIM] key and afterwards adjust the LO LIMIT.
During all these procedures, the instrument will be in HOLD mode, and this will be shown by the "HOLD" - led in the display area.
Every time the function is changed within the HOLD mode, the last measurement that was made before the HOLD mode was entered, will be recalculated.
The display reading value is adjusted to the new settings.
Only after pressing [RUN], the instrument will make new measurements.
To change the range, the 50/60Hz, the 3.5D/4.5D or the IEEE settings, the user has to leave the HOLD mode first (RUN-key). The reason is, to prevent settings to be changed erroneously.

Compare

Another feature, related to the limits, is the COMPARE mode, where the display will show "HI", "LO" and "PASS":

"LO" is shown when the measurement is below the LO LIMIT,
"HI" is shown when the measurement is more than the HI LIMIT.
In all other cases the display will show "PASS".

During positive overrange the "HI" will blink, during negative overrange the "LO" will blink.

Selecting the COMPARE mode can be achieved by first pushing the [COMP] key, when in HOLD mode. The display will show "Comp".
The COMPARE mode can be turned "ON" or"OFF" with the [UP] and [DOWN] keys. When the COMPARE mode is turned "ON", the last measurement that was made before the HOLD mode was entered, will be recalculated, and the display reading will be "HI", "LO" or "PASS".
If the COMPARE mode is turned "OFF", the reading will return to the normal decimal value.The instrument is still in the HOLD mode (indicated by the HOLD led). Only after pressing [RUN] the instrument will make new measurements in either the COMPARE mode or the normal mode.
During the COMPARE setting mode the following modes are available by pressing:

[LOLIM]	to set LO LIMIT
[HILIM]	to set HI LIMIT
[BEEP]	to the BEEPER mode setting,
[RUN]	continuous measurement

Other keys do not react.

To change the range, the 50/60Hz, the 3.5D/4.5D or the GPIB settings, the user has to leave the HOLD mode first ([RUN] - key). This is to prevent settings to be changed erroneously.
After pressing [RUN], any primary level key, (except [HOLD, UP, DOWN or INST ID]), will make the instrument leave the COMPARE mode automatically.
If the COMPARE mode is combined with the beep mode, the beeper will sound at "HI" and "LO".
If the COMPARE mode is combined with the NULL function, the limits are compared with the resulting value.

Temperature Measurements

Pressing the [HOLD] and [TEMP] key will put the instrument in the temperature measuring function.
In this case the DM5110 will not remain in the HOLD mode, but will automatically go to the RUN mode.
The temperature mode has just one range.
The reading is in degrees Celsius, from – 62.0 °C to +240.0 °C with a 0.1 degree resolution.

The display will show "Open" when overrange (> 250.0 °C) occurs and a blinking – 62.0 °C reading, when the temperature is exceeding the minimum value. Also when a valid measurement is taken above the maximum temperature of the P6602 cable (+230 °C), the display will blink.

DMM Settings

Pressing the [HOLD] and [50/60Hz] key will make the instrument show the 50 or 60 Hz setting in the display. The setting can be changed with the [UP] and [DOWN] keys.
The [RUN] key will make the instrument leave the 50/60 Hz setting mode and store the new value in EEPROM.
Any other key does not react.

At power-up the DMM will be in the 4.5 digit mode.
Pressing the [HOLD] and the [3.5/4.5] key will make the instrument show 3.5 or 4.5 in the display.
The setting can be changed with the [UP] and [DOWN] keys.
The [RUN] key will make the instrument leave the 3.5/4.5 set mode and proceed in the selected resolution.
Any other key does not react.
The 3.5 digit mode enables faster response measurement. It is made visible as the least significant digit is blanked.
In the 3.5 digit mode COMPARE, NULL and BEEPER modes are still valid.

GPIB Settings

Pressing the [HOLD] and the [GPIB] key will make the instrument show the primary GPIB address setting in the display [Adxx].
The [UP] and [DOWN] keys enable the user to increment and decrement to an alternative address setting.
The other keys that will react, are:

[RUN], to save the corrected GPIB address, or
[GPIB], to proceed to the next GPIB function;
the LF/EOI setting. In this function, the display will show "LF" or "EOI" in the display.
The setting can be changed with the [UP] and [DOWN] keys.
The other keys functioning, are:

[RUN], to save all GPIB settings in EEPROM, or
[GPIB] to return to the address setting mode.

A GPIB message can be terminated in two different ways:

- EOI Mode. The instrument terminates on EOI only.

- LF Mode. When the instrument is in the LF mode, a LF or EOI in the input stream will terminate the message.

Summary of Keyboard Functions

The following keyboard sequences start from the normal "RUN" measuring mode.

Table 2.-1
Summary of Keyboard Functions

Function	Sequence of keys to be pressed
Basic measurement functions	
Resistance	[Ω]
DC Voltage	[DCV]
AC Voltage	[ACV]
AC Voltage dBm	[dBm]
AC Voltage dBV	[dBV]
DC Current	[DCA]
AC Current	[ACA]
Temperature	[HOLD], [TEMP].
Autoranging OFF	[UP] or [DOWN]
More sensitive range	[DOWN]
Higher range	[UP]
Autoranging ON	[UP] and [DOWN] simultaneously.
Stop measuring	[HOLD]
Make one measurement	[HOLD], [TRIG].

Summary of keyboard functions (Cont.)

Table 2.1 (Cont.)

Function	Sequence of keys to be pressed
DMM setting functions	
Set linefreq. to 50Hz	[HOLD], [50/60Hz], [UP] or [DOWN], [RUN].
Set linefreq. to 60Hz	[HOLD], [50/60Hz], [UP] or [DOWN, [RUN].
Select 3.5 digit mode	[HOLD], [3.5/4.5], [UP] or [DOWN], [RUN].
Select 4.5 digit mode	[HOLD], [3.5/4.5], [UP] or [DOWN, [RUN].
NULL mode ON	[NULL]
NULL mode OFF	[NULL] or any Function Key
Set LOLIMIT	[HOLD], [LOLIM], [UP] or [DOWN] , [RUN].
Set HILIMIT	[HOLD], [HILIM], [UP] or [DOWN] , [RUN].
COMPARE-mode ON	[HOLD], [COMP], [UP] or [DOWN], [RUN].
COMPARE-mode OFF	[HOLD], [COMP], [UP] or [DOWN], [RUN] or any Function Key.
BEEPER-mode ON	[HOLD], [BEEP], [UP] or [DOWN], [RUN].
BEEPER-mode OFF	[HOLD], [BEEP], [UP] or [DOWN], [RUN] or any Function Key.
GPIB setting functions (DM5110 only)	
GPIB Service Request	[INST ID]
Select GPIB address	[HOLD], [GPIB], [UP] or [DOWN] , [RUN].
Select GPIB EOI-only setting	[HOLD], [GPIB], [GPIB], [UP] or [DOWN], [RUN].
Select GPIB LF/EOI setting	[HOLD], [GPIB], [GPIB], [UP] or [DOWN, [RUN].

BASIC MEASUREMENTS

The following paragraphs describe the basic procedures for making voltage, resistance, current, and dB measurements.

For detailed explanation of GPIB commands, see the Programming section.

High Energy Circuit Safety Precautions

To optimize safety when measuring voltage in high energy distribution circuits, read and use the directions in the following warning.

WARNING

Dangerous arcs of an explosive nature in a high energy circuit can cause severe personal injury or death.

If the meter is connected to a high energy circuit when set to a current range, low resistance range or any other low impedance range, the circuit is virtually shorted.

Dangerous arcing can also result when the meter is set to a voltage range if minimum voltage spacing is reduced, or if maximum input voltage limits are exceeded.

When making measurements in high energy circuits use test leads that meet the following requirements:

- Test leads should be fully insulated.
- Only use test leads that can be connected to the circuit (e.g. alligator clips, spade lugs, etc.) for hands-off measurements.
- Do not use test leads that decrease voltage spacing. This diminishes arc protection and creates a hazardous condition.

Use the following sequence when testing power circuits:

1. De-energize the circuit using the regular installed connect-disconnect device such as the circuit breaker, main power switch, etc.
2. Attach the test leads to the circuit under test. Use appropriate safety rated leads for this application.
3. Set the DMM to the proper function and range.
4. Energize the circuit using the installed connect-disconnect device and make measurements without disconnecting the DMM.
5. De-energize the circuit using the installed connect-disconnect device.
6. Disconnect the test leads from the circuit under test.

WARNING

The maximum common-mode input voltage (the voltage between input LO and chassis ground) is 1000 V peak. Exceeding this value may create a shock hazard.

Warm Up Period

The DM 5110 / DM 511 is usable immediately when it is first turned on.
However, the instrument must be allowed to warm up for at least 30 minutes to achieve rated accuracy.

Null

The null feature serves as a means of baseline suppression by allowing a stored offset value to be subtracted from subsequent readings. When the [NULL] key is pressed the instrument takes the currently displayed reading as baseline value. All subsequent readings represent the difference between the applied signal level and the stored baseline.
A baseline level can be established (via input levels or remotely entered values) for only one measurement function at a time.
Once a baseline is established for a measurement function, that stored level will be the same regardless of what range the DM 5110/511 is in.

For example, if 1 V is established as the baseline on the 2 V range, then the baseline will also be 1 V on the 20 V through 1000 V ranges.
A NULL baseline level can be as large as full range.

NOTE :
The following discussion on dynamic range is based on a display resolution of 4 1/2 digits. At 3 1/2 d resolution, the number of counts would be reduced by a factor of 10.

By design, the range of the DM 5110/511 display, is +/- 19999 counts.
With NULL enabled in DCV or DCA, with a maximum NULL value of 20000 counts, the reading that is to be displayed does not match the capabilities of the display in part of the range.
Then the resulting reading is shown with reduced resolution, to increase display range. (The decimal point is shifted one position to the right)

It is important to note that the increased display range does not increase the maximum allowable input level to the instrument.
For example, on the 2 V range, the DM 5110/511 will always overrange when more than 1.9999 V is connected to the input.

Example :

The instrument is set to the 2V DC range and a maximum – 2.0000 V is established as the NULL value.
When –1.0000 V is connected to the input of the DM 5110/511, the display will read + 1.0000 V.
When +1.0000 V is connected to the input, the display will read +3.000 V.

NULL Correction

A range in which the NULL correction is often used, is in the 200 Ohms range, compensating the resistance of the test leads.
To use NULL for NULL correction, perform the following steps:

1. Disable NULL, if presently enabled, by pressing the [NULL] key.
   The NULL indicator will turn off.
2. Select the 200 Ohms range.
3. Connect the test leads to the DM 5110 / 511 input and short them together.
4. Press the [NULL] key. In the display the "NULL"- sign will be lit.
5. Remove the short and connect the test leads to the resistance to be measured.

Baseline Levels

Baseline values can be established by either applying baseline levels to the instrument or, (DM5110 only) by setting baseline values with the GPIB bus. An application could be AC measurement in amplifiers or filters, when the level of the input signal is nulled in a dB function.
Measurement of gain or attenuation in dB's can then directly be made at the output of the device under test.
To establish a baseline level by applying a level to the DM 5110 / 511, perform the following steps:

1. Disable NULL, if presently enabled, by pressing the [NULL] key.
   The NULL indicator will turn off.
2. Select a function and range that is appropriate for the anticipated measurement.
3. Connect the desired baseline level to the input of the DM 5110 / 511 and note that level on the display.
4. Press the [NULL] key. The display will NULL and the NULL indicator will be enabled. The previously displayed reading will be the stored baseline.

WARNING

With NULL enabled, a hazardous voltage baseline level (+/- 40V or more), not displayed, may be present on the input terminals. If not sure what is applied to the input, assume that a hazardous voltage is present.

5. Disconnect the stored signal from the input and connect the signal to be measured in its place. Subsequent readings will be the difference between the stored value and the applied signal.

DC Voltage Measurements

The DM 5110/511 can be used to make DC voltage measurements up to to +/- 1000 V with a maximum resolution of 10 µV. Use the following procedure to make DC voltage measurements:

1. Select the DC volts function by pressing the DCV key.
2. Select a range that will cover the expected voltage by pressing the [UP] or [DOWN] range key or press both keys simultaneously to use autorange.
3. Connect the signal to be measured to the LOW and VOLT/ Ω /TEMP input terminals.
4. Observe the reading from the display.

Resistance Measurements

The DM 5110/511 can make resistance measurements up to to 20 MΩ with a max. resolution of 10 mΩ. To make resistance measurements, proceed as follows:

1. Select the ohms function by pressing the [Ω] key.
2. Select a range consistent with the expected resistance or use autorange.
3. Connect the resistance to the LOW and VOLT/Ω/TEMP terminal of the instrument.

CAUTION

The maximum input voltage between the VOLT/Ω/Temp and LO input terminals is 1000V peak. Do not exceed these values or instrument, damage may occur.

4. Observe the reading from the display.

TABLE 2-2
RESISTANCE RANGES

Range	4 1/2d Resolution	Nominal Output Current	Full scale Voltage
(1) 200 Ω	10 mΩ	1.0 mA	200 mV
(2) 2 kΩ	100 mΩ	1.0 mA	2 V
(3) 20 kΩ	1 Ω	10 µA	200 mV
(4) 200kΩ	10 Ω	10 µA	2 V
(5) 2 MΩ	100 Ω	0.1 µA	200 mV
(6) 20 MΩ	1 kΩ	0.1 µA	2 V

NOTE:
Typical open circuit voltage is 11 V.

GPIB range number shown in parentheses.
Sending Range 0 means Auto Range..
Table 2-2 shows the current output for each resistance range. It helps to shield a resistance >100 kΩ to achieve a stable reading.
Place the resistance in a shielded enclosure and electrically connect the shield to the LO input terminal of the instrument.

Diode Test

Because of their 2 V fullscale voltages, the 2 kΩ, 200 kΩ and 20 MΩ range can be used to test diodes (indicated by  in the display)
Testing diodes can be done as follows:

1. Select the 2 kΩ range.
2. Forward bias the diode by connecting the red terminal of the DM5110 /511 to the positive side of the diode. A good diode will typically measure between 300 Ω and 1 kΩ (0.3 - 1.0 Volts at 1 mA).
3. Reverse bias the diode by reversing the connections on the diode. A good diode will overrange the display.

Insulation Resistance Measurements

Measurement of high resistance values can be done by using the 10 MΩ input resistance of the DM5110 /511 in the DCV ranges, together with a DC Voltage supply.
This can be done as follows:

1. Select the DCV function by pressing the DCV key.
2. Select autoranging.
3. Press the NULL key with open DM inputs. The NULL indicator will turn on and the display will null. In this way, possible leakage of the DM inputs is compensated .
4. Connect the DM5110 /511 VOLTS /Ω /TEMP terminal in series with the resistance that is to be measured and connect them to a DC Voltage of (for instance) 10 V. Connect the Low terminal to chassis ground and to the Low terminal of the DC voltage.

5. Leakage currents through the resistance to be measured will cause a voltage across the 10 MΩ input of the DM5110 / 511.

A 1 GigaOhm resistor at 10 Volts will give a reading of :

$$10\ M\Omega \times \frac{10\ V}{1\ G\Omega\ (10^{12}\ \Omega)} = 100\ mV$$

A reading of less then 0.1 mV will indicate that the resistance under test has a higher impedance then 1000 GigaΩ.

TRMS AC Voltage Measurements

The instrument can make TRMS AC voltage measurements up to to 500 V with a max. resolution of 10 µV.
To measure AC volts, proceed as follows:

1. Select the AC volts function by pressing the [ACV] key.
2. Select a range consistent with the expected voltage or use autorange.
3. Connect the signal to be measured to the LOW and VOLT/Ω /TEMP input terminals.
4. Observe the reading from the display.

The settling time is 0.3 sec to within 1% of change in reading. This time specification is for analog circuitry to settle and does not include A/D conversion time.

NOTE:
See TRMS Considerations.

Current Measurements (DC or TRMS AC)

The DM 5110 /511 can make DC or TRMS AC current measurements up to 2000 mA with a max. resolution of 10 nA.. Use the following procedure to make current measurements:

1. Select the DC current or AC current function by pressing the [DCA] or [ACA] key respectively.
2. Select a range consistent with the expected current or use autorange.
3. Connect the signal to be measured to the LOW and mA -input terminals.
4. Observe the reading from the display.

dB Measurements

The dB measurement mode enables you to compress a large range of measurements into a much smaller scope.
AC- dB measurements can be made with the instrument in the dBV or dBm function .The relationship between dB and voltage, can be expressed by the following equation:

$$dB = 20 \log \frac{|\ Vin\ |}{|\ Vref\ |}$$

dBV is defined as decibels above or below a 1 V reference.
The instrument will read 00.00 dB when 1 V is applied to the input.
00.00 dBm equals 1 mWatt in a 600 Ohms load (0.775 V RMS).

Reference levels other than 1 V and 0.775 V can be established using the NULL feature. This simply consists of applying a signal to the instrument and pressing the [NULL] key. The suppressed level is the dB reference (0 - dB point).
Another method is to enter the desired reference value over the GPIB bus (DM5110 only).
The following procedure explains how to use the NULL feature to establish a reference:

1. Select the [dBm] or [dBV] function by pressing the dBm or dBV key respectively.
2. Select a range consistent with the expected voltage signal or use autorange.
3. Apply a voltage signal, that is to be used as the dB reference, to the input of the DM 5110.
4. Press the [NULL] key.
   The NULL indicator will turn on and the display will null. The reference is now whatever the applied signal is.
5. Disconnect the signal from the instrument.
6. Connect the signal to be measured to the input of the DM 5110/511.
7. Take the dB reading from the display.

WARNING

With NULL enabled, a hazardous voltage baseline level (+/- 40 V or more), not displayed, may be present on the input terminals. If not sure what is applied to the input, assume that a hazardous voltage is present.

TRMS Considerations

Most DMMs actually measure the average value of an input waveform, but they are calibrated to read its RMS equivalent. This poses no problems as long as the waveform being measured is a pure, low-distortion sine wave.
For complex, nonsinusodial waveforms, however, measurements made with an averaging type meter can be grossly inaccurate.
Because of its TRMS measuring capabilities, the DM 5110 /511 provides accurate AC measurements for a wide variety of AC input waveforms.

TRMS Measurement Comparison

The RMS value of a pure sine wave is equal to 0.707 times its peak value.
The average value of such a waveform is 0.637 times the peak value. So, for an average-responding meter, a correction factor must be designed in. This correction factor, (K), can be found by dividing the RMS value by the average value as follows:

$$K = 0.707 / 0.637$$
$$= 1.11$$

By applying this correction factor to an averaged reading, a typical meter can be designed to give the RMS equivalent.
This is doing fine as long as the waveform is a pure sine, but the ratios between the RMS and average values of different waveforms can vary considerably.
Table 2-3 shows a comparison of common types of waveforms.
For reference, the first waveform is an ordinary sine wave with a peak amplitude of 10 V.
The average value of the voltage is 6.37 V, while its RMS value is 7.07 V.

If we apply the 1.11 correction factor to the average reading, you see that both meters will give the same reading, resulting in no error in the average - type meter reading.
The situation changes with the half-wave rectified sine wave.
As before, the peak value of the waveform is 10 V but the average value drops to 3.18 V.
The RMS value of this waveform is 3.86 V but the average responding meter will give a reading of 3.53 V (3.18 x 1.11), creating an error of 11%.
A similar situation exists for the rectified square wave, which has an average value of 5 V and an RMS value of 5.0 V.
The average responding meter gives a TRMS reading of 5.55 V (5 x 1.11), while the DM5110/511 gives a TRMS reading of 5 V.
Other waveform comparisons can be found in Table 2-3.

Crest Factor

The crest factor of a waveform is the ratio of its peak value to its RMS value. So, the crest factor specifies the dynamic range of a TRMS instrument.
For sinusoidal waveforms, the crest is 1.414.
For a symmetrical square wave, the crest factor is 1.
The crest factor of other waveforms will, of course, depend on the waveform in question because the ratio of peak to RMS value will vary.
For example, the crest factor of a rectangular pulse is related to its duty cycle; as the duty cycle decreases, the crest factor increases.
The DM5110 / 511 has a maximum crest factor of 3, which means the instrument will give accurate TRMS measurements of rectangular waveforms with duty cycles as low as 10%.

dB Applications

Measuring Circuit Gain/Loss

Any point in a circuit can be established as the 0 dB point. Measurements in that circuit then are referenced to that point and expressed in terms of gain (+dB) or loss –dB).
To set the null dB point proceed as follows:

1. Set the DM 5110/511 in dBm or dBV mode.
2. Connect the DM 5110 /511 to the desired location in the circuit.
3. Press the NULL key. The display will read 0 dB.
4. Gain / loss measurements can now be made referenced to the 0 dB point.

Measuring Bandwidth

The DM 5110 /511 can be used to determine the bandwidth of an amplifier as follows:

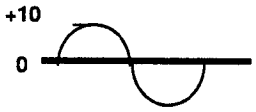
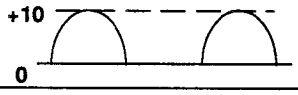
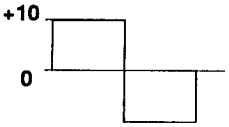
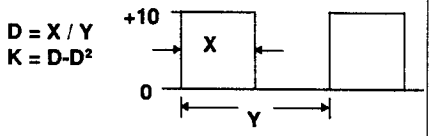
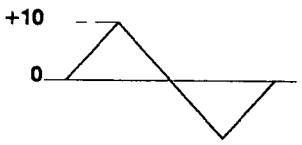
1. Connect a signal generator and a frequency counter to the input of the amplifier.
2. Set the DM 5110 /511 to dBm or dBV and autorange.
3. Connect the DM 5110 /511 to the load of the amplifier.
4. Adjust the frequency of the signal generator until a peak voltage reading is measured on the DM5110 /511. This is the center frequency.
5. Press the [NULL] key. The 0 dB point is now established.
6. Increase the frequency input until the DM5110 /511 reads –3.00 dB.
   The frequency measured on the frequency counter is the high-end limit of the bandwidth.
7. Decrease the frequency input until the dB reading again falls to –3.00 dB. The frequency measured on the signal generator then is the low-end limit of the bandwidth.

Temperature Measurements

In combination with the Tektronix P6602 temperature-probe the DM5110/511 can measure temperature from –62.0 °C up to + 240.0 °C .
The P6602 probe is especially designed for temperature sensing on electronic components, because the tip has a minimal thermal leakage.
This enables the user to accurately measure the temperature of small size components.
The NULL function can be used efficiently when a raise in temperature of parts needs to be measured.
The procedure to make temperature measurements is :

1. Connect the P6602 to the LOW and V/Ω/Temp input jacks.
2. Select the temperature measurement mode, pressing the [HOLD] and [TEMP] keys.
3. Allow the P6602 some time to adjust to ambient temperature.
4. Push the [NULL] key, to set the ambient temperature as baseline level.
5. Now a relative temperature measurement can be made.

Table 2-3
Comparison of Average and TRMS Meter Readings

Waveform	AC Coupled Peak Value	RMS Value	Average Responding Meter Reading	AC Coupled TRMS Meter Reading	Averaging Meter Percent Error
Sine 	10 V	7.07 V	7.07 V	7.07 V	0 %
Half-Wave Sine 	10V	3.86 V	3.90 V	3.86 V	1%
Full-Wave Sine 	10 V	3.08 V	2.98 V	3.08 V	3.2%
Square 	10 V	10.00 V	11.10 V	10 V	11%
Rectified Square Wave 	10 V	5.00 V	5.55 V	5.00 V	11%
Rectangular Pulse 	10 V	10 .√K	22.2K	10 .√K	$\left[\frac{2.22K^{3/2}-K}{K}\right]$ x 100%
Triangular Sawtooth 	10V	5.77 V	5.55 V	5.77 V	4%

DM 5110 / 511 Display Error Reporting

Except the errors that can occur only during calibration procedures, which are described in the service manual, the following messages can be shown on the DM5110 / 511 display:

- A constant blinking of the "AUTO"-led.
  This means that the internal calibration-enable jumper is in the "CAL"-position!!
  The instrument can now easily be recalibrated.
  Contact a qualified service person!

- The display shows EErr briefly.
  This can happen in the following cases:

  - At powerup when the contents of the EEPROM are checked.
  - When an attempt is made to change an EEPROM related setting, and reprogramming the EEPROM with the new setting fails. (50/60 Hz or GPIB address and LF/EOI setting)

  Send your DM to the nearest TEKTRONIX Service Center!

- A constant blinking of the two least significant digit of the reading.
  This means that the calibration-settings as stored in EEPROM are improper and the DM5110/511 returned to default calibration-settings!!!
  Although the instrument is still measuring, the reading is likely to be very inaccurate (+/- 2%).
  Send your DM to the nearest TEKTRONIX Service Center!

PROGRAMMING

(This section does not apply to the DM511)

Introduction

This section of the manual provides information for programming the DM 5110 Programmable Digital Multimeter via the IEEE - 488.1 digital interface.
The IEEE - 488.1 interface function subsets for the DM 5110 are listed in Table 1-1 in Section 1.

The DM 5110 can be operated by remote control over the digital bus as specified in IEEE Standard 488.1-1987, *Standard Digital Interface for Programmable Instrumentation,* and is commonly called the General Purpose Interface Bus (GPIB).

The information in this section assumes that the reader is knowledgeable in GPIB bus communication and has some experience in programming the system.

TM 5000 instruments are designed to communicate with any bus-compatible controller that can send and receive ASCII messages (commands) over the IEEE-488.1 bus. These commands program the instruments or request information from the instruments.
Recommended controllers for use in programming the DM 5110 are IBM® PC-compatible controllers, such as the Tektronix PEP 301, PEP303 with the Tektronix GURU (GPIB User's Resource Utility for the IBM® PC) software and GPIB interface card, and the 2402 TekMate.

Commands for TM 5000 programmable instruments are designed for compatibility among instrument types. The same commands are used in different instruments to control similar functions.
After the DM 5110 is set to the remote mode by a system controller, its operating modes and front-panel settings can be set and read by programming mnemonics sent to it in ASCII over the bus.
Operating modes and front panel settings can be read by the controller in either the local or remote state.

TM 5000 programmable instruments connect to the GPIB through a TM 5000 power module . Refer to the Operating Instructions section for installing the instrument in the power module.

The DM 5110 is designed to operate in a single compartment of a TM 5000 series (IEEE-488.1 - compatible) power module.
The DM 5110 is connected to the bus through a passive connector system in the power module.
All buffering is contained in the instrument.

IEEE- 488.1 BUS ADDRESS AND TERMINATOR

The GPIB address and terminator are stored in EEPROM.
The address and terminator are set via the front panel, as described in Section 2, Table 2-1, (GPIB Setting Functions).

At shipment, the DM 5110's GPIB address is factory- set to 16; the terminator is set for EOI only.

The GPIB address and terminator can be changed as indicated in Section 2, Table 2-1 , under GPIB Setting Functions.

DM5110 RESPONSE TO INTERFACE CONTROL MESSAGES

MESSAGE AND COMMUNICATION PROTOCOL

Introduction

The DM 5110 is controlled by the front panel keys or via commands received from the controller. There are four types of command :

- Measurement Setting commands ; Control instrument settings.
- User Interface Setting Commands ; Control the GPIB interface settings and the front panel.
- Query / Output ; Request data.
- Operational ; Cause a particular action.

When the instrument is in the remote state, it provides a response or executes all commands as appropriate.

In the local state , only query / output commands are executed ; setting and operational commands generate error responses, since the instrument functions are under front panel control.

The DM 5110 accepts abbreviated commands like other products in the TM 5000 series.

Command Separator

A message consists of one command or a series of commands, followed by a message terminator. Messages consisting of multiple commands must have the commands separated by semicolons. A semicolon at the end of a message is optional.

For example, each line below is a message.

- INIT
- TEST?;INIT;RQS ON; USER OFF;ID?;SET?
- TEST?;

Message Terminator

Message may be terminated with EOI or the ASCII line feed (LF) character.
Some controllers assert EOI concurrently with the last data byte; others use only the LF character as a terminator. The instrument can be set to accept either terminator.

With EOI ONLY selected as the terminator, the instrument interpretes a data byte received with EOI asserted as the end of the input message; it also asserts EOI concurrently with the last byte of the output message.

With the LF/EOI setting, the instrument interpretes the LF character without EOI asserted (or any data byte received with EOI asserted) as the end of an input message; it transmits carriage return (CR) followed by the line feed (the LF with EOI asserted) to terminate output messages.
Refer to Section 2, Table 2-1 for information on setting the message terminator.

TM5000 instruments are shipped with EOI ONLY selected.

Formatting a Message

Commands sent to TM5000 instruments must have the proper format (syntax) to be understood; however, this format is flexible, so many variations are acceptable. The following describes this format and the acceptable variations.

The instruments expect all commands to be encoded in ASCII; however, they accept both upper and lower case ASCII characters. All data output is in upper case.
A command consists of a header and , if necessary, followed by arguments.
A command with arguments must have a header delimiter that is the space character (SP) between the header and the argument.
The space character (SP), carriage return (CR), and line feed (LF) are shown as subscript in the following examples.

- RQS_{SP} ON

If extra formatting characters SP, CR and LF (the LF cannot be used for format in the LF/EOI terminator mode) are added between the header delimiter and the argument, they are ignored by the instrument.
Example 1 : $RQS_{SP}ON$

Example 2 : $RQS_{SP\ SP}ON$

Example 3 : $RQS_{SP\ CR\ LF\ SP\ SP}$ ON

Example 3 works only if the GPIB terminator is set to EOI only. If set to EOI/ LF, then the LF will be treated as the end of the message, and a command error will be returned. (Missing argument)
In general, these formatting characters are ignored after any delimiter and at the beginning and end of a message.

$_{SP}$ RQS $_{SP}$ ON ;$_{CR\ LF}$

$_{SP}$ $USER_{SP}$ OFF

In the command list, some headers and arguments are listed in two forms, a full-length version and an abbreviated version.
The instrument accepts any header or argument containing at least the characters listed in the short form; any character added to the abbreviated version must be those given in the full-length version.
For documentation of programs, the user may add alpha characters to the full-length version.
Alpha characters may also be added to a query header, provided the question mark is at the end.

USER?
USERE?
USEREQ?
USEREQUEST?

Multiple arguments are separated by comma.

2,3
$2,_{SP}3$

NOTE :
In the last example, the space is treated as a format character because it follows the comma (the argument delimiter).

Number Formats

The instrument accepts the following kinds of numbers for any of the numeric arguments.

- Signed or unsigned integers (including +0 and –0). Unsigned integers are interpreted as positive.

  Example: +1, 2, –1, –10

- Signed or unsigned decimal numbers. Unsigned decimal numbers are interpreted to be positive.

  Examples:–3.2, +5.0, 1.2

- Floating point numbers expressed in scientific notation.

  Examples: +1.0E–6, 1.0E–2, 1.E–2, 0.01E+0

The largest acceptable number for an argument is +/–99999E+99.

Message Protocol

As the instrument receives a message it is stored in the input Buffer, processed and executed.
Processing a message consists of decoding command, detecting delimiters and checking syntax.
For setting commands, the instrument then stores the indicated changes in the Pending Settings Buffer.
If an error is detected during processing, the instrument asserts SRQ, ignores the remainder of the message and resets the Pending Settings Buffer.
Resetting the Pending Settings Buffer avoids undesirable states that could occur if some setting commands are executed while others in the same message are not.
Executing a message consists of performing the actions specified by its command(s).
For setting commands, this involves updating the instrument settings and stores these updates in the Current Settings Buffer.
The setting commands are executed in groups ; that is, a series of setting commands is processed and stored in the Pending Settings buffer before execution takes place.

This allows the user to specify a new instrument state without having to consider whether a particular sequence would be valid.
Execution of the settings occurs when the instrument processes the message terminator, a query - output command, or an operational command in a message.
When the instrument processes a query-output command in a message, it executes any preceding setting commands to update the state of the instrument. It then executes the query-output command by retrieving the appropriate data and putting it in the Output Buffer. Then, processing and execution continue for the remainder of the message. The data is sent to the controller when the instrument is made a talker.
When the instrument processes an operational command in a message, it executes any preceding setting commands before executing the operational command.

Multiple Messages

The Input Buffer has finite capacity (about 50 bytes) and a single message may be long enough to fill it. In this case, a portion of the message is processed before the instrument accepts additional input.
During command processing the instrument holds off additional data (by asserting NRFD) until space is available in the buffer.
When space is available, the instrument can accept a second message, before the first has been processed. However, it holds off additional messages with NRFD, until it completes processing the first.
After the instrument executes a query-output command in a message, it holds the response in its Output Buffer until the controller makes the instrument a talker. If the instrument receives a new message before all of the output from the previous message is read, it clears the Output Buffer before executing the new message. This prevents the controller from getting unwanted data from old messages.
An other situation may cause the instrument to delete output.
The execution of a long message might cause both the Input and Output buffers to become full (output buffer > 28 bytes). When this occurs, the instrument cannot finish executing the message because it is waiting for the controller to read the data it has generated;
but the controller cannot read the data because it is waiting to finish sending its message. Because the instrument's Input buffer is full and it is holding off the rest of the controllers message with NRFD, the system is hung up with the controller and instrument waiting for each other. When the instrument detects this condition, it generates an error, asserts SRQ, and deletes the data in the Output buffer. These actions allow the controller to transmit the rest of the message and informs the controller that the message was executed and that the output was deleted.

A TM 5000 instrument can be made a talker without having received a message that specifies what it should output. In this case, acquisition instruments (counters and multimeters) return a measurement if one is ready. If no measurement is ready, they return a single byte message with all bits equal to 1 HEX FF)(with message terminator as the" talked with nothing to say" (TWNTS)); other TM 5000 instruments will return only this message.

Instrument Response to IEEE-488.1 Interface Messages

Interface messages and their effects on the instrument's interface functions are defined in IEEE Standard 488.1-1987.
Abbreviations from the standard are used in this discussion, which describes the effects of interface messages on instrument operation.

UNL Unlisten
UNT Untalk

When the UNL command is received, the instrument's listener function goes to its idle state (unaddressed).
In the idle state, the instrument will not accept instrument commands from the GPIB.
The talker function goes to its idle state when the instrument receives the UNT command. In this state, the instrument cannot output data via the GPIB.

The ADDR light is off when both the talker and listener functions are idle. If the instrument is either talk addressed or listen addressed, the light is on.

DCL Device Clear.

This message restarts device dependent message processing, resets the input and output buffers, clears any buffered settings waiting for the GET message, and clears the instrument status, except for the power - on status.

NOTE:

DCL and SDC do not reset the instrument to the power-on state. Use the INIT command to reset the instrument to the power on state.

SDC Selected Device Clear.

Same as DCL message. The instrument responds to SDC only, if it is listen addressed.

SPE Serial Poll Enable
SPD Serial Poll Disable

The SPE message enables the instrument to output serial poll status bytes when it is talk addressed.
The SPD message switches the instrument back to its normal operation of sending the data from the Output Buffer.

MLA My Listen Address
MTA My Talk Address

The primary listen addresses are established by the instrument's GPIB address.The current setting is displayed when the ID button is pressed. When the instrument is addressed to talk or listen, the front-panel ADDR indicator is illuminated.

GET Group Execute Trigger.

If DT is on, and GET is received, while listen addressed, a trigger is created and the conversion sequence is started.The GET message is ignored and an SRQ generated , if the DT function is disabled (DT OFF), the instrument is in the local state, or if a message is being processed when GET is received.

GTL Go-To-Local.

This causes the instrument to go to a local state.
This state is described under Remote-Local Functions.
The instrument responds to GTL only if it is listen - addressed.

LLO Local Lockout.

This command causes the instrument to go to the Local With Lockout State (LWLS) or the Remote With Lockout State (RWLS) if REN is asserted.
(See Remote-Local Function Operation).

REN Remote Enable.

If REN is true, the instrument goes to a remote state (from LOCS to REMS or from LWLS to RWLS) when its listen address is received. REN false causes a transition from any state to LOCS; the instrument stays in LOCS as long as REN is false.

IFC Interface Clear.

Pulsing IFC is the equivalent of sending UNT, UNL, SPD. The message buffer will NOT be cleared so that input or output operations can be continued with no loss of data.

ASCI & GPIB CODE CHART

BITS B7 B6 B5 / B4 B3 B2 B1	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 NUL 0 0	20 DLE 16 10	40 SP 0 20 32	60 0 16 30 48	100 @ 0 40 64	120 P 16 50 80	140 ` 0 60 96	160 p 16 70 112
0 0 0 1	1 SOH GTL 1 1	21 DC1 LLO 17 11	41 ! 1 21 33	61 1 17 31 49	101 51 A 1 41 65	121 Q 17 51 81	141 a 1 61 97	161 q 17 71 113
0 0 1 0	2 STX 2 2	22 DC2 18 12	42 " 2 22 34	62 2 18 32 50	102 B 2 42 66	212 R 18 52 82	142 b 2 62 98	162 r 18 72 114
0 0 1 1	3 EXT 3 3	23 DC3 19 13	43 # 3 23 35	63 3 19 33 51	103 C 3 43 67	123 S 19 53 83	143 c 3 63 99	163 s 19 73 115
0 1 0 0	4 SDC EOT 4 4	24 DCL DC4 20 14	44 $ 4 24 36	64 4 20 34 52	104 D 4 44 68	124 T 20 54 84	144 d 4 64 100	164 t 20 74 116
0 1 0 1	5 PPC ENQ 5 5	25 PPU NAK 21 15	45 % 5 25 37	65 5 21 35 53	105 E 5 45 69	125 U 21 55 85	145 e 5 65 101	165 u 21 75 117
0 1 1 0	6 ACK 6 6	26 SYN 22 16	46 & 6 26 38	66 6 22 36 54	106 F 6 46 70	126 V 22 56 86	146 f 6 66 102	166 v 22 76 118
0 1 1 1	7 BEL 7 7	27 ETB 23 17	47 ' 7 27 39	67 7 23 37 55	107 G 7 47 71	127 W 23 57 87	147 g 7 67 103	167 w 23 77 119
1 0 0 0	10 GET BS 8 8	30 SPE CAN 24 18	50 (8 28 40	70 8 24 38 56	110 H 8 48 72	130 X 24 58 88	150 h 8 68 104	170 x 24 78 120
1 0 0 1	11 TCT HT 9 9	31 SPD EM 25 19	51) 9 29 41	71 9 25 39 57	111 I 9 49 73	131 Y 25 59 89	151 i 9 69 105	171 y 25 79 121
1 0 1 0	12 LF A 10	32 SUB 26 1A	52 * 10 2A 42	72 : 26 3A 58	112 J 10 4A 74	132 Z 26 5A 90	152 j 10 6A 106	172 z 26 7A 122
1 0 1 1	13 VT B 11	33 ESC 27 1B	53 + 11 2B 43	73 ; 27 3B 59	113 K 11 4B 75	133 [27 5B 91	153 k 11 6B 107	173 { 27 7B 123
1 1 0 0	14 FF C 12	34 FS 28 1C	54 , 12 2C 44	74 < 28 3C 60	114 L 12 4C 76	134 \ 28 5C 92	154 l 12 6C 108	174 | 28 7C 124
1 1 0 1	15 CR D 13	35 GS 29 1D	55 — 13 2D 45	75 = 29 3D 61	115 M 13 4D 77	135] 29 5M 93	155 m 13 6D 109	175 } 29 7D 125
1 1 1 0	16 SO E 14	36 RS 30 1E	56 . 14 2E 46	76 > 30 3E 62	116 N 14 4E 78	136 ^ 30 5R 94	156 n 14 6E 110	176 ~ 30 7E 126
1 1 1 1	17 SI F 15	37 US 31 1F	57 / 15 2F 47	77 ? UNL 3F 63	117 O 15 4F 79	137 — UNT 5F 95	157 o 15 6F 111	177 DEL (RUBOUT) 7F 127
	ADDRESSED COMMAND	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS	

KEY octal / hex — 25 PPU / NAK / 15 21 — GPIB code / ASCII characters / decimal

Tektronix COMMITTED TO EXCELLENCE

REF: ANSI STD X3.4-1977
IEE STD 488-1978
ISO STD 646-1973

Fig. 3-1 ASCII and IEEE (GPIB) Code Chart

REMOTE - LOCAL FUNCTION OPERATION

Introduction

The Remote-Local functions of the DM 5110 are controlled by the system controller and the front panel controls. There are four states associated with the Remote-Local functions of the DM 5110 , two "local" states and two "remote" states :

- Local State (LOCS)
- Remote State (REMS)
- Local With Lockout State (LWLS)
- Remote With Lockout State (RWLS)

Local State (LOCS).

In LOCS, the front panel controls are under the control of the operator ; the front panel settings can not be changed via setting commands from the bus. However, the instrument will respond to query commands via the GPIB bus (REN bus line need not be asserted).
In a "local" state, all front panel controls are operational.
If a remote command cannot be executed because the instrument is in a "local" state, an execution error will be reported to the controller (error 201).

Remote State (REMS).

When the DM 5110 receives its listen address, with the REN bus line asserted, and rtl is false, it enters the Remote State and the REM indicator light is illuminated. While in REMS, the instrument responds to and executes all setting commands, queries, and interface messages. For all commands having corresponding front panel controls, the front panel is updated to display the new settings as the commands are executed.
If the DM 5110 is in REMS, there are three conditions under which it will return to the Local State (LOCS):

- when any key , except INST ID is depressed by the operator,
- when the instrument receives the Go To Local (GTL) interface message, or
- If the REN bus line becomes un-asserted (false).

NOTE:

The DM 5110 can be in either the Local State (LOCS) or Remote State (REMS) when the Local Lockout (LLO) interface message is received. If in LOCS and REN is asserted, it will enter the Local With Lockout State (LWLS) or if in REMS, it will enter the Remote With Lockout state (RWLS) when LLO is received.

The LWLS and RWLS state transitions are completely controlled by the controller.

Local With Lockout State (LWLS).

If the DM 5110 enters the Local With Lockout State, the REM indicator light will not be lit and the instrument operates exactly as in the Local State (LOCS).

Remote With Lockout State (RWLS).

While in RWLS, the REM indicator will be illuminated, all setting commands, queries, interface messages will be executed and all front-panel controls, except INST ID will be ignored.If the GTL message is received while in RWLS, the instrument goes to the Local With Lockout State (LWLS).

NOTE:

The DM 5110 returns to the Local State (LOCS) any time the REN bus line becomes un-asserted (false).

DEVICE DEPENDENT COMMAND SET

Introduction

The remote control messages for the DM 5110 are device-dependent messages on the GPIB.
As such, they are not specified in IEEE Standard 488.1-1987.
However, the Tektronix Standard Codes and Formats specifies the syntax, delimiters, and characters allowed for high-level programming of TEKTRONIX instruments.

All front-panel functions are also GPIB controllable, except for the FRONT REAR INPUT switch, 50/60 Hz setting, the GPIB address and LF/EOI settings.

Description Of The Syntax Diagrams

The syntax in the section below is described in a BNF format. The symbols used in the syntax definitions are described below.

Symbol Description:

- < > Defined element.
- ::= Is define as
- ( ) Explanation
- { } Grouping of arguments and variables. Do not include the braces in the message.
- [ ] Optional data. Do not include the data in the message.
- | Exclusive OR. A vertical line is used in a series of two or more units ; any one unit must be selected and sent as part of the command message. Do not include the line in the message.
- <NRF> ::= <NR1> | <NR2> | <NR3>
  (Any of the three number types)
  Is used by the DM 5110 to accept or transmit a number . Numbers may be NR1 (integer), NR2 (decimal) and NR3 (with exponent) format.

Symbols not enclosed by < > are terminals or literals.

Spaces in a definition are for formatting and are not part of the definition.

DM5110 Detailed Command Set

Each DM 5110 command , like those in all TM 5000 instruments, begins with a header, which is a word or acronym that describes the function implemented.

Following the header, many commands require an argument, which is a word or number that specifies the desired state for the function.

The commands are presented alphabetically on the following pages.

When abbreviation of the header is allowed, the optional part is printed in lower case.

GPIB Command Set Summary :

To control the DM5110 the following GPIB commands are defined:

ACA [< Amps>]	Set to the AC current function
ACV [<Volts>]	Set to the AC voltage function
BEEper ON	Beeper mode on
BEEper OFf	Beeper mode off
BEEper ?	Response from DM: BEEP ON | OFF
CALEN?	Response CALEN ON|OFF {internal cal jumper}
CAL	{calibrate} If not cal-jumper in "CAL" then error 260 If calibration fails then error xxx
CALC CMPr	Turns on the compare calculation function
CALC OFf	Turns off all calculator functions
CALC ?	Response from DM: CALC CMPR | OFF
DATA?	Return the reading causing a monitor event.
DBM [< dBm's>]	Set to the dBM function
DBV [<dBV's>]	Set to the dBV function
DCA [<Amp's>]	Set to the DC current function
DCV [< Volts>]	Set to the DC Volts function
DIGit [<Digits>]	Sets the measurement resolution of the DM 5110.
DIGit ?	Response from DM: DIGI 3.5|4.5
DT OFf	Device Trigger off
DT TRIg	Device Trigger mode
DT ?	Response from DM: DT OFF | TRIG
ERR?	Response from DM: ERR <NUMBER>
EVent ?	Response from DM: EVENT <NUMBER>
FUNCT DCV	DC Voltage Measurement
FUNCT ACV	AC Voltage Measurement
FUNCT DCA	DC Current Measurement
FUNCT ACA	AC Current Measurement
FUNCT OHMS	Ohms Measurement
FUNCT DBM	dBm Measurement
FUNCT DBV	dBm Measurement
FUNCT TEMP	Temperature Measurement
FUNCT?	Response from DM: FUNCT DCV|ACV|DCA|ACA|OHMS|DBM| DBV|TEMP
HELp ?	Returns all instrument commands
ID?	Response from DM: ID TEK/DM5110,V81.1,FVx.x
INIt	Power "on" conditions : - FUNCT DCV RANGE 3 USER OFF MODE RUN DIGIT 4.5 - RQS ON OPC OFF

GPIB Command Set Summary (Cont.)

LIMits<high limit>,<low limit>	Set limit values
LIMits ?	Returns the state of the limit function
LINEFreq ?	Response from DM: LINEF 50 |60
MODE RUN	RUN mode
MODE TRIG	TRIG mode (HOLD)
MODE?	Response from DM: MODE RUN|TRIG
MONitor ON	Monitors the HIGH LOW limits and set SRQ is out of limits
MONitor OFf	Turns off the monitor function
MONitor ?	Response from DM: MONITOR ON|OFF
NULL [<Null value>]	Turns on the null function and set the null value
NULL ?	Returns the state of the null function.
OHMs [<Ohms>]	Set to the Ohms function
OPC ON	OPC reporting on
OPC OFf	OPC reporting off
OPC ?	Response from DM: OPC ON|OFF
OVEr ON	OVER reporting on
OVEr OFf	OVER reporting off
OVEr ?	Response from DM: OVER ON | OFF
RANge <Range number>	
RANge ?	Response from DM: RANGE <0..6>
RQS ON	Enable RQS
RQS OFf	Disable RQS
RQS?	Response from DM: RQS ON|OFF
SENd	Response <READING DATA>
SET?	Returns the complete state of the instrument
SOURce ?	Response from DM: SOURCE FRONT | REAR
TEMP [<°C>]	Set to the temperature function
TEST?	Start self test
USER ON	Enable INST ID Service request
USER OFf	Disable INST ID Service request
USERreq ?	Response from DM: USER ON|OFF

DETAILED COMMAND LIST

ACA
(AC Current Function)

Type : Setting

Setting Syntax : ACA [<number>]

Examples :	**Range Selected :**
ACA 18E–3	20 mA
ACA 500E–3	2000 mA
ACA	No range, Auto ranging

Discussion :

number ::= <NRF> (valid current to the instrument)

This command will set the instrument to the AC-current function.
Also sets the range of the AC- current function.

The argument is used to select the range.
If there is no argument, the range is set to autorange, starting in the highest range.

If the argument is a valid current reading, the instrument rounds the argument up to the first full scale value, and selects that specific range.

If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

Ranges :

200	µA
2	mA
20	mA
200	mA
2000	mA

ACV
(AC Voltage Function)

Type : Setting

Setting Syntax : ACV [<number>]

Examples :	**Range Selected :**
ACV 15	20 V
ACV 15E–2	200 mV
ACV	No range, Auto ranging

Discussion :

number ::= <NRF> (valid voltage input to the instrument)

This command will set the instrument to the AC-voltage function. Also sets the range of the AC-voltage function.

The argument is used to determine the range.
If there is no argument, the range is set to autorange, starting in the highest range.

If the argument is valid , the instrument rounds the argument up to the first full scale value, and selects that specific range.

If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

Ranges :

200	mV
2	V
20	V
200	V
500	V

BEEper

Type : Setting or Query

Setting Syntax : BEEper ON | OFf

Query Syntax : BEEper?

Query Response : BEEP ON | OFF;

Discussion :

This BEEper ON | OFF command enables or disables the BEEPER mode.

The beeper mode works on all functions and makes the beeper sound if the reading is below the low limit or above the high limit, with an exception when the instrument is in the Ohms mode, in overrange, and the HI LIMIT is set at 19999 in the measurement range.

CALC (Compare Mode)

Type : Setting or Query

Setting Syntax : CALC COMp | OFf
CALC CMPr | OFf

Query Syntax : CALC?

Query Response: CALC CMPR | OFF;

Examples : CALC CMPR
CALC OFF
CALC COMP

Discussion :

With the CALC CMPR command the instrument will display HI if the reading is higher than the HI LIMIT, LO if the reading is less than the LOW LIMIT or PASS in all other cases.
The value of the limits is set by the LIMITS command.

Over the GPIB-bus, the SEND command will make the DM5110 output the following results:

1. for LO,
2. for PASS,
3. for HI
+1E+99 or -1E+99 for overrange.

The OFF argument turns off the compare function.

DATA?

Type : Query

Syntax : DATA?

Response : < number >

Discussion :

This command returns one of the responses listed below.

1) After power on, returns 0 until a reading is available.

2) If a MONITOR SRQ has occurred, DATA returns the measurement causing the SRQ.

3) If neither of the above condition is true, DATA returns the most recent reading. DATA will return the same reading until the next conversion is triggered and a new reading is available.

It does not trigger a conversion nor wait to return a new reading as the SEND command does.

DBM [<number>] (dB Milli Watt Function)

Type : Setting

Setting Syntax : DBM [<number>]

Discussion :

This command will set the instrument to the DBM function. Also sets the range of the DBM function.

The DBM function is a recalculated version of the ACV ranges.
The reading is converted to dB with a 1 mW reference (.775 Volt).
If there is no argument, the range is set to autorange, starting in the highest range.
If the argument is valid , the instrument rounds the argument up to the first full scale value, and selects that specific range.
If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

number ::= <NRF> (valid dBm to the instrument)

Ranges :

–57.78	–11.76	dBm
–37.78	+ 8.24	dBm
–17.78	+28.24	dBm
+ 2.02	+48.24	dBm
+42.22	+56.20	dBm

(00.00 dBm equals 1 mWatt in 600 Ω load (0.775 V RMS)).

DBV [<number>] (dB Voltage Function)

Type : Setting

Setting Syntax : DBV [<number>]

Discussion :

This command will set the instrument to the DBV function. Also sets the range of the DBV function.
The DBV function is a recalculated version of the ACV ranges.
The reading is converted to dBV (1 volts reference).
The argument is used to determine the range.
If there is no argument, the range is set to autorange, starting in the highest range.
If the argument is valid, the instrument rounds the argument up to the first full scale value, and selects that specific range.
If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

number ::= <NRF> (valid dBV to the instrument)

Ranges :

–60.0	–13.98 dBV
–40.0	+6.02 dBV
–20.0	+26.02 dBV
0	+46.02 dBV
+20.0	+53.98 dBV

(0 dBV equals a voltage of 1 V RMS)

DCA [<number>] (DC Current Function)

Type : Setting

Setting Syntax : DCA [<number>]

Examples :	**Range Selected :**
DCA 18E–3	20 mA
DCA 500E–3	2000 mA
DCA	No range, Auto ranging

Discussion :

This command will set the instrument to the DC current function. Also sets the range of the DC current function.
The argument is used to determine the range.
If there is no argument, the range is set to autorange, starting in the highest range.
If the argument is valid , the instrument rounds the argument up to the first full scale value, and selects that specific range.
If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

number ::= <NRF> (valid current input to the instrument)

Ranges :

200	µA
2	mA
20	mA
200	mA
2000	mA

DCV [<number>] (DC Voltage Function)

Type : Setting

Setting Syntax : DCV [<number>]

Examples :	**Range Selected :**
DCV 15	20 V
DCV 15E-2	200 mV
DCV	No range, Auto ranging

Discussion :

This command will set the instrument to the DC voltage function. Also sets the range of the DC voltage function.
The argument is used to determine the range.
If there is no argument, the range is set to autorange, starting in the highest range.
If the argument is valid , the instrument rounds the argument up to the first full scale value, and selects that specific range.
If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

number ::= <NRF> (valid voltage input to the instrument)

Ranges :

200	mV
2	V
20	V
200	V
1000	V

DIGit [<number>] (Digital Resolution)

Type : Setting or Query

Setting Syntax : DIGit [<number>]

Query Syntax : DIGit?

Query Response : DIG 3.5 | 4.5 ;

Examples :	**Resolution Selected:**
DIG 3	3.5 digit
DIG 4.5	4.5 digit
DIG 4	4.5 digit

Discussion :

This command selects the conversion rate.

The argument 3 will set the resolution to 3 1/2 digits, and the conversion rate to at least 25 readings per second.
An exception is made for the 20 MOhm range where the conversion rate is at least 11 readings per second.

The argument 4 will set the resolution to 4 1/2 digits, and the conversion rate to at least 3 readings per second.

Number :: = < NRF > (Valid setting to the instrument)

DT TRIG | OFf (Device Trigger)

Type : Setting or Query

Setting Syntax : DT TRIg | OFf

Query Syntax : DT?

Query Response : DT TRIG | OFF;

Discussion :

This command enables or disables the device trigger function.

If Device Trigger is enabled, the <GET> IEEE-488.1 interface message causes the instrument to trigger the instrument to make a measurement.
If <GET> is received while the message processor is busy or when DT is OFF, the instrument generates an error which indicates the <GET> was ignored (error 206).

ERRor? (Error)

Type : Query

Query Syntax : ERRor?

Query Response : ERR_{sp} < number >

Discussion :

The ERROR query will return an error message showing the status of the instrument.
ERROR can be caused by incorrect command or the user, pressing the ID button, overrange or other events.

EVent?

Type : Query

Query Syntax : EVent?

Query Response : EVENT $_{sp}$ <number >

Discussion :

The EVENT query will return the same information as the ERROR query, except that the response header is EVENT instead of ERROR.

FUNCtion DCV | DCA | ACV | ACA | OHMS | DBM | DBV | TEMP
(Function Selection)

Type : Setting or query

Setting Syntax : FUNCtion DCV | DCA | ACV | ACA | OHMS | DBM | DBV |TEMP

Query Syntax : FUNCtion ?

Query Response : FUNC DCV | ACV |DCA | ACA | DBV | DBM | OHMS | TEMP;

Discussion :

The FUNCTION command will set the function of the DM 5110. When the FUNCTION command is sent, the range is not changed.

DCV
This command will set the instrument to the DC Voltage function.
DCA
This command will set the instrument to the DC Current function.
ACV
This command will set the instrument to the AC Voltage function.
ACA
This command will set the instrument to the AC Current function.
DBV
This command will set the instrument to the AC Volts function and does a conversion to DBV.
DBM
This command will set the instrument to the AC volts function and does a conversion to DBM.
OHMS
This command will set the instrument to the Ohms function.
TEMP
This command will make the instrument measure temperature. This can be done using a special temperature probe (P6602) connected to the front panel LOW and V /Ω / Temp jacks.

HELp?

Type : Query

Query Syntax : HELp?

Query Response : All Commands

Discussion :

The HELP? query will return all instrument commands.

ID? (Identification)

Type : Query

Query Syntax : ID?

Query Response : IDTEK/DM5110,V81.1,Fx.x ;

Discussion :

The ID? query will return the ID string for the DM 5110.
The ID query will return the ID string in the form:
The breakdown of the string is as follows:

ID	::= Command header
TEK	::= Manufacturer of the instrument
DM5110	::= Model number of the instrument
V81.1	::= Codes and formats version, this instrument conforms to.
Fx.x	::= The firmware version that is used in this instrument.

INIt
(Initiate)

Type : Operational

Syntax : INIt

Discussion :

The INIT command will reset the instrument to the power on state except that a power on SRQ report will not occur.

The power-on setting list is as indicated below :

The instrument will be in the local state with the following default settings:

- BEEPER OFF
- CALC OFF
- DIGIT 4.5
- DT OFF
- FUNC DCV
- LIMITS 0., 0.
- MODE RUN
- MONITOR OFF
- NULL 0.
- OPC OFF
- OVER OFF
- RANGE 0
- RQS ON
- USER OFF

LIMits
(Limit Setting)

Type : Setting or Query

Setting Syntax : LIMits<high limit>,<low limit>

Query Syntax : LIMits?

Query Response : LIMITS<high limit>,<low limit>;

Discussion :

high limit ::= <NRF> (valid reading for function)

low limit ::= <NRF> (valid reading for function less or equal than high limit)
Units are in Amps, Volts, Ohms, dB's and °C.
The arguments for this command set the value of the limits used by the CALC CMPR calculation, the BEEPER mode and the MONITOR SRQ.
Error 232 will occur when:

1) The lo limit argument is above the hi limit argument.

2) Argument 1 and/or 2 are beyond the span of the selected function.

The settings remain stored in memory until the function is changed.
Note, that the front-panel operation is different at this subject.

LINEFreq?
(Line Frequency)

Type : Query

Query Syntax : LINEfreq ?

Query Response : LINEF 50 | 60;

Discussion :

This command returns the setting of the line frequency.

MODE RUN | TRIg
(RUN | TRIG Setting)

Type : Setting or Query

Setting Syntax : MODE RUN | TRIg

Query Syntax : MODE?

Query Response : MODE RUN | TRIG;

Discussion :

The mode command will set the trigger/run mode . If MODE RUN is set, readings are taken continuously.
The TRIG argument sets the TRIGGERED mode. In this mode, a trigger occurs upon receipt of one of the following commands :

* A "SEND" command
* A Group Execute Trigger <GET> interface message (Only if Device Trigger is enabled).

If over-range or under-range occurs, or a more accurate range is available, while MODE TRIG is enabled and the instrument is in auto-ranging, it will change range and output the last stable reading. This evidently increases the time it takes to make a measurement.
If measuring speed is required, selecting a proper range is advisable.

MONitor ON | OFf

Type : Setting or Query

Setting Syntax : MONitor ON | OFf

Query Syntax : MONitor?

Query Response : MONITOR ON | OFF;

Discussion :

The MONitor ON | OFF command enables or disables the MONITOR SRQ.
With the MONITOR SRQ enabled, the instrument saves the first measurement outside the limits (set by the LIMITS command) and generates an SRQ.
SRQ's are not generated for subsequent measurements (outside the limits) until the SRQ is serviced and the measurement is reported to the controller in response to the DATA ? query.

NULL [<null value>]

Type : Setting or Query

Setting Syntax : NULL [<null value>]

Query Syntax : NULL?

Query Response : NULL <number>;

Discussion :

null value ::= <NRF> value for the null calculation (valid reading for function)

This command enables the NULL function; the argument specifies the value of the offset.
If no null value argument is sent, the NULL value is acquired from the next valid reading.

The NULL function is disabled when the measurement function is changed or when the argument is 0. (Changing the measurement function also sets the argument to 0.) If the argument is not a valid reading for the function selected, the instrument generates a command error (and asserts SRQ if RQS is on).

The NULL query returns the value used in the null calculation. If the number 0 is returned, the NULL function is disabled.
If any other value is returned, the NULL function is enabled and set to the value returned.

OHMs [<number>] (Ohms Function)

Type : Setting

Setting Syntax : OHMs [<number>]

Examples :	**Range Selected :**
OHMS 18	200 Ω
OHMS 500	2 kΩ
OHMS 1.5E+7	20 MΩ
OHMS	Auto ranging

Discussion :

number ::= <NRF> (valid ohms to the instrument)

This command will set the instrument to the OHMS function. Also sets the range of the OHMS function.

The argument is used to determine the range. If there is no argument, the range is set to autorange, starting in the highest range. If the argument is valid , the instrument rounds the argument up to the first full scale value, and selects that specific range. If the argument is above the highest range, the instrument generates an execution error (and asserts SRQ if RQS is on).

Ranges :

200	Ω
2	kΩ
20	kΩ
200	kΩ
2	MΩ
20	MΩ

OPC ON | OFf (Operation Complete)

Type : Setting or Query

Setting Syntax : OPC ON | OFf

Query Syntax : OPC?

Query Response : OPC ON | OFF;

Discussion :

This command will enable or disable the reporting of an operation complete event.

If the function is ON and when a reading is complete, SRQ will be asserted (if RQS is ON) so that the controller can come and get the reading. This will allow the DM5110 to use a large delay time to get a reading and then report to the controller that the reading is ready to be transferred.
If RQS is OFF the event is reported using the EVENT or ERROR query.

OVEr ON | OFf
(Over Range)

Type : Setting or Query

Setting Syntax : OVEr ON | OFf

Query Syntax : OVEr?

Query Response : OVER ON | OFF;

Discussion :

The OVER ON command will cause an over range event to report an error.

If RQS is ON then the ERROR will be reported using the RQS line.

If RQS is OFF then the ERROR query will be used to report the ERROR.

If OVER is OFF, the instrument returns +/-1.E+99 when talked to indicate over-range (does not assert SRQ).

RANge <number>
(Range Setting)

Type : Setting or Query

Setting Syntax : RANge < number>

Query Syntax : RANge?

Query Response : RANGE < number>

Discussion :

This command will set the range of the DM5110.
If a number is given,the range is set according to Table 3-1.

Number :: = < NRF > (Valid range to the instrument)

Table 3-1.
Function / Range v.s. Range number

Full Scale value of range							
Range #	**DCV**	**ACV**	**DCA**	**ACA**	**Ohms**	**dBV/dBm**	**TEMP**
0	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	–62 to +240 °C
1	200 mV	200 mV	200 µA	200 µA	200 Ω	200 mVAC	–62 to +240 °C
2	2 V	2 V	2 mA	2 mA	2 kΩ	2 VAC	–62 to +240 °C
3	20 V	20 V	20 mA	20 mA	20 kΩ	20 VAC	–62 to +240 °C
4	200 V	200 V	200 mA	200 mA	200 kΩ	200 VAC	–62 to +240 °C
5	1000 V	500 V	2000 mA	2000 mA	2 MΩ	500 VAC	–62 to +240 °C
6	1000 V	500 V	2000 mA	2000 mA	20 MΩ	500 VAC	–62 to +240 °C

Note : When internal cal-jumper is in Cal position, range 0 generates error 205.

RQS ON | OFf (Request Service)

Type : Setting or Query

Setting Syntax : RQS ON | OFf

Query Syntax : RQS?

Query Response : RQS ON | OFF;

Discussion :

This command enables the instrument to generate any service requests.

The OFF argument disables all service requests.

See Status and Error Reporting in this section for further information.

SENd

Type : Output

Syntax : SENd

Discussion :

The instrument triggers a measurement and then outputs it.
If the COMPARE calculation is enabled (CALC CMPR) the instrument outputs one of the following numbers which indicate the relationship between the input and the limits set by the LIMITS command :

- 3.; if the input is above both limits.
- 2.; if the input is between or equal to one of the limits.
- 1.; if the input is below both limits.
- +1.E+99; or –1.E+99; if over-ranged.

If the period, waiting for the new reading is longer than the timeout of the DM5110 (5 sec.), the DM5110 will send the "talked with nothing to say" response. .("FF"- byte)

SET?
(Function toSet all Commands in a String)

Type : Query

Query Syntax : SET?

Discussion :

The SET query will return the response to all settable commands in one string.

The format is :

- <FUNC?> <RANGE?> <LIMITS?>
  <CALC?><NULL?> <DIGIT?>
  <MODE?> <BEEPER?> <DT?>
  <MONITOR?> <OPC?> OVER?>
  <USER?> <RQS?> .

SOURce?
(Returns the position of the Input Switch)

Type : Query

Query Syntax : SOURce?

Query Response : SOURCE FRONT | REAR

Discussion :

The SOURCE? query returns the position of the input switch.

TEMP [<number>] (Temperature Function)

Type : Setting

Setting Syntax : TEMP [<number>]

Discussion :

This command will set the instrument to the temperature function.

If the argument is above the maximum of the temperature range, the instrument generates an execution error (and asserts SRQ if RQS is on).

number ::= <NRF> (valid temperature to the instrument)

Range : –62 °C to +240 °C

TEST?

Type : Query

Query Syntax : TEST?

Query Response : TEST <problem number>;

Discussion :

The TEST query command is used to cause a self test to occur and report the results. The problem number can be either 0, if no error have occurred, or 302 if the test has failed.

USERreq ON | OFf

Type : Setting or query

Setting Syntax : USERreq ON | OFf

Query Syntax : USERreq?

Query Response : USER ON | OFF;

Discussion :

This command enables or disables the INST ID button service request.

If enabled, the instrument asserts SRQ when the INST ID button is pressed.

CALIBRATION COMMANDS LIST

CAL
(Calibration Command Function)

Type : Operational

Syntax : CAL

Response : CAL <error number>

Discussion :

This command will start the calibration of the instrument and reports the result.

NOTE:
If the CAL command is used when the voltage reference is not set up the calibration of the instrument can be affected.

If the cal jumper is set for calibration disable, and the CAL command is sent, error 260 is returned.
If the deviation between the reference voltage and the predicted calibration reading is to great then error 655 is returned. Other errors that can occur are numbers 651 - 654.
The error query responses and status information is as listed below:

Calibration step done	: 455
Calibration stopped	: 651
Calibrate LOVAC first	: 652
Unstable measurement error	: 653
Eeprom error	: 654
Calibration beyond bounderies	: 655

For more information on the calibration procedure, see the Service Manual.

CALEN?
(Return to Normal Operation Function)

Type : Query

Query Syntax : CALEN?

Query Response : CALEN ON | OFF

Discussion :

This query will return the state of the calibration jumper.

If CALEN ON; is returned then the jumper is set to enable the calibration of the instrument.

If CALEN OFF; is returned then the jumper is set to disable the calibration of the instrument.

If CALEN OFF; is returned, then the CAL command will cause an error if it is sent (error 260).

POWER-ON / INITIAL CONDITIONS

At power up, the DM5110 will be set in the following mode:

- Primary address, LF/EOI setting as stored in EEPROM.
- The conversion rate is set to 4.5 digit in the RUN mode.
- The function will start at the 1000 Volt DC range, autoranging.

The instrument will be in the local state with the following settings:

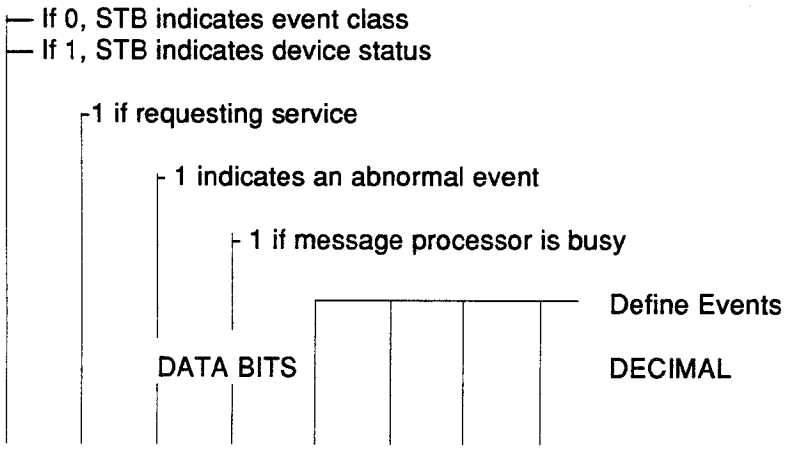
- BEEPER OFF
- CALC OFF
- DIGIT 4.5
- DT OFF
- FUNC DCV
- LIMITS 0., 0.
- MODE RUN
- MONITOR OFF
- NULL 0.
- OPC OFF
- OVER OFF
- RANGE 0
- RQS ON
- USER OFF

STATUS AND ERROR REPORTING

Through the Service Request function (defined in the IEEE-488.1 standard), the instrument may alert the instrument that it needs service. This service request is also a means of indicating that an event (a change in status or an error) has occured.

To service a request the controller performs a Serial Poll; in response the instrument returns a Status Byte (STB), which indicates whether it was requesting service or not.
The STB can also provide a limited amount of information about the request.
The format of the information is structured as shown in Fig.3-2 .
Because the STB conveys limited information about an event, the events are divided in classes: the Status Byte reports the class.
The classes of events are defined as follows:

- COMMAND ERROR
  Indicates the instrument has received a command that it cannot understand.
- EXECUTION ERROR
  Indicates that the instrument has received a command that it cannot execute.
- INTERNAL ERROR
  Indicates the instrument has detected a hardware condition or firmware problem that prevents operation.
- SYSTEM EVENTS
  Events that are common to instruments in a system. (e.g. Power on, User Request, etc.).
- INTERNAL WARNING Internal warning indicates that the instrument has detected a problem.
  The instrument remains operational but the problem should be corrected.
- DEVICE STATUS
  Device dependent events.(see Fig. 3-2)



Status Byte (Example)	8	7	6	5	4	3	2	1	Not Busy	Busy
Power On	0	1	0	X	0	0	0	1	65	81

Fig.3-2. Definition of STB bits.

The instrument can provide additional information about many of the events, particularly the errors reported in the Status Byte. After determining that the instrument requested service, (by examining the STB), the controller may request the additional information by sending error query (ERR?). In response, the instrument returns a code which defines the event. These codes are described in Table 3-2.
All events and errors have a priority assigned to them.
If more than one error or event is put into the Queue and RQS is ON then the oldest error is returned first and the highest priority is returned next.
If more than one error or event is put into the Queue and RQS is OFF then the highest priority error will be returned first.
Only one error is stored at each priority level. If an error of a certain priority is queued and another error with the same priority occurs the new error is discarded.
If a message being sent to the instrument has an error in it, then all message units up to the error, are handled.
The message unit with the error in it and all remaining message units are discarded.

Table 3 -2
ERROR QUERY AND STATUS INFORMATION

Abnormal Events Error:	Query Response:	Serial Poll Response:	Priority Level:
Command errors			
Command header error	101	97	2
Header delimiter error	102	97	2
Command argument error	103	97	2
Argument delim. error	104	97	2
Missing argument	106	97	2
Inval. message unit del.	107	97	2
Execution errors			
Not executable in local	201	98	3
Settings lost due rtl	202	98	3
Input and output buffer full	203	98	3
Settings conflict	204	98	3
Argument out of range	205	98	3
GET ignored	206	98	3
Beyond limit set or null capabilities	232	98	3
Cal locked	260	98	3
System events			
System Error	302	99	4
Power on	401	65	1
Operation Complete	402	66	6
ID user request	403	67	5
Internal warning			
Overrange error	601	102	6
Device status			
Below limits	701	193	6
Above limits	703	195	6

REMARK If the message processor is busy serial poll - response returns 16 higher.

DM5110 DETAILED ERROR LISTING

Table 3-3
Detailed Error Listing

Error	Error Type	Error Cause	Priority
COMMAND ERRORS (100) SRQ byte = 97 decimal or 113 decimal (busy bit set)			
101	Command header error	When the keyword of a command is unknown or misspelled. (Incorrect syntax.)	02
102	Header delimiter error	When the delimiter between the header and the argument is missing or the wrong character. (Incorrect syntax.)	02
103	Command argument error	When the syntax of the argument is wrong. (Incorrect syntax.)	02
104	Argument delimiter error	When the delimiter between arguments is the wrong character. (Incorrect syntax.)	02
106	Missing argument	When a command is missing one of its arguments.	02
107	Invalid message unit delimiter	When the delimiter between commands is missing or the wrong character.	02
EXECUTION ERRORS (200) SRQ byte = 98 decimal or 114 decimal (busy bit set)			
201	Command not executable	When a command cannot be executed while the instrument in local is under local control. This includes all of the commands that control the settings of the instrument. It does not include queries, RQS ON, USER ON.	03
202	Settings lost due to rtl	If a button is pressed while a command is being set or executed.	03
203	Input and output buffer full	Output data has been deleted. The instrument cannot finish executing the message because it is waiting for the controller to read the data it has generated.	03
204	Settings conflict	This error occurs if you try to execute a command that conflicts with the current mode of operation.	03
205	Argument out of range	You will get this error if a numerical argument is out of the range of the instrument.	03

Table 3-3 (cont.)

Error	Error Type	Error Cause	Priority
206	GET ignored	A GET has been ignored for one of the following reasons: - DT is off. - DM5110 is in local state - A hardware update of the DM5110 is not finished.	03
232	Beyond limit set or null capabilities.	This error is returned if one of the arguments for the LIMITS command is out of range, or when the lo limit argument is above the hi limit argument. This error is also returned if the argument for NULL command is out of range.	03
260	CAL locked	This error is returned if the calibration jumper is not set to the calibration position and the CAL command is sent to the DM 5110.	03
SYSTEM ERRORS (300) SRQ byte = 99 decimal or 115 decimal (busy bit set)			
302	System Error	This error is the return if a instrument test has failed. The results are reported by sending TEST and a number representing the error type. The response to the TEST? query is : TEST <problem number>; The problem number can be either 0, if no error have occurred, or 302 if the test has failed.	04

Table 3-3 (cont.)

Error	Error Type	Error Cause	Priority	STB
		SYSTEM EVENTS (400)		
401	Power on	This will be returned if the instrument has just powered on. This event cannot be masked.	01	65
402	Operation complete	New measurement available	06	66
403	User Request	If USER ON is set and the front panel ID button is pushed, SRQ is asserted and after the instrument is polled, this event code will be returned. The SRQ byte returned by the poll is 67 or 83 (busy bit on).	05	67

Error	Error Type	Error Cause	Priority
		INTERNAL WARNINGS (600) SRQ byte = 102 decimal or 118 decimal (busy bit set)	
601	Overrange error	This error is generated when overrange occurs and the CAL jumper is in the normal position.	6
		DEVICE STATUS (700)	
701	Below limits	If the DM5110 is set in MONITOR ON, this error is generated if a measurement is above the HI LIMIT.	6
703	Above limits	If the DM5110 is set in MONITOR ON, this error is generated if a measurement is below the LO LIMIT.	6

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

MAINTENANCE

Introduction

This section of the manual provides information on changing the internal fuse and also on general maintenance of the DM5110 / DM511.

Recalibration / Adjustment

To assure accurate measurements, check the calibration of the instrument every 6 months or after 1000 hours of use,whichever occurs first.

Adjustments of internal circuits to specified accuracy, and / or calibration check should be performed at the factory or a Tektronix Service Center.

Before returning the instrument for any servicing, please contact your nearest Tektronix Service Center.

WARNING

To avoid fire hazard, use only the fuse of correct type, voltage rating, and current rating as specified on the instrument and in the fuse replacing instructions below.

Internal Fuse Replacement DM 5110 / 511

A fuse is located on the left side of the instrument, on the main board just behind the front panel.
(As you face the front of the instrument)

The side cover can be loosened by turning the plastic screw at the end of the cover, with a coin or screw driver. The cover can be removed now.
To remove the fuse, carefully pull it out of the fuseholder.

If the fuse is blown, replace it with a 2A, 250V, 3 AG, fast blow fuse.(See Part List in the Service Manual or contact your Tektronix Service Center.)

After replacement, reinstall the side cover.

Cleaning Instructions

This instrument should be cleaned as often as operation conditions require. Accumulation of dirt on components may act as an insulating blanket and prevents efficient heat dissipation that can cause overheating and component breakdown.

Use a non-residue type of cleaner; preferable isopropyl alcohol or denatured ethyl alcohol.
Before using any other type of cleaner consult your Tektronix Service Center or representative.

Exterior : Loose dust accumulated on the front can be removed by a soft cloth or a small brush. Dirt that remains on the front can be removed with a soft cloth dampened with a mild detergent and water solution.

CAUTION

Do not use abrasive cleaners.

Interior : It is recommended that in cleaning the interior that the accumulated dust be first blown off with dry low pressure air, then use a soft brush to remove any remaining dust.

CAUTION

This instrument contains electrical components that are susceptible to damage from static discharge. Discharge the static voltage from your body by wearing an approved wrist strap and pad connection while cleaning the interior of the instrument !!

OPTIONS AND ACCESSORIES

OPTION 02

OPTION 02 adds a TEKTRONIX P6602 that has been calibrated with the instrument.
Information concerning the TEKTRONIX P6602 Temperature Probe can be found in the instruction manual for that accessory or contact your local Tektronix Service Center or representative.

Standard Accessories

-	1 DM 5110 / 511 Operators Manual	070-7478-xx
-	1 Pair of Test Leads	196-3212-xx
-	1 GPIB Reference Guide (DM5110 only)	070-7559-xx
-	1 Instrument Interface Guide (DM5110 only)	070-7560-xx

Optional Accessories

-	Temperature Probe	P6602 (Tektronix)
-	RF Probe	P6420 (Tektronix)
-	High Voltage Probe	010-0277-xx
-	Service Manual	070-7479-xx

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.