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TEK

Part No. 070-8563-00
Product Group 30

ScopeCal

SCALCF1

Instruction Manual

WARNING

The following servicing instructions are for use by qualified service personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Summary prior to performing any service.

First Printing APR 1992

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Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number 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:

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GENERAL SAFETY SUMMARY

The general safety information in this summary is for operating and servicing personnel. Specific warnings and cautions can be found throughout the manual where they apply and may not appear in this summary.

TERMS IN THIS MANUAL

CAUTION

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

WARNING

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

TERMS AS MARKED ON EQUIPMENT

CAUTION indicates a hazard to property, including the equipment itself, and could cause minor personal injury.

WARNING indicates solely a personal injury hazard not immediately accessible as you read the marking.

DANGER indicates a personal injury hazard immediately accessible as you read the marking.

SYMBOLS AS MARKED ON EQUIPMENT

DANGER—High voltage.

Protective ground (earth) terminal.

ATTENTION—REFER TO MANUAL.

GROUNDING THE PRODUCT

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground.

WARNING: This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle. A protective-ground connection by way of the grounding conductor in the power cord is essential for safe operation. (I.E.C. Safety Class I)

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 electric shock.

POWER DISCONNECT

The main power disconnect is by means of the power cord or, if provided, an ac power switch.

USE THE PROPER POWER CORD

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition. CSA Certification includes the equipment and power cords appropriate for use on the North America power network. All other power cords supplied are approved for the country of use.

USE THE PROPER FUSE

To avoid fire hazard use only a fuse of the correct type, voltage rating, and current rating.

USE THE PROPER VOLTAGE SETTING

Make sure the line selector is in the proper position for the power source being used.

REMOVE LOOSE OBJECTS

During disassembly or installation procedures, screws or other small objects may fall to the bottom of the mainframe. To avoid shorting out the power supply, do not power up the instrument until such objects have been removed.

DO NOT OPERATE WITHOUT COVERS

To avoid personal injury or damage to the product, do not operate this product with covers or panels removed.

USE CARE WITH COVERS REMOVED

To avoid personal injury, remove jewelry such as rings, watches, and other metallic objects before removing the cover. Do not touch exposed connections and components within the product while the power cord is connected.

REMOVE FROM OPERATION

If you have reason to believe that the instrument has suffered a component failure, do not operate the instrument until the cause of the failure has been determined and corrected.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Section 1: Introduction

The SCALCF1 Calibration Fixture is a single-wide module designed to install in a TM5006 mainframe and operate with the ScopeCal System. This fixture provides a programmable 20 VDC supply for testing instrument overload protection circuits, a 1V p-p sine-wave supply for testing trigger inputs, and a capacitance meter (C-meter) for measuring instrument input capacitance. All supply voltage and C-meter settings are programmed via the IEEE-488 General Purpose Interface Bus (GPIB). The SCALCF1 Calibration Fixture conforms to the 1981 Tektronix internal standards for GPIB codes, formats, conventions, and features.

SPECIFICATIONS

20 VDC Output

Characteristic	Value	Supplemental Information
Output Voltage	20 VDC ±5.0 mV	Programmable in 100 mV ±5.0 mV increments; 100 ms max. command input response time
Current-Limit Load	<25 Ω	
Current Limits	40 to 800 mA	Current limits are a function of the programmed voltage, i.e., 40 mA at 1 V, 800 mA at 20 V settings.
Status	Output Off	Default at power on

1 VAC p-p Output

Characteristic	Value	Supplemental Information
Output Voltage	1 VAC ± 20%	Output frequency and phase match line input.
Current-Limit Load	<25 Ω	
Status	Output Off	Default at power on

C-Meter Input

Characteristic	Value	Supplemental Information
Capacitance Range	10 to 47 pF ± 3%	Capacitance-to-frequency conversion is linear in the capacitance range.

Temperature

Characteristic	Value	Supplemental Information
Operating	15 to 40 °C	
Non-Operating	–20 to 65 °C	Meets MIL-T-28800D Class 5, except for operating temperature

Humidity (Non-Condensing)

Characteristic	Value	Supplemental Information
Operating	90% ±5% RH, 10 to 30 °C	RH not controlled below 10 °C
Non-Operating	75% ±5% RH, 30 to 40 °C	

Altitude

Characteristic	Value	Supplemental Information
Operating	10,000 ft (3 km)	
Non-Operating	50,000 ft (15 km)	

Vibration

Characteristic	Value	Supplemental Information
Operating	0.38 mm (0.015") peak-to-peak displacement	10 to 55 Hz for 75 minutes

Shock

Characteristic	Value	Supplemental Information
Non-Operating	30 g half sine	11 ms duration, 3 shocks in each direction along 3 major axes, 18 shocks total.

Bench Handling

Characteristic	Value	Supplemental Information
Operating	45 ° or 4"	Or point of balance, whichever occurs first

Mechanical

Characteristic	Value	Supplemental Information
Length X Width X Height	11.5" X 2.625" X 5.0" (292.1 X 66.68 X 127 mm)	
Weight	24 oz (681 gm)	

Section 2: Operating Instructions

INTRODUCTION

The SCALCF1 has no front panel controls, since it is operated via GPIB commands. This section describes how to install and remove the Calibration Fixture, its default power-up status, and the functions of its front-panel connections and LEDs.

INSTALLING AND REMOVING

NOTE

The SCALCF1 Calibration Fixture is designed to operate when installed in a TM 5000 Mainframe Power Supply.

The SCALCF1 Calibration Fixture is calibrated and ready for use as received. It operates when installed in a compartment of the TM 5000 Mainframe Power Supply. Refer to the manual accompanying your TM 5000 Mainframe for line voltage requirements and Mainframe operation.

CAUTION

To prevent damage to the SCALCF1 Calibration Fixture, power off the Mainframe Power Supply before installation or removal. Do not use excessive force to install or remove the SCALCF1 Calibration Fixture.

To install the Calibration Fixture module in the Mainframe Power Supply:

1. Align the module's chassis with the upper and lower guides of the selected compartment.
2. Slide the module into the compartment and firmly seat its card-edge connectors in the Mainframe's interconnect jack.

CAUTION

Be sure the SCALCF1 Calibration Fixture is fully seated in the Mainframe Power Supply before applying power.

3. Remove the module by pulling the release latch (lower left corner of the front panel) and sliding it out of the Mainframe compartment.

POWER UP DEFAULT CONDITIONS

The Calibration Fixture operates in Remote (GPIB) mode. At power up, the Calibration Fixture's 20 VDC supply is set to 2.00 VDC with output off, and the line pick-off supply is switched off. At power up, diagnostic self-test routines are performed to check ROM and RAM function, the GPIB controller, and the selection of the GPIB primary address. If the tests produce errors, the front panel LEDs report the error condition (see the Diagnostics section for more information about the diagnostics).

FRONT PANEL LEDS AND CONNECTIONS

The Calibration Fixture front panel contains three LEDs and three male BNC connectors. The LEDs, labeled ADDR, SRQ, and LOCK, have the following functions when lit:

ADDR — The Calibration Fixture has been addressed (listened or tslked)

SRQ — The Calibration Fixture is asserting SRQ

LOCK — The instrument is in the remote Remote With Lockout State (RWIS)

The LEDs also report diagnostic errors by flashing a code. Interpreting the flash sequence determines the type of diagnostic failure. For information about the Calibration Fixture diagnostics and the LED failure codes, see the Diagnostics section.

The front panel male BNC connectors have the following functions:

20 VDC OUT — Calibration Fixture output used for checking DUT overload protection circuitry

C Meter Input — Input to the Calibration Fixture's capacitance meter

Line Pickoff (1 V p-p) — Calibration Fixture output used for checking DUT line trigger threshold

REMOTE AND LOCAL OPERATION

The Calibration Fixture powers up ready to accept GPIB interface messages or device-dependent commands via the GPIB. There is no front panel (local) control for forcing a transition from Remote to Local mode.

Section 3: GPIB Communications and Commands

GPIB COMMUNICATIONS

SCALCF1 Calibration Fixture communications is via an 8-bit parallel byte serial format based on the IEEE488.1 1987 standard (General Purpose Interface Bus or GPIB). This specification identifies interface function subsets. The subsets that apply to the SCALCF1 Calibration Fixture are listed in Table 3-1.

Table 3-1
Calibration Fixture GPIB Function Subsets

Function	Subset	Capability
Source Handshake	SH1	Complete
Acceptor Handshake	AH1	Complete
Basic Talker	T6	Responds to serial poll, untalk if MLA received
Basic Listener	L4	Unlisten if MTA received
Service Request	SR1	Complete
Remote-Local	RL1	Complete
Parallel Poll	PP0	Does not respond to parallel poll
Device Trigger	DT0	No capability
Device Clear	DC1	Complete
Controller	C0	No controller functions
Drive Electronics	E1	Open collector

In the GPIB environment, communications between devices (controller and instrument) are via two types of messages sent across the interface:

1. Interface messages that control the state of the interface functions.
2. Device-dependent messages that do not alter the state of the interface functions, but are sent to the device to make it perform a specific function. These messages are sent to the device as a string of data bytes (characters) that the Calibration Fixture accumulates and interprets as commands.

Selecting a GPIB Primary Address

The Calibration Fixture is assigned an address on the GPIB between 0 and 30, as set by internal switch SW1 on the CPU board. Switch positions 1 – 5 select the Calibration Fixture's primary address. Setting a switch to 1 (ON) sets the binary weight for that bit. Adding binary weights establishes the decimal address (secondary addressing is not implemented on this module).

Figure 3-1 shows example switch settings for a primary GPIB address of decimal 26 with an EOI-only terminator selected. Address 31 is "OFFBUS", and if the Calibration Fixture is addressed to this value it will not respond to GPIB commands (it flashes the ADDR LED).

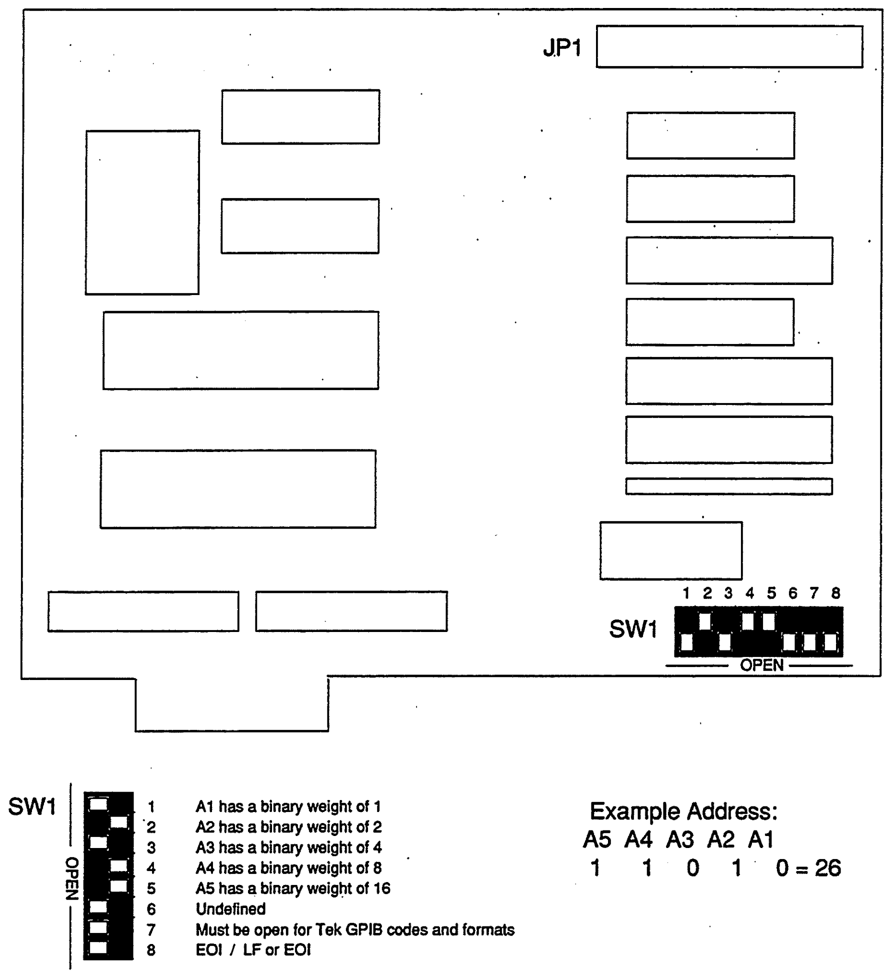

Figure 3-1. Example switch setting for GPIB address decimal 26.

SW1, position 8 is set at the factory to EOI only.

GPIB Message Codes and Formats

Command codes for controlling the Calibration Fixture are strings of ASCII characters sent over the GPIB as device-dependent messages for the SCALCF1 GPIB device addressed as a listener.

These codes conform to Tektronix standards (Codes and Formats, 1981).

Message and Command Format

Each command begins with a header - a word that describes the function to be implemented. Many commands require an argument following the header — alphanumeric characters that specify the desired state of the implemented function. Query commands have no arguments; the header for a query command contains a question mark (?) to identify the header as a query command. Command headers and arguments must contain the exact characters and minimum number of characters shown uppercase in the following command explanations.

Command Separator (Message Unit Delimiter)

A complete message contains one command or a series of commands, followed by a message terminator. Messages consisting of multiple commands must have the commands separated (delimited) by semicolons (a semicolon at the end of a complete message is optional). For example, each line immediately following is a complete message:

```
INIT
TEST;INIT;RQS ON;ID?;LPICK?
DCSET?
```

Terminating a GPIB Message

A complete message may be terminated with EOI or the ASCII linefeed character <LF>. Some controllers assert the EOI line on the GPIB concurrently with the last data byte in the message. Others use only the <LF> character as a message terminator. The Calibration Fixture can be set to accept either type of message terminator.

With EOI ONLY selected as the message terminator, the Calibration Fixture interprets a data byte received with EOI line asserted as the end of an input message. The Calibration Fixture also asserts the EOI line concurrently with the last data byte of an output message.

If LF/EOI is selected as the message terminator, the Calibration Fixture interprets the LF character without EOI asserted (or any data byte received with EOI asserted) as the end of an input message. At the end of an output message, the Calibration Fixture transmits carriage return <CR>, followed by linefeed <LF>, with EOI asserted.

NOTE

CPU board SW1 A8 controls GPIB termination. This switch is factory set for EOI ONLY.

Message Formatting

Commands must have the proper format (message syntax) to be understood. However, this format is flexible because many variations are possible. This section describes the message format and acceptable variations.

The Calibration Fixture expects all commands to be encoded in ASCII and will accept both upper and lowercase characters. All data output returned to the controller is uppercase.

A command consists of a header followed (if necessary) by an argument (or arguments). A command with arguments must have a header delimiter, which is the space character <SP> between the header and argument. If extra formatting characters are added between the header and argument they are ignored. Formatting characters are: <SP>, <CR>, <LF>.

The formatting characters <SP>, <CR>, <LF> are ignored when they are placed after a delimiter and at the begining and end of a message. All message units (commands) must be delimited with a semicolon (;) or a message terminator.

NOTE

The linefeed character <LF> cannot be used in a message unit if the LF/EOI message terminator mode is selected.

In the command list some of the headers and arguments are listed in two forms, a full-length command version and an abbreviated version. Any header or argument containing at least the characters listed in the abbreviated form is acceptable. Any characters added to the abbreviated version must be those given in the full-length version.

The Calibration Fixture accepts only positive numeric arguments in the range 0.000 to 20.000. The format of the numeric argument may be either integer, floating point, or exponential notation. The Calibration Fixture rounds the decimal part of real numbers. Any number having a decimal value of .0000 — .4999 is rounded to the nearest whole number, while decimal values .5000 — .9999 are rounded to the greater whole number (10.345 is rounded to 10.30 and 10.654 is rounded to 10.70).

After decimal rounding the argument is checked to see if it is in the legal range of supply voltage settings for the Calibration Fixture. If it is not, an out-of-range argument error is reported. See the discussion on the DCSET command for more information about argument range.

Message/Command Processing

When a message is received, it is stored in an input buffer, processed, and executed. Processing a message consists of decoding commands and their arguments, detecting delimiters, and checking the message syntax. If an error is detected during processing, the GPIB Service Request (SRQ) line is asserted, and the rest of the message ignored.

Executing a message consists of performing the actions specifed by its command(s). This involves updating the instrument settings and recording these updates in a current settings buffer. Command execution occurs when the instrument processes the message unit delimiter.

The query command is executed by retrieving the appropriate data and loading it in an output buffer; processing and execution then continues for the rest of the message. The data in the output buffer is sent to the controller when the Calibration Fixture becomes a talker. All commands are executed in the order they are received.

Multiple Messages

The input buffer has a finite capacity, and to avoid having a single message long enough to fill it, each portion of the message is processed before additional input data is accepted. During command processing, additional data is held off (NRFD line on the GPIB is asserted) until space is available in the input buffer.

After a query command in a message is executed, the response is held in the output buffer until the controller addresses the Calibration Fixture as a talker. If a new message is received before all data in the output buffer is read, the output buffer is cleared before executing the new message. This prevents the controller from getting unwanted data from old messages.

One other situation may cause the data in the output buffer to be deleted. The execution of a long message may cause the output buffer to become full. This occurs when many queries are being retained for transmission.

When the Calibration Fixture detects this condition (output buffer full), it generates an error message, asserts the SRQ line, and deletes the data in the output buffer. This tells the controller that the message was executed and the output deleted.

Status And Event/Error Reporting

The GPIB service request function (SRQ) may be used by the instrument to tell the controller that it needs service. The SRQ function also indicates that an event, status change, or error has occured. When the GPIB controller services the request, it performs a serial-poll routine. In response, the instrument returns a status byte (STB), indicating whether it needs service or not. The status byte provides limited information about the SRQ.

Because the status byte conveys limited information about an event, events are divided into classes and the status byte reports the class of event. The classes of events are:

Command Error — The instrument has received an invalid command or one that it cannot understand.

Execution Error — The instrument has received a command it cannot execute (argument out of range or settings conflict).

Internal Error — The instrument has detected a hardware or firmware problem that prevents normal operation.

System Events — events that are common to instruments in a system (Power On, User Request, etc.).

Execution Warning — Instrument is operating but the user should be aware of potential problems.

Internal Warning — The instrument has detected an internal problem, but remains operational (e.g., out of adjustment).

Device Status — Device-dependent status

The following describes how the status bytes are organized; Table 3-2 lists status examples.

DIO1–DIO4	Used with DI08 to further specify system or device status (see Table n-1).
DIO5	The busy bit 1 = SCALCF1 is processing or executing a command 0 = SCALCF1 is ready

DIO6 The error bit
1 = abnormal condition (error)
0 = normal condition (no error)

DIO7 RQS
1 = SCALCF1 is requesting service
0 = SCALCF1 is not requesting service

DIO8 The Device/System status bit
1 = DIO1 – DIO4, code corresponding to a particular device status
0 = DIO1 – DIO4, code corresponding to a particular system status

Table 3-2
Status Examples

Meaning	Bit Position 8765 4321
System Status (DIO8 = 0)	
Abnormal Conditions (DIO6 = 1)	
command error	011x 0001
execution error	011x 0010
internal error	011x 0011
execution warning	011x 0101
internal error warning	011x 0110
Normal Conditions (DIO6 = 0)	
power on (online)	010x 0001
operation complete	010x 0010
Device Status (DIO8 = 1)	
Abnormal Conditions (DIO6 = 1)	
Reported via response to event query(EVENT?), not encoded in this status byte	111x 0000
Normal Conditions (DIO6 = 0)	
Front panel switch pressed	110x 0001
Normal device-dependent status (DI06, DI07 = 0)	
No status to report	100x 0000

The instrument continues to assert the SRQ line, if more than one event or error must be reported, until all events or errors are reported. Each event or error is automatically queued via serial poll. The DCL (Device Clear) interface message may be used to clear all events except for power-on SRQ.

Commands are provided to disable all serivce requests and control the reporting of individual events. The Request For Service (RQS) command controls whether the instrument reports events by asserting the SRQ line on the GPIB. RQS OFF inhibits all SRQs except power up. With RQS OFF the controller may find out about events by performing a serial poll. The error query (ERR?) may be sent at any time and the instrument returns an error code waiting to be reported.

The controller can clear all errors with the DCL message or by sending the error query (EVE? or ERR?) until a zero (0) code is returned.

With RQS OFF the controller may perform a serial poll, but the status byte contains only device-dependent status information. But with RQS ON, the status byte contains the class of the event; a subsequent query returns more information about the previous event reported in the status byte.

The event/error query (ERR? or EVE?) may be used by the controller program to get additional information not provided by the status byte. After examining the status byte to determine whether the instrument requested service or not, the EVE? or ERR? command may be sent. In response, the instrument reports a number code that defines the error or event in more detail.

Table 3-3 lists serial poll responses (status byte) and error code numbers.

Table 3-3
Status Byte and Event/Error Codes

Description	Event/Error Query Response	Serial Poll Response
No Errors or Events	0	0
Active, No Errors To Report	0	128
Command Errors		
Command header error	101	97
Header delimiter error	102	97
Command argument error	103	97
Argument delimiter error	104	97
Nonnumeric Argument (if numeric expected)	105	97
Missing Argument	106	97
Invalid message unit delimiter	107	97
Unrecognized argument type	150	97
Argument contains too many characters	151	97
Execution Errors		
Remote Only Command, while in local mode	201	98
I/O buffers full, output dumped (deadlock)	203	98
Integer Overflow, maximum 65520	253	98
Attempt to execute TEST command with RQS OFF	257	98
Output Buffer full(too many query commands)	271	98
Input Buffer full(command too long)	272	98
Internal Errors		
RAM error	350	99
ROM error	351	99
Illegal GPIB Primary Address	352	99
Execution Warnings		
DCS command received with argument value that required rounding to nearest value	550	101
System Events		
Power on	401	65
Operation complete(TEST), all is okay	799	66
Device-Dependent Errors		
Firmware Error - illegal event occured	823	224

Number codes are shown in decimal format.

Talk Addressed With Nothing To Say

If the Calibration Fixture is addressed as talker without having received messages that specify its output, it returns an output buffer empty message (FFh with message terminator).

SCALCF1 GPIB Command List

The following is a list of the Calibration Fixture GPIB commands. Three command types define the commands based on the internal processing. These are:

1. Operational commands — cause a particular action.
2. Setting commands — control instrument settings.
3. Query or Output commands — ask for data or status.

Table 3-4 summarizes the Calibration Fixture commands.

Table 3-4
Calibration Fixture Command Summary

Command	Summary
DCOut	Switch on/off programmable 20 VDC supply
DCSet	Set programmable 20 VDC supply
DCTim	Switch on programmable 20 VDC supply for specified time
LPlck	Switch on/off 1 Vpp squarewave supply
INPutc?	Reading capacitance on input-C
HELp?	List of available command headers
ERRor?	Event/error status reporting
EVEnt?	Event/error status reporting
ID?	SCALCF1 identification
INIt	Return instrument to power-up configuration
RQS	Service request
SET	Query setup of SCALCF1
TEST	SCALCF1 power up tests

DCOut

This command and query is used to set or determine the on/off state of the programmable 20 VDC supply output.

Type:	Setting and Query
Modes:	Settings – remote only Query – local/remote
Setting Syntax:	DCO [ON | OFF]

Where ON switches the programmable 20 VDC supply output on, OFF switches it off.

Example:	DCO ON (switches 20 VDC supply output on) DCO OFF (switches 20 VDC supply output off)
Query Syntax:	DCO?
Query Response:	DCOUT ON; or DCOUT OFF;

Depending on the state of the programmable 20 VDC supply.

Example:	DCOUT ON; (20 VDC supply output is on)

DCSet

The DCS command is used to set the output voltage of the programmable 20 VDC supply. Output voltages range from 2.000V to 20.000V in 100mV increments. The format of the voltage argument may be integer, floating point, or exponential. If the voltage argument is not a multiple of 100mV, it is rounded to the nearest 100 millivolts, i.e.:

2.349 is rounded to 2.300V
2.450 is rounded to 2.400V

If a voltage argument is rounded to make it a multiple of 100mV, an execution warning event is reported. This informs the controller that the 20 VDC supply output voltage setting has changed, but may not be the exact value requested (see the execution warning error codes).

If the voltage argument is negative or greater than 20.000V, an execution error is reported (see the execution warning error codes).

Type:	Setting and Query
Modes:	Local/remote

Setting Syntax:	DCS <value>

Where <value> is a voltage expressed in integer, decimal, or exponential form.

Example:	DCS 13.200 (sets programmable 20 VDC supply to 13.2V)
Query Syntax:	DCS?
Query Response:	DCSET <value>;

where <value> is a voltage expressed in NR2 form.

Example:	DCS 8.100; (current 20 VDC supply setting is 8.1 VDC)

DCTim

The DCT command switches the 20 VDC supply output on for a time specified by <TIMEOUT> seconds. The value of TIMEOUT can be in the range 1 to 60 seconds.

Type:	Setting
Modes:	Local/remote
Setting Syntax:	DCTim <timeout>

Where <timeout> is the timeout interval in seconds.

Example:	DCT 10 (switches the 20 VDC supply output on for 10 seconds)

LPIck

The LPI command/query is used to control the Calibration Fixture's 1 Vpp supply. The Settings form of the message is used to activate or deactive supply output, while the query form is used to determine the supply output state (ie, on or off).

Type:	Settings/Query
Modes:	Local/Remote
Setting Syntax:	LPI [ON | OFF]

Where ON commands the Calibration Fixture to switch on the 1 Vpp output and OFF commands it to switch off the 1 Vpp output.

Query Syntax: LPI?

Query Response: LPICK [ON | OFF]

Where ON/OFF indicates the state of the 1 Vpp supply output.

INPutc?

The C-Meter input circuit uses the capacitance of a connected load to drive a variable oscillator (the oscillator's output frequency is directly proportional to the connected capacitance). The output frequency is counted by a digital counter. The INP? query reads the count latched in the counter.

Type: Query

Modes: Local/Remote

Query Syntax: INP?

Query Response: INPUTC NR1

HELp?

A query command that causes the Calibration Fixture to send a list of all valid command headers.

Type: Query

Modes: Local/Remote

Query Syntax: HEL?

Query Response: HELP DCOut;DCSet;DCTim;LPick;ERror;EVent; HELp;ID;INIT;RQS;SET;TEST

EVEnt? or ERRor?

A query that can be sent to the Calibration Fixture's GPIB controller to retrieve an event code. The Calibration Fixture's response to this query is EVENT <event code>. <event code> is a number corresponding to a certain condition in the Calibration Fixture that can cause an SRQ. The event code returned by the Calibration Fixture depends on whether RQS is on or off.

With RQS on, the event query returns the event code for the most recent SRQ generated. When the event code is returned to the controller, that event is considered reported and will not be reported again. An event code of zero means that there are no events to report.

With RQS off, the Calibration Fixture returns the event code corresponding to the highest priority pending status. The event code and status byte are removed from the pending status list.

This command returns error code 0 if there are no errors.

ERR? is an alternate header for the EVENT? query. ERR? and EVENT? are equivalent messages and result in the same response from the Calibration Fixture except for the different header, ERR < event code >.

Type:	Query
Modes:	Local/Remote
Query Syntax:	EVEnt? or ERRor?
Query Response:	EVENT < event code > or ERROR < event code >

ID?

ID is the query sent by the controller when it wants the Calibration Fixture to identify itself. The Calibration Fixture returns the ID command header (ID) followed by the name of the instrument (TEK/SCALCF1), Tektronix Codes & Formats version (V81.1), and firmware version (F1.00).

Type:	Query
Modes:	Local/Remote
Query	Syntax: ID?
Example:	ID?
Query Response:	ID TEK/SCALCF1,V81.1,F1.00

INIT

This command returns the Cslibration Fixture to its power-up default values. Power-up defaults are:

RQS ON;

DCSET OFF;

LPICK OFF;

Internal diagnostics are not run, the power-on SRQ is asserted, and the Calibration Fixture is not unlistened.

Type:	Operational
Modes:	Remote Only
Setting Syntax:	INit
Example:	INit

RQS

When the Calibration Fixture needs service from the system controller it generates a service request by asserting the SRQ interface line. The resulting controller interrupt causes a serial poll to determine which instrument on the bus asserted the SRQ line.

This command lets the controller disable or enable a device's ability to generate SRQs. The Calibration Fixture generates SRQs when RQS is on, and does not when RQS is off.

If RQS is changed from off to on the Calibration Fixture sends the SRQs accumulated when RQS was off. When RQS is off the controller can poll the Calibration Fixture for events that may be accumulating by using the serial poll and EVENT? queries.

RQS? is the query sent by the controller to determine the Calibration Fixture's current RQS mode — on or off.

Type:	Setting and Query
Modes:	Local/Remote
Setting Syntax:	RQS ON <or> RQS OFF
Query Syntax:	RQS?
Query Response:	RQS ON; <or> RQS OFF;

SET?

The settings query returns the current RQS setting, current 20 VDC supply setting, current 20 VDC supply on/off state, and current 1Vpp supply on/off state. The reply to the SETTINGS? query doesn't contain the SET header, but is a concatenation of the response to the RQS?, MSGDLM?, DCSET?, DCOUT? and LPICK? queries in one message.

Type:	Query
Modes:	Local/Remote
Query Syntax:	SET?
Query Response:	< current settings >
Example:	RQS OFF;DCSET 1.000;DCOUT ON;LPICK OFF;

TEST

This command causes the Calibration Fixture to run power-up diagnostics. The Calibration Fixture performs three diagnostic tests on its circuitry:

1. Runs a checksum on all EPROM locations.
2. Checks RAM functionality.
3. Checks for legal GPIB primary address.

If the three tests are error free, the "OPC" SRQ is sent to the controller when the last test completes. If one of the tests finds an error it is reported via SRQ, the internal error status byte, and an error code. This command is not run if RQS is OFF.

Type:	Output
Modes:	Remote Only
Syntax:	TEST

GPIB Controller Interface Messages

The Calibration Fixture responds to interface messages sent by the GPIB controller. These messages are listed in Table 3-5 and described in the following paragraphs.

Table 3-5
Controller Interface Messages and Codes

Message	Code
Attention	ATN
Interface Clear	IFC
Device Clear	DCL
Selected Device Clear	SDC
Go To Local	GTL
Remote Enable	REN
Local Lockout	LLO
My Listen Address	MLA
My Talk Address	MTA
Unlisten	UNL
Untalk	UNT
Group Execute Trigger	GET
End of Message	END
Serial Poll Enable	SPE
Serial Poll Disable	SPD

Attention (ATN) — Tells the Calibration Fixture that the accompanying multiline message should be interpreted as an interface message.

Interface Clear (IFC) — Resets talker and listener interface functions but does not terminate any operation.

Device Clear (DCL) — Restarts the Calibration Fixture's communications process. None of the Calibration Fixture's settings are changed but it stops running any previously received command, clears the input and output pipeline buffers and the SRQ, the status byte, and any pending status.

Selected Device Clear (SDC) — SDC is the same as DCL but is an addressed command sent to the devices on the bus that are addressed as listeners. None of the Calibration Fixture's settings are changed but it stops running any previously received command, clears the input and output pipeline buffers and the SRQ, the status byte, and any pending status.

Go To Local (GTL) — An addressed command sent to the Calibration Fixture by the controller to switch it from Remote to Local mode.

Remote Enable(REN) — A controller-to-Calibration-Fixture message indicating that the remote-enable interface signal line is being asserted. This message sent with MLA causes the Calibration Fixture to enter remote mode.

Local Lockout (LLO) — A controller-to-Calibration-Fixture message that lights the LOCK indicator. Returning the Calibration Fixture to Local mode requires that it receive the GTL command from the controller or that the remote enable line becomes unasserted.

My Listen Address (MLA) — A command sent by the controller to listen-address the Calibration Fixture.

My Talk Address (MTA) — A command sent by the controller to talk-address the Calibration Fixture. If the Calibration Fixture has data to transmit it does so after receiving this command. If the Calibration Fixture has no data to transmit, it sends the "talked-with-nothing-to-say" message (FF hex and EOI).

Unlisten (UNL) — A controller-to-Calibration-Fixture message that directs the Calibration Fixture to stop listening. Placing the Calibration Fixture in this temporary status does not cause data loss, because the Calibration Fixture again receives data when it receives the MLA command.

Untalk (UNT) — A command that causes the Calibration Fixture to stop talking. If the Calibration Fixture is talking when it receives the command, transmission is interrupted but no data is lost. When it receives the MTA command, the Calibration Fixture resumes talking where it stopped when it received the UNT command.

Group Execute Trigger (GET) — Not implemented on the Calibration Fixture.

End of Message (END) — A message sent to the Calibration Fixture that indicates the end of the message. SW1, position 8 on the GPIB controller (CPU board) selects either EOI with last data byte or ASCII linefeed character with or without EOI (see Figure 3-1).

Serial Poll Enable (SPE) — This message enables the Calibration Fixture to send serial poll status bytes when talk addressed.

Serial Poll Disable (SPD) — This message places the Calibration Fixture in normal mode, sending data bytes when talk addressed.

Section 4: Diagnostics

INTRODUCTION

This section describes the four Calibration Fixture diagnostics that run either at power up or when a TEST command is issued via the GPIB. The four tests check module hardware and are described below.

CALIBRATION FIXTURE DIAGNOSTICS

The Calibration Fixture runs the following diagnostics at power up or when a TEST command is issued via the GPIB.

Checksum — Runs a checksum calculation on all bytes in system ROM (locations 8002h – FFFFh). The calculation consists of converting an 8-bit exclusive OR (XOR) of all locations into a checksum value. The diagnostic performs the calculation by XORing the even bytes from 8002h – FFFEh and comparing them with a value previously stored in ROM at location 8000h. After XORing and comparing the even bytes, the diagnostic performs the same operation on the odd bytes from E003h – FFFFh, comparing them with a value previously stored in ROM at location 8001h.

RAM — Verifies the ability to read and write all RAM locations from 0000h – 1FFFh by reading and writing a simple checkerboard pattern of 55h followd by AAh (an alternating 10101010/01010101 pattern) in memory.

Register read/write — Determines whether the GPIB controller responds to the CPU.

GPIB primary address selection — Checks the GPIB primary address for a legal value, 0 – 30.

The Calibration Fixture no longer responds to GPIB commands once any diagnostic fails. Any error condition also causes the front-panel LEDs to flash a distinctive error code, described below.

MODULE RESPONSE TO DIAGNOSTIC FAILURES

Diagnostic failures cause the Calibration Fixture's front panel LEDs to flash a distinctive code (see below) at half-second intervals.

Diagnostic Failure	LED Failure Code (LOCK – SRQ – ADDR)
Checksum	ON – ON – ON / ALL OFF
RAM	ON – ON – OFF / ALL OFF
Register read/write	ON – OFF – ON / ALL OFF
GPIB address selection	OFF – OFF – ON / ALL OFF

Section 5: Adjustment and Functional Testing

INTRODUCTION

This section describes how to functionally test the Calibration Fixture. The section also provides step-by-step procedures for adjusting the fixture's 20 VDC supply voltage and C-Meter input circuits to published specifications.

To troubleshoot the Calibration Fixture, we suggest the following approach:

1. Run the functional test to identify adjustments that are out of specification.
2. Perform any adjustment procedures needed.

Besides returning the 20 VDC supply and the C-Meter input to specifications, these procedures can help you identify faulty circuits (those that cannot be adjusted).

RUNNING THE FUNCTIONAL TEST

The functional tests detailed in this section are designed to check the three major Calibration Fixture operating areas: the 20 VDC supply, the 1 VAC p-p supply, and the C-Meter input-conversion circuitry. The Calibration System power-up sequence checks the Calibration Fixture's CPU board and the GPIB communications.

Tools and Equipment Required

The following equipment is needed to perform the two adjustment procedures described below:

- ScopeCal Oscilloscope Calibration System with National Instruments GPIB driver and IBIC program
- Cable adapter, BNC coax to DMM; Tek part 012-1341-xx
- Cable adapter, dual banana; Tek part 103-0090-xx
- Cable adapter, BNC coax to clip leads, Tek part 013-0076-xx
- 10 pF capacitor; Tek part 283-0648-xx
- 47 pF capacitor; Tek part 283-0115-xx

Preparing the Calibration Fixture for Testing

Running the seven tests described in this section requires that you get the Calibration Fixture ready for testing. Follow these 10 steps to prepare the Calibration Fixture for functional testing.

1. Power off the ScopeCal System and remove the SCALCF1 Calibration Fixture from the mainframe power supply.
2. Remove the cover from the Calibration Fixture to expose the DIP switch (SW1) on the fixture's CPU board.
3. Record the current SW1 settings before performing step 4 (when testing is complete you may return SW1 to these settings).
4. Set SW1 for segment 1 closed and segments 2 – 7 open (this sets the Calibration Fixture to talk at GPIB address 1).
5. Reinstall the Calibration Fixture in the mainframe.
6. Use the BNC-coax-to-DMM adapter to connect the ScopeCal System's digital multimeter to the Calibration Fixture's 20 VDC output
7. Power on the ScopeCal System and exit the system software to the DOS prompt.
8. At DOS prompt, change to the C:/GPIB-PC directory and at the next DOS prompt type:

   ```
   IBIC
   ```

   and press Return. This starts the interactive GPIB communications program.
9. At the IBIC prompt, type

   ```
   IBFIND SCALCF1
   ```

   and press Return. Now type

   ```
   IBPAD 1
   ```

   and press Return. The system should return the prompt "scalcf1".

The Calibration Fixture is now ready to run the tests described in the following sections.

20 VDC Supply Relay Test

1. Set the DMM to autorange in DCV mode.
2. At the "scalcf1" prompt, type

   ```
   IBWRT "DCS 10.0;DCO ON"
   ```

   and press Return (the quotes are required). This command sets the Calibration Fixture's 20 VDC supply to 10.0 volts and switches the output relay on.

2. Check that the reading displayed on the DMM is approximately 10.0 VDC. If the DMM displays a reading of approximately 10.0 VDC, the test passes.
3. At the "scalcfl" prompt, type

   ```
   IBWRT "DCO OFF"
   ```

   and press Return (the quotes are required). This command opens the supply relsy (switches the voltage off).
4. Check that the DMM displays a reading of approximately 0.0 VDC. If it does, the test passes.
5. If you are finished with testing, restore the Calibration Fixture to operating condition. Otherwise, continue by running the test in the following section.

20V DC Supply Settings Test

If you have not done so, prepare the Calibration Fixture for this test by following the steps in the section *Preparing the Calibration Fixture for Testing*.

1. Set the DMM to autorange in DCV mode.
2. At the "scalcfl" prompt, type

   ```
   IBWRT "DCS X.XX;DCO ON"
   ```

   where X.XX is a voltage setting in the range (2.00, 2.100, 2.200 ... 20.0).
3. Press Return (the quotes are required). This command sets the DC supply to X.XX VDC and switches the supply relay on.
4. For each setting, check that the DMM reading is ±1% of the setting. The test passes if all 181 readings are within tolerance.
5. If you are finished with testing, restore the Calibration Fixture to operating condition. Otherwise, continue by running the test in the following section.

20V DC Supply Timeout Test

If you have not done so, prepare the Calibration Fixture for this test by following the steps in the section *Preparing the Calibration Fixture for Testing*.

1. Set the DMM to autorange in DCV mode.
2. At the "scalcfl" prompt, type

   ```
   IBWRT "DCS 10.0;DCT 10"
   ```

3. Press Return (the quotes are required). This command sets the DC supply to 10.0 VDC and switches the supply relay on for 10 seconds.

   The test passes if the DMM reads 10.0 VDC for about 10 seconds (until the supply relay opens) and then drops to 0.0 VDC.

4. If you are finished with testing, restore the Calibration Fixture to operating condition. Otherwise, continue by running the test in the following section.

20 VDC Supply Shorts Test

If you have not done so, prepare the Calibration Fixture for this test by following the steps in the section *Preparing the Calibration Fixture for Testing*.

1. Set the DMM to autorange in DCV mode.
2. At the "scalcfl" prompt, type

   ```
   IBWRT "DCS 10.0;DCO ON"
   ```

   and press Return (the quotes are required). This command sets the Calibration Fixture's 20 VDC supply to 10.0 volts and switches the output relay on.

3. Check that the reading displayed on the DMM is approximately 10.0 VDC.
4. Disconnect the banana plugs from the DMM and short them together (this shorts the Calibration Fixture's 20 VDC supply).
5. Reconnect the banana plugs. The DMM should now read approximately 0.0 VDC. If it does, the test passes; otherwise the test fails.
6. If you are finished with testing, restore the Calibration Fixture to operating condition. Otherwise, continue by running the test in the following section.

1 VAC Supply Relay Test

If you have not done so, prepare the Calibration Fixture for this test by following the steps in the section *Preparing the Calibration Fixture for Testing*.

1. Set the DMM to autorange in ACV mode.
2. Connect the Calibration Fixture's 1 VAC supply to the DMM.
3. At the "scalcfl" prompt, type

   ```
   IBWRT "LP1 ON"
   ```

and press Return (the quotes are required). This command switches on the 1 VAC supply.

4. Check that the DMM displays a voltage of 0.5 to 1 VAC. If it does, the step passes.
5. At the "scalcf1" prompt, type

```
IBWRT "LPI OFF"
```

   and press Return (the quotes are required). This command switches off the 1 VAC supply by opening the 1 VAC supply relay. The DMM should display a reading of approximately 0.0 VAC. If it does, the step passes; otherwise the step and the test fail.
6. If you are finished with testing, restore the Calibration Fixture to operating condition. Otherwise, continue by running the test in the following section.

1 VAC Supply Shorts Test

If you have not done so, prepare the Calibration Fixture for this test by following the steps in the section *Preparing the Calibration Fixture for Testing*.

1. Set the DMM to autorange in ACV mode.
2. Connect the Calibration Fixture's 1 VAC supply to the DMM.
3. At the "scalcf1" prompt, type

```
IBWRT "LPI ON"
```

   and press Return (the quotes are required). This command switches on the 1 VAC supply.
4. Check that the DMM displays a voltage of 0.5 to 1 VAC.
5. Disconnect the banana plugs from the DMM and short them together (this shorts the Calibration Fixture's 1 VAC supply).
6. Reconnect the banana plugs. The DMM should now read approximately 0.0 VDC. If it does, the test passes; otherwise the test fails.
7. If you are finished with testing, restore the Calibration Fixture to operating condition. Otherwise, continue by running the test in the following section.

C-Meter Input Conversion Circuit Test

If you have not done so, prepare the Calibration Fixture for this test by following the steps in the section *Preparing the Calibration Fixture for Testing*.

1. At the "scalcf1" prompt, type

    ```
    IBWRT "INPUTC?"
    ```

    and press Return (the quotes are required).
2. Now, type the followowing command:

    ```
    IBRD "100"
    ```

3. Press Return. This command reads 100 characters from the Calibration Fixture.
4. Check that the response shown is less than 10,000.

    The response should be of the form "INPUTC <count>". Since nothing is connected to the C-Meter inoput, the count should be less than 10,000. If it is, the step passes.
5. Now, use the BNC-coax-to-clipleads cable adapter to connect a 10 pF capacitor to the C-Meter input.
6. Repeat steps 1 – 3. The displayed count should be 12,000 ±500. If it is, the step passes.
7. Remove the 10 pF capacitor and connect a 47 pF capacitor to the C-Meter input.
8. Repeat steps 1 – 3. The displayed count should be 16,500 ±500. If it is, the step and the test pass.
9. If you are finished with the testing, restore the Calibration Fixture to operating condition.

Restoring the Calibration Fixture to Operation

If the tests have run successfully and the Calibration Fixture requires no further work, return it to operation by following these steps.

1. Power off the ScopeCal System and remove the cable adapters.
2. Remove the Calibration Fixture from the mainframe power supply.
3. Return the SW1 DIP switch settings to their original values.
4. Install the cover on the Calibration Fixture and reinstall the fixture in the Mainframe Power Supply.

ADJUSTING THE CALIBRATION FIXTURE

This section details the two Calibration Fixture adjustment procedures and lists the tools and equipment needed to run them.

Tools and Equipment Required

The following equipment is needed to perform the two adjustment procedures described below:

- ScopeCal Oscilloscope Calibration System
- GPIB data extender cable; Tektronix part no. <TBD>
- Power extender cable; Tektronix part no. <TBD>
- Cable adapter, BNC coax to DMM; Tektronix part no. <TBD>
- Cable adapter, BNC coax to clip leads
- 10 pF capacitor; Tektronix part no <TBD>
- 47 pF capacitor; Tektronix part no <TBD>
- Insulating pad (to isolate CPU board from module chassis when board is removed for adjustment)
- Small adjusting tool
- Phillips-head screwdriver

Preparing the Calibration Fixture for Adjustment

1. Power off the ScopeCal System and remove the SCALCF1 Calibration Fixture from the mainframe power supply.
2. Install the GPIB data extender and power extender cable adapters in the mainframe and connect them to the Calibration Fixture.
3. Remove the cover from the Calibration Fixture and remove the 3 screws retaining the CPU board.
4. Leaving the interface cable connected to the CPU board, turn the board over to expose its component side and locate R436, the 20 VDC supply adjustment.

CAUTION

Use the insulating pad to isolate the CPU board from potential contact with anything conductive. Failure to do so can damage Calibration Fixture components.

5. Using the BNC-coax-to-DMM adapter, connect the ScopeCal System's digital multimeter to the Calibration Fixture's 20 VDC output
6. Using the BNC-coax-to-clip leads adapter, Connect a 10 pF capacitor across the Calibration Fixture's C-meter input.

7. On the CPU board, record the current SW1 DIP switch settings before performing step 8.
8. Set SW1 for segment 1 closed and segments 2 – 7 open (this sets the Calibration Fixture to talk at GPIB address 1).
9. Power on the ScopeCal System and exit the system software to the DOS prompt.
10. At DOS prompt, change to the C:/GPIB-PC directory and type:

    ```
    IBIC
    ```

    Press Return.
11. At the IBIC prompt, type

    ```
    IBFIND SCALCF1
    ```

    and press Return. Now type

    ```
    IBPAD 1
    ```

    and press Return. The system should return the prompt "scalcfl".

Adjusting the 20 VDC output

1. At the "scalcfl" prompt, type

    ```
    IBWRT "DCS 10.0;DCO ON"
    ```

    and press Return (the quotes are required). This command sets the Calibration Fixture's 20 VDC supply to 10.0 volts and switches the output on.
2. Check that the reading displayed on the DMM is near 10.0 VDC.
3. Adjust R436 for a reading of 10.0 VDC ±5 mV.

    NOTE

    If you are unable to adjust it to 10.0 VDC, the 20 VDC supply is faulty.

4. At the "scalcfl" prompt, type

    ```
    QUIT
    ```

    and press Return to exit the IBIC program and return to the DOS prompt.

Adjusting the C-Meter Input Circuit

1. Using the insulating pad, turn the CPU board over to its original (installed) position to expose C381 and R392.
2. At the DOS prompt, type

   ```
   INPUTC
   ```

   and press Return to start the C-Meter test routine loop.
3. With the 10 pF capacitor connected to the C-Meter input, the count displayed on the monitor should stabilize at about 12,000. Adjust C381 and R392 for 12,000 ±30 counts.
4. With the count stable at 12,000, disconnect the 10 pF and replace it with a 47 pF capacitor. The displayed count should stabilize at 16,500 ±500.
5. Remove the 47 pF capacitor and leave the clipleads unconnected. The count should stabilize somewhere below 10,000.

NOTE

If steps 3, 4, and 5 are not successful, the C-Meter circuit is faulty.

Reassembling the Calibration Fixture

1. Power off the ScopeCal System and remove the cable extenders.
2. Position the CPU board in the Calibration Fixture and reinstall the three retaining screws.
3. Return the SW1 DIP switch settings to their original values.
4. Install the covers on the Calibration Fixture and reinstall the fixture in the Mainframe Power Supply.

The Calibration Fixture is now ready for functional testing.

Section 6: Theory of Operation

INTRODUCTION

The SCALCF1 Calibration Fixture plug-in consists of two boards: Mcroprocessor and Analog. The Microprocessor board contains circuitry for the GPIB interface. The Analog board interfaces to the microprocessor board and contains all analog functions.

The interface between the boards consists of 8 data lines, 14 decoded address lines, reset, NMI, IRQ, R/W and power.

This section describes the Microprocessor (CPU) and Analog boards. The CPU board discussion references schematic page 1, while the Analog board discussion references schematic pages 2, 3, and 4.

THE CPU BOARD

The CPU board contains a Motorola 6809 kernel (U1) clocked at 8 MHz by system clock U2. The RC network consisting of C2, C3, R1, R2, and U3 (upper left section of CPU board schematic) generates a power-on reset.

The CPU provides a 16-bit address and an 8-bit data bus. It has 3 asynchronous interrupt inputs: FIRQ, IRQ, and NMI. FIRQ is driven by the 1 ms timer; IRQ is driven by GPIB interface chip U13; NMI is driven from the analog board interface through pin 22 of JP1. The microprocessor's DMA capability is not used on this board.

Address Decoding

Address lines A12 - A15 drive U5, which performs page decoding. The page decoding functions of U5 (pins 11 - 19) are:

Pin 11	drives U6, a 3-to-8 decoder that provides discrete address enabling lines for addresses 2000H to 2007H
Pin 12	drives U7, another 3-to-8 decoder that provides discrete address enabling lines for addresses 3000H to 3007H
Pin 13	resets the 1 ms timer U4
Pin 14	supplies global write-enable
Pin 15	supplies global output-enable
Pin 16	enables GPIB address latch U12

Pin 17	enables U13, the GPIB interface
Pin 18	enables U10, an 8 kB x 8 RAM chip
Pin 19	drives U11, a 32 kB x 8 EPROM

The U5 decode map is shown below:

Pin	Function	Address
11	Decode Lines S0-S7	2000h - 2007h
12	Decode Lines S8-S15	3000h - 3007h
13	1mS Timer Reset	7000h
14	Write Enable	—
15	Output Enable	—
16	GPIB Address Sel	5000h
17	GPIB I/F Register	6000h - 6007h
18	RAM Sel	0000h - 1FFFh
19	ROM Sel	8000h - FFFFh

Data Bus Latching

The data bus, lines D0 - D7, are latched by U8 and U9. U8 provides processor read latching, while U9 provides processor write latching to global data bus DA0 - DA7.

Random-Access Memory

RAM is implemented by a 8 kB x 8 static RAM chip, U10. CPU lines A0-A12 are bused directly to the RAM chip; RAM chip data lines D0 - D7 drive onto the global data bus DA0 - DA7. Write-enable, output-enable, and chip-select are driven from decoder U5 pins 14, 15, and 18 respectively. The RAM is mapped to addresses 0000h - 1FFFh.

Read-Only Memory

ROM is provided by a 32 kB x 8 EPROM, U11. CPU lines A0 - A14 are bused directly to the EPROM. EPROM data lines D0 - D7 drive onto the global data bus DA0 - DA7. The EPROM is permanently chip selected; output enable is provided by decoder U5, pin 19. The read-only memory is mapped to addresses 8000h - FFFFh.

1 ms Timer

The 1 ms timer (U4) is clocked at 8 MHz from the microprocessor E-phase clock output, and is reset by decoder U5 pin 13 (reading or writing to address 7000h resets the timer). Timer output (U4, pin 1) drives transistor Q1, which inverts the timer output and drives the microprocessor's FIRQ interrupt.

GPIB Address Selection

SW1, an 8-bit switch, is used to set the SCALCF1's GPIB address, while resistor pack R8 supplies pull-up current. U12 latches the switch settings onto global data bus pins DA0 - DA7. Latch U12 is driven by decoder U5 pin 16, and is mapped at address 5000h.

GPIB Interface

The GPIB interface (U13) implements IEEE-488.1 slave (listener, talker, and serial poll) capabilities. The U13 clock input (pin 19) is driven from the microprocessor's E-phase clock. Chip enable is driven from decoder U5 pin 17, basing the GPIB interface's 8 internal registers at address 6000h (address lines A0 - A2 determine the internal register accessed). Write-enable is driven by U5 pin 14, the global write enable. Internal register read/write (pin 5) is driven by the CPU. U13 reset, pin 19, is driven by system reset, U3 pin 5. The U13 interrupt request output, pin 9, drives the microprocessor's IRQ interrupt.

The U13 GPIB signals, DIO0-DIO7, and control/handshake lines (REN, IFC, NDAC, NRFD, DAV, EOI, ATN, and SRQ) are buffered by ICs U15 and U14 respectively.

CPU/Analog board Interface

The CPU board's Analog board interface is connector JP1. This connector buses the global data bus, lines DA0 - DA7 and supplies CPU signals R/W, NMI, IRQ, and system reset to the Analog board. Sixteen address-enable lines are connected to JP1:

- Lines S0 - S7 represent addresses 2000h - 2007h
- Lines S8 - S15 represent addresses 3000h - 3007h

THE ANALOG BOARD

The Analog board interfaces to the microprocessor and contains all analog functions.

The Analog board may have up to 16 independently-enabled 8-bit registers.

NOTE

The IRQ line is also used by the GPIB interface. If the Analog board uses the IRQ line, the firmware IRQ handler polls to determine the interrupt source.

The interface consists of 8 data lines, 14 decoded address lines, reset, NMI, IRQ, R/W and power. The lines actually used by the analog board are the 8 data lines, 4 decode addresses, R/W, reset and power. All registers on the analog board can be read.

Sheet 3 of the schematics contains the interface connector J350. U447 is the DAC output-level register located at address 2001. The DAC provides the interface that determines the value of the 2 – 20 V output. By reading address 2001, the DAC values are returned via U450.

NOTE

The interface between the DAC and the output-level register is reversed. In other words, the msb of the data bus is the lsb of the DAC. The 2 - 20 V output is equal to the value written into address 2001 times 100 mV.

Sheet 3 of the schematics also contains register U460 at address 2000. This register can be read by reading address 2000 through U470. Only 6 bits of U460 are used, so only those 6 bits can be read. Bits 6 and 7 of address 2000 can be written to, but they are written into U360A and U360B (schematic sheet 4). The address 2000 bit functions are:

bit 0	GPIB lock indicator active low
bit 1	GPIB service request indicator active low
bit 2	GPIB address indicator active low
bit 3	not used
bit 4	not used
bit 5	not used
bit 6	2 to 20 Volt output enable active active high
bit 7	line trigger enable active high

An over-current failure on the line trigger output causes bit 7 to be held low to disable its output. When bit 7 is set high by a write instruction to address 2000 and read back as a 0, an over-current condition exists or has existed since the last time it was set on the line trigger output.

An over-current condition on the 2 - 20 V output is handled differently than in the line trigger. An over-current condition on the 2 - 20 V output causes all DAC bits to be reset to 0, reducing the output to less than 2 V. Software can determine this by reading the bits and checking that they are low.

A microprocessor reset causes the DAC bits to be set to 0 and the relay to be disabled. This reset causes the line pick-off relay to be disabled and bit 7 of port 2000 to be low.

Schematic sheet 4 shows the 2 - 20 V output and the line trigger output circuits. U440 is the DAC; op amp U430C changes its current output to a voltage output with a scaling factor of 100 mV per bit. This voltage (equal to the output voltage) is used as a reference in U430B, an integrator. Transistor Q427 is used with Q1 to form a Darlington transistor (Q1 is actually located in the backplane of the mainframe; it is shown on schematic page 4 for reference only).

The output of Q1 is returned to U430B. The 1KΩ resistor is present to load the output when the output is not connected or is connected to a high-impedance load. C428 is small enough that when an over-current condition exists the output is switched off quickly, even before relay K270 releases.

Current limiting is achieved by sensing the voltage drop across 1 Ω resistor R420. Current source U430D, Q434, and R435 lowers the voltages on the resistor to within the input range of op amp U430A. Q434 is used to increase the output current of the op amp. The current is equal to 2.5 V divided by 523 Ω (the current source error is 1 divided by the beta of the transistor). U430A is used as a comparator to drive the DAC reset line. R433 and R432 divide the output voltage of the op amp to logic levels. Current limiting on this output does not open the output relay. Instead, a microprocessor reset opens the output relay, so on power up the output is disabled.

The line trigger output is a divided version of the 17 VAC signal on the backplane. This signal is divided in R325, R324, R323, and R322. R331 is a 10 Ω resistor used to measure the output current. U330D is an op amp connected as a differential amplifier to generate a voltage proportional to the output current. Since this is an AC signal the output for over-current is sensed on the positive and negative half cycles. The over-current trip point is determined by R320 and R321.

This voltage drives U330A and, inverted, also drives U330B. U330A goes low when the positive current is exceeded and U330B goes low when the negative current is exceeded. These are diode ORed and used to reset flip flop U360A and open relay K310. D330 disables the relay when the microprocessor is in reset mode.

Schematic page 2 shows the capacitance meter. This is an op-amp multivibrator whose frequency varies with input capacitance. Two adjustments are associated with this circuit: R392 and C381. The C381 adjustment compensates for variations in the op amp's input capacitance and the R392 adjustment determines the slope of frequency vs. input capacitance. U380C converts the analog signal to a digital level. U375 divides this frequency to a lower frequency. While the output of U375 is low, counters U475 and U480 are cleared. When U375 goes high, the counters increment at a 16 MHz rate until U375 again goes low. On the falling edge (output of U375 transitions to low) the output of the counters is latched in the counter internal registers.

Counter output is read by first reading address 2004 and then reading address 2005. When 2004 is read it resets the first divide counter (U375) to ensure that the contents of the counter do not change for some time, during which address 2005 is read.

Analog board power supplies consist of U410, a 5 V regulator, U313 a –5 V regulator, and U340 a 2.5 V reference.

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.

Replaceable Mechanical Parts

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ITEM NAME

In the Parts List, an item Name is separated from the description by a colon(:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 *Name & Description*

Assembly and/or Component
Attaching parts for Assembly and/or Component
END ATTACHING PARTS

Detail Part of Assembly and/or Component
Attaching parts for Detail Part
END ATTACHING PARTS

Parts of Detail Part
Attaching parts for Parts of Detail Part
END ATTACHING PARTS

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

Abbreviations conform to American National Standards Institute YI.I

CROSS INDEX – MFR CODE NUMBER TO MANUFACTURER

Mfr Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	2800 FULLING MILL	HARRISBURG PA 17105
50434	HEWLETT-PACKARD CO	370 W TRIMBLE RD	SAN JOSE CA 95131
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR	BEAVERTON OR 97077-0001

REPLACEABLE MECHANICAL PARTS

Fig. & Index No.	Tektronix Part Number	Serial Number Effect	Serial Number Discont	Qty	12345 Part Name & Description	Mfr Code	Mfr Part Number
1 -1	671-2580-00			1	CIRCUIT BD ASSY:GPIB	80009	671-2580-00
-2	671-2530-00			1	CIRCUIT BD ASSY:MAIN	80009	671-2530-00
-3	150-1090-00			3	.LT EMITTING DIO:RED,660NM,30MA	50434	HLMP-5030
-4	131-3378-00			3	.CONN,RF JACK:BNC,:50 OHM,FEMALE,RTANG	00779	227677-1
					STANDARD ACCESSORY		
	070-8563-00			1	MANUAL,TECH:INSTRUCTION,SCALCF1	80009	070-8563-00

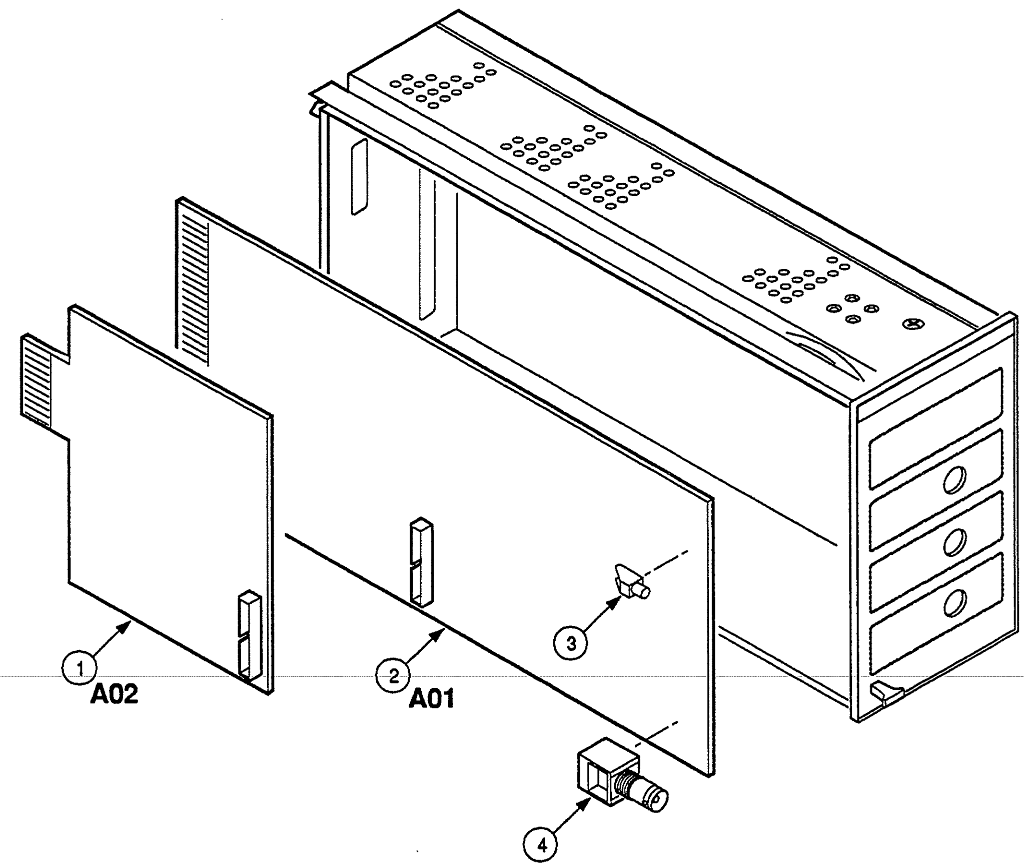

Figure 1. Exploded view.