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53A-522 DIGITAL MULTIMETER CARD

OPERATING MANUAL

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53A-522 DIGITAL MULTIMETER CARD

OPERATING MANUAL

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53A-522 DIGITAL MULTIMETER CARD

OPERATING MANUAL

DESCRIPTION

The 53A-522 Digital Multimeter Card is a printed circuit board assembly for use in a CDS 53/63 Series System. The 53A-522 Card is a 4½ digit, guarded, dual slope integrating systems multimeter that takes measurements at a maximum rate of 15 readings per second. The card provides the following measurement functions and ranges:

VDC	±0.020000, ±0.20000, ±2.0000, ±20.000, ±200.00, ±700.0.
VAC, True RMS	0.20000, 2.0000, 20.000, 200.00, 700.00.
Ohms	200.00, 2000.00, 20.000k, 200.00k, 2.0000M, 20.000M.

The 53A-522 Card is programmed by ASCII characters sent from the system controller to the 53/63 Series System. The data are returned to the system controller as decimal ASCII characters, the last character followed by carriage-return and line-feed <CR><LF>.

CONTROLS AND INDICATORS

The following controls and indicators are provided to select and display the functions of the 53A-522 Card's operating environment.

Switches

Address-Select Switch

The 53A-522 Card has a miniature 10-position switch labeled "ADDRESS" that selects the 53A-522 Card's address (0-9) in the 53/63 Series System. The switch's cover opens to allow the address to be reselected. A screwdriver with a narrow, flat blade should be used to turn the cam-action wiper to the desired address position.

Halt Switch

The Halt Switch is a 2-position slide switch that selects the state of the 53A-522 Card after an "@XH" (HALT) command or STOP is received by the 53/63 Series System.

a. In the "ON" position, the 53A-522 Card resets to its initial power-up condition, and the Power LED lights, indicating de-selection of the card, following an "@XH" (HALT) command or STOP.

b. In the "OFF" position, the 53A-522 Card Power LED lights, indicating de-selection of the card, following an "@XH" (HALT) command or STOP, but the 53A-522 Card will retain its last programmed range and function.

60Hz/50Hz Switch

The 60Hz/50Hz switch is a single rocker switch that selects the power line frequency for which the 53A-522 Card will provide maximum power line rejection.

SWITCH POSITION	FUNCTION SELECTED
C1	Maximum 60 Hz rejection
C2	Maximum 50 Hz rejection

Scanner Enable Switch

The Scanner Enable Switch is a 4-position rocker switch that selects measurement input via the 53A/63A System card cage backplane from one or more 53A-331 Scanner Cards. If measurement input is from 53A-331 Scanner Cards, then rockers 1, 2, 3, 4 must be closed. If measurement input is from the front-edge connector of the 53A-522 Card, then rockers 1, 2, 3, 4 should be open.

SWITCH POSITION	FUNCTION	53A-331 SCANNER SIGNAL
1	Input - High	High
2	Input - Low	Low
3	Guard/4-wire resistance - High	Guard
4	4-wire resistance - Low	Not used

Encode Enable Switch

The Encode Enable Switch is a 2-position rocker switch that selects the source of an external encode input. If external encode is not to be used, open both rockers.

If the encode source is from a 53A-331 Scanner Card, set Rocker 1 Open, 2 Closed.

If the encode source is a negative-going pulse applied to front-edge connector Pin 23, set Rocker 1 Closed, 2 Open.

CAUTION: The front-edge connector should be removed when using backplane scanner input or encode capability.

Fuse

The fuse protects the system from overload conditions. If the fuse has blown, the power LED will not light.

LEDs

Power LED

The Power LED provides a valuable diagnostic tool by giving the system programmer a visual indication of the action which the system is currently taking. Whenever the 53A-522 Card is addressed by the system controller, the Power LED goes out. The LED remains out until another function card is addressed. Since only one function card can be addressed at a time, an unlit Power LED indicates the function card with which the system controller is currently communicating. The Power LED being lit not only indicates that the 53A-522 Card is unaddressed, but that all required dc power (5 V dc, ±15 V dc) is being supplied.

Function LEDs (AC, DC, OHM, 4W)

One of the three function LEDs lights to indicate the type of measurement being made - i.e., AC Volts, DC Volts, Resistance. The 4W LED lights when the card has been programmed for 4-wire ohms measurement.

Range LEDs

The six Range LEDs indicate the 53A-522 Card's present selected or autoranged input range, as follows:

RANGE	VDC	VAC (RMS)	OHMS
R1	±0.020000	-------	200.00
R2	±0.20000	0.20000	2000.0
R3	±2.0000	2.0000	20.000k
R4	±20.000	20.000	200.00k
R5	±200.00	200.00	2.0000M
R6	±700.0	700.00	20.000M

Autorange LED

The Autorange LED lights whenever autoranging has been programmed.

Error LED

When the 53A-522 Card is being used to make measurements, the Error LED lights whenever an improper command is sent to the card, for example, the R (RANGE) command R8.

When the 53A-522 Card is in the calibration mode, the Error LED, along with the Calibration LED, flashes to indicate an unsuccessful calibration attempt.

Calibration LED

The Calibration LED lights when the 53A-522 Card is in the calibration mode. In addition, the Calibration LED flashes, along with the Error LED, to indicate an unintentional or unsuccessful attempt to calibrate the 53A-522 Card.

SPECIFICATIONS

DC VOLTAGE:

Range	Maximum Value	Overrange Value
20 mV	±0.019999	±0.020000
200 mV	±0.19999	±0.20000
2 V	±1.9999	±2.0000
20 V	±19.999	±20.000
200 V	±199.99	±200.00
700 V	±699.9	±700.0

Sensitivity: 1 μv on 20 mV range.

Accuracy and Temperature Coefficient: 1 year at 23°C, ±(% of reading + number of counts)

Range	Accuracy	Coefficient/°C
20.000 mV	0.04 + 14	0.003 + 2
200.00 mV	0.04 + 4	0.003 + 0.3
2.0000 V	0.03 + 3	0.003 + 0.05
20.000 V	0.04 + 6	0.003 + 0.5
200.00 V	0.04 + 3	0.003 + 0.05
700.0 V	0.04 + 3	0.003 + 0.05

Input Resistance: 10 megohms ±0.5%, 20V, 200V, 700V range.
>1 gigohm, all other DC ranges.

Normal Mode Rejection:
>73 dB @ 50/60Hz

Effective Common Mode Rejection (1k ohm unbalance): >115 dB @ DC; >125 dB @ 50/60Hz

AC VOLTAGE, TRUE RMS

Range	Maximum Value	Overrange Value
200 mV	0.19999	0.20000
2 V	1.9999	2.0000
20 V	19.999	20.000
200 V	199.99	200.00
700 V	699.9	700.0

Sensitivity: 10 μv on 200 mV range.

Accuracy*: 1 year at 23°C, ±(% of reading + number of counts)

Range	15 to 25 Hz	25 to 50 Hz	50 to 7.5 kHz	7.5 to 12 kHz	12 to 20 kHz
200.00 mV	1.25+100	0.8+100	0.6+100	1.0+100	1.5+100
2.0000 V	1.25+60	0.8+60	0.6+60	1.0+60	2.0+60
20.000 V	1.25+80	0.8+80	0.6+80	1.6+80	3.9+80
200.00 V	1.25+80	0.8+80	0.6+80	1.6+80	3.9+80
** 700.0 V	1.25+80	0.8+80	0.6+80	1.6+80	3.9+80

* with input voltage greater than 10% of full scale.
** specification in 700V range applicable for voltage less than 220V or frequency <1 kHz. (Not applicable for voltage >220V and frequency >1 kHz.

Temperature Coefficient:
±(0.008% of reading + 0.9 counts)/°C on ranges 2 and 4.
±(0.008% of reading + 0.6 counts)/°C on all other ranges.

Settling Time:
0.1 second to 99% of final value.
1.2 seconds to within 3 counts of final value.

Crest Factor:
1 to 2 for specified accuracy.
3 for additional - 0.1% error.
7 for additional - 1% error.

NOTE: Crest factor is the ratio between peak and RMS value. The range should be selected so that the peak input voltage does not exceed 1.75 times the full scale RMS value of the range selected.

Input Resistance:
1 megohm ±0.5%.

RESISTANCE:

Range	Maximum Value	Overrange Value
200 ohm	+199.99	+200.00
2k ohm	+1999.9	+2000.0
20k ohm	+19999.0	+20000.0
200k ohm	+199990.0	+200000.0
2M ohm	+1999900.0	+2000000.0
20M ohm	+19999000.0	+20000000.0

Sensitivity:
0.01 ohms on 200-ohm range.

Accuracy (1 year at 23 C):
±(0.08% of reading + 3 counts) on ranges 2, 3, and 4.
Add 0.06% of reading on ranges 1 and 5. Add 0.9% of reading on range 6.

Drift:
±(0.007% of reading + 0.05 counts)/°C on low ranges.
Add 0.007% of reading/°C on 2-megohm range.
Add 0.07% of reading/°C on 20-megohm range.

Current Through Unknown:

1mA on 200-ohm range
1mA on 2-kilohm range
100µA on 20-kilohm range
10µA on 200-kilohm range
1µA on 2-megohm range
0.1µA on 20-megohm range

Modes: Programmable, 2-wire or 4-wire ohms measurement.

GENERAL

Programmed By: ASCII Characters.

Data Returned As: ASCII Characters, base 10 decimal notation.

Type: Dual slope integrating, guarded.
4½ digit multimeter.

Functions: VDC, VAC True RMS, Resistance: 2-wire or 4-wire.

Calibration cycle: Every 12 months.

Range Selection: Programmable-autorange or specified range.

Autoranging Levels: Up-ranging for >100% FS.
Down-ranging for <9% FS.

Maximum Input: 700V maximum, DC or AC RMS.
500V if powered off on lowest three ranges.

Input Type: Floating, ±300 VDC common to ground,
±200 VDC common to guard.

Maximum Reading Rates:

12.5 readings/second, 60Hz
(Auto-Range Off) 10.4 readings/second, 50Hz

External Encode: Type Input - TTL, Low true
Loading - Two TTL loads
Minimum pulse width - 50 ns.
Maximum pulse width - 33.3 ms.

Power-Up: When power is turned on, the card goes to the following known states:
Unaddressed (Power LED - lit)
DC, Range 6, Autorange - (LEDs lit: DC, AUTO, and R6)

Power Requirements: Voltage 4.75 VDC to 5.25 VDC
Current: 0.90 A, maximum quiescent.
1.20 A, peak.

Cooling: Provided by fan in 53A-002 or 63A-012 Card Cage.

Temperature Ambient: 0°C to 50°C Operating.
-40°C to +85°C Storage.

Humidity: Less than 95% R.H. noncondensing.

Dimensions: 197mm High, 220mm Deep, 13mm Wide
(7.75" X 8.66" X 0.5")

Dimensions, Shipping: When ordered with a 53A-002 or 63A-012 Card Cage, this card will be plugged into one of the function card slots.

When ordered alone, the shipping dimensions are:
254mm X 254mm X 127mm
(10" X 10" X 5")

Weight: 0.4 kg. (0.9 lbs.)

Weight, Shipping: When ordered with a 53A-002 or 63A-012 Card Cage, this card will be plugged into one of the function card slots.

When ordered alone the shipping weight is:
0.64 kg. (1.4 lbs.).

Mounting Position: Any orientation.

Mounting Location: Plugs into any function slot of the 53A-002 or 63A-012 Card Cage.

DMM Input Connections:
A 48-pin printed circuit type hooded connector (53A-780), provides the connection for analog input signals.

Required Equipment:
(Not supplied) Either a 53A-780 Hooded Connector, a 53A-002 or a 63A-012 Card Cage with an analog backplane output interface is required to route input analog signals to the card.

Equipment Supplied: 53A-522 Digital Multimeter Card
Spare fuse (Part #42202-52003)
Operating Manual (Part #00000-15220)
Service Manual (Part #00000-25220)

OPERATION

OVERVIEW

The 53A-522 Card is programmed by ASCII characters issued from the system controller (calculator or computer) to the 53A/63A System communications card. The 53A-522 Card is connected to the communications card via the 53A-002/63A-012 Card Cage backplane. This section lists the commands recognized by the 53A-522 Card and the actions initiated.

CARD COMMANDS

To address the 53A-522 Card for the first time, the system command "@XY" must be sent. "X" is the mainframe address (0-9); "Y" is the card slot address (0-9) within that mainframe. Once the 53A-522 Card is addressed, it stays addressed until the system receives a new "@XY" command with a new "XY". Appendix A fully discusses the "@XY" command and the other system commands. After the 53A-522 Card is addressed, the commands listed below may be issued until another function card is addressed.

If input is requested by the system controller after the 53A-522 Card is addressed, the card initiates a measurement cycle (if one has not already been initiated by a T command) and returns the completed measurement to the system controller.

Example: Assume for this and the following examples that the 53A-522 Card has address 6 and is located in a mainframe which has address 0. The command @06 would address the 53A-522 Card and extinguish the Power LED. If the system controller next requested input, a 5-digit decimal number with sign and decimal point, followed by carriage-return and line-feed <CR><LF>, would be returned to the system controller. If ohms measurements are being made, the decimal number returned will vary in length from five digits to eight digits. The <CR><LF> characters must be read by the system controller for proper operation of the 53A-522. <CR> or <LF> characters are optional following card commands. To take full advantage of the T (Trigger) command, it is recommended that the <CR><LF> be suppressed.

The 53A-522 Card commands are described on the following pages.

Command	Action

FZ — The F (FUNCTION) command is used to program the 53A-522 Card Card's function, AC, DC, or OHMS (2- or 4-wire)

The "F" in the command sequence instructs the 53A-522 Card that this is a FUNCTION command.

"Z" is a decimal number 1, 2, 3, or 4 and has the following meaning:

Z	Meaning
1	DC
2	AC
3	OHMS (2-wire)
4	OHMS(4-wire)

Example: The command @06F2 would cause the 53A-522 Card to switch to the AC Volts function.

NOTE: When programming the AC function, the DMM should be programmed for a range other than Range 1 or Autorange to avoid placing the DMM in an illegal mode (AC Range 1).

RZ — The R (RANGE) command is used to program the 53A-522 Card to a fixed input range.

The "R" in the command sequence instructs the 53A-522 Card that this is a RANGE command.

"Z" is a decimal number 1 through 6 whose meaning is described under RANGE LEDs.

Example: The command @06F2R3 would cause the 53A-522 Card to switch to the AC VOLTS function and the 2.0000-Volt range.

A — The A (AUTORANGE) command is used to place the 53A-522 Card in the Auto-Range Mode. The 53A-522 Card is taken out of the Auto-Range Mode by issuing any R command.

The "A" in the command sequence instructs the 53A-522 Card to go to Auto-Range Mode.

T

The T (TRIGGER) command will initiate a measurement cycle.

The T command is optional. If input is requested by the system controller when the 53A-522 Card is addressed, a measurement cycle will automatically be initiated and the measurement returned when completed. The T command allows the user's system controller to trigger the 53A-522 Card and then perform other tasks during the time measurement conversion is taking place. A <CR> or <LF> character following the T character will "hang" the system controller until the measurement is complete. To take advantage of the T command, the <CR><LF> characters should not be sent following the T character. When the system controller later addresses the 53A-522 Card and requests input, the measurement taken by the T command will be returned.

E

The E (ERROR) command is used to interrogate the error status of the 53A-522 Card and to clear the ERR LED or flashing ERR and CAL LEDs.

The "E" in the command sequence instructs the 53A-522 Card to send back to the system controller on its next data input request a 2-digit ASCII number error code followed by carriage-return and line-feed <CR><LF>.

The procedure of the system controller issuing an "E" command followed by an input request should be repeated until an error code of 99 is returned. Error code 99 indicates that all pending errors have been returned to the system controller. See Appendix D for a list of error codes.

The ERR LED will extinguish after error code 99 is returned to the system controller. When in the calibration mode, the ERR and CAL LEDs will continue to flash until error code 99 is returned to the system controller.

IZ

The I command is used to enable the interrupt mode of the 53A-522 Card.

The "I" in the command sequence instructs the 53A-522 Card that this is an INTERRUPT ENABLE command.

"Z" is a decimal number 0 or 1, and has the following meaning:

Z	Meaning
0	Disable interrupt generation.
1	Enable interrupt generation.

If the interrupt mode is enabled, the 53A-522 Card will generate an interrupt each time a measurement is available.The interrupt is cleared when the system controller requests input from the 53A-522 Card. (See the 53A-171 Control Card

Operating Manual for a further description of the detection and handling of interrupts (see Appendix A - System Commands - S command]).

CZCL

The (C) CALIBRATE command is typically used every 12 months when the 53A-522 Card requires calibration. The calibration data is stored in the card's non-volatile memory and will not be lost when power is turned on or off.

The first "C" in the command sequence instructs the 53A-522 Card that this is a CALIBRATION command.

"Z" is a decimal number, with or without a decimal point, that specifies to the 53A-522 Card the value of the voltage or resistance that will be measured in order to perform a calibration. Examples of valid decimal numbers are 1.8746,15000000., 0, -.18.

The "CL" in the command sequence instructs the 53A-522 Card that the specified input has been physically applied to the 53A-522 Card input terminals and that the card is to begin its calibration cycle. A 2-character calibration command is used to help avoid the possibility of inadvertently issuing a C (CALIBRATION) command.

SYSTEM CONTROLLER TIMEOUT RECOMMENDATIONS

Modern system controller/IEEE-488 interface cards provide a system timeout capability to "un-hang" a system if a n instrument does not respond within some specified time. The 53A-522 is designed to hold off the system controller when making mode or range changes to guarantee that a valid measurement can be made before allowing the system controller to proceed. The AC measurement requires 1.2 seconds to accept a range change to allow settling of the TRMS value. In autorange, 4 range changes may be required in AC. It is recommended that any system controller timeout be programmed for greater than 10 seconds or for no timeout for proper operation of the 53A-522.

INSTALLATION

The 53A-522 Card is a function card; therefore, it may be plugged into any blue card slot. Setting the address-select switch defines the card's programming address. To avoid confusion, it is recommended that the slot number and the programming address be the same.

CAUTION: To avoid plugging the card in backwards, observe the following:

a. Match the keyed slot on the card to the key in the backplane connector. The component side should be to the right for a 53 Series Chassis and to the top for a 63 Series Chassis.

b. There are two ejectors on the card. Make sure the ejector marked "53A-522" is at the top for a 53 Series Chassis and to the left for a 63 Series Chassis.

CAUTION: The 53A-522 Card is a piece of electronic equipment and therefore has some susceptibility to electrostatic damage (ESD). ESD precautions must be taken whenever the module is handled.

CALIBRATION

It is recommended that the 53A-522 Card be calibrated every 12 months in order for the card to meet its published accuracy specifications. Calibration should be carried out in an environment where the temperature is between 21°C and 25°C.

The calibration of the 53A-522 Card is somewhat different from that of most multimeters in that no manual adjustments are made by the operator during calibration. Instead, during calibration the microprocessor on the 53A-522 Card updates a non-volatile memory which contains error terms for the difference between a voltage input to the 53A-522 Card and the actual voltage measured by the card. These "Error Terms" are later used by the microprocessor to correct measurement values taken by the 53A-522 Card integrating A/D before the measurements are returned to the user.

TEST EQUIPMENT REQUIRED

A precision voltage source capable of putting out the following voltages to within an accuracy of 1 count of specified voltage is required.

1. A known positive DC voltage between 45% and 100% of full scale for each DC- voltage range to be calibrated.

2. A known negative DC voltage between 45% and 100% of full scale for each DC- voltage range to be calibrated.

3. A known True RMS voltage between 45% and 100% of full scale for each AC- voltage range to be calibrated. A positive DC voltage or an AC voltage from 60 Hz to 1600 Hz may be used.

A known resistance whose value is between 45% and 100% of full scale is required for each resistance range to be calibrated. The value of the resistance must be known to an accuracy of 1 count of specified resistance.

CALIBRATION PROCEDURE

When calibrating the 53A-522 Card the following precautions must be observed:

1. DC calibration for a given range must be performed before AC calibration.

2. The null calibration (0 volts or resistance input) must be performed before the gain calibration on any range is performed.

3. If a DC voltage is used to calibrate the AC ranges, a positive value DC voltage must be used.

4. The known calibration voltage or resistance must be applied to the DMM input terminals for a period of 1 second prior to sending the C (CALIBRATION) command to the 53A-522 Card. This precaution is taken to insure that settling time errors caused

by stray capacitance in the cabling between the DMM and calibration source will not effect the calibration.

5. The ERR and CAL LEDs must both be extinguished before a C (CALIBRATION) command is sent to the 53A-522 Card. (See E (ERROR) command).

6. Resistance calibration must be done in the 4-wire mode.

To calibrate a given function and range proceed as follows:

1. Program the function and range to be calibrated, i.e., "F1R3" for DC volts, Range 3.

2. Place a short across the required input pin number.

Calibration	Input Pin Number
DC	15, 16
AC	15, 16
Resistance	13, 14; 15, 16

3. Issue the C (CALIBRATION) command, i.e., "C0.0CL".

4. Check to see that the ERR and CAL LEDs are not flashing. If the ERR and CAL LEDs are flashing, use the E (ERROR) command to determine the reason for the unsuccessful calibration.

5. Input the known calibration voltage or resistance.

6. Issue the C (CALIBRATION) command. If DC voltage, Range 3 were being calibrated, using a calibration voltage of +1.5000, the correct C (CALIBRATION) command would be "C1.5000CL".

7. Check to see that the ERR and CAL LEDs are out. If they are flashing, proceed as in Step 4.

8. If a DC voltage range is being calibrated, repeat steps 5 through 7 and calibrate using a negative input voltage.

CAUTION: The adjustable capacitor calibration provided on the 53A-522 is a one time calibration performed at the factory. It does not require recalibration during the lifetime of the product, and should never require adjustment. If the capacitor has been adjusted by mistake, the 53A-522 may not meet its published frequency response specifications in AC range 4. If this occurs, consult the factory.

APPENDIX A

SYSTEM COMMANDS

Command	Description
@XY	The "@XY" command addresses a function card in the 53A/63A System. The "@" is a delimiter used by the 53A/63A System. The "X" is a mainframe address (0-9); the "Y" is a function card slot address (0-9) in that mainframe. Once a mainframe and function card combination is addressed, it remains addressed until the 53A/63A System detects a new "@" character.
@XH	The "@XH" (HALT) command halts all function cards within the mainframe defined by "X". The command does not affect function cards in other mainframes. How a function card reacts to the "@XH" command depends on the card. In all cases, an addressed function card (power LED out) becomes unaddressed (power LED lit).
STOP	The STOP command is not a string of ASCII characters. The command is hard-wired from the system controller (calculator or computer) to the 53A/63A System communications card in each mainframe. When the system controller issues a STOP command, each function card, including the 53A-522 Card, reacts as if it received the "@XH" command described above. How the system controller executes the STOP command depends on the communications card used. With the 53A-127 IEEE-488 Card, for example, a STOP command is executed when the system controller asserts the IEEE-488 bus line IFC (Interface Clear) true.

APPENDIX B

FRONT-EDGE CONNECTOR PIN ASSIGNMENTS

Pin Number	Signal
1,A	+5V DC
13	4-wire resistance (+)
14	4-wire resistance (-)
15	Input-High
16	Input-Low
20	Guard
23	External Encode (active low)
24,BB	53A/63A System Ground

INPUT SIGNAL CONNECTIONS

DC or AC Voltage Measurements - connect the signal to be measured between Pins 15 and 16.

2-Wire Ohms Measurements - connect the resistance to be measured between Pins 15 and 16.

4-Wire Ohms Measurements - connect the resistance to be measured between Pins 13 and 14. Connect Pin 15 to Pin 13 and Pin 16 to Pin 14 at the point the unknown resistance is to be measured. Connecting Pins 15 and 16 directly to the unknown resistance eliminates errors due to lead resistance, which can become significant for low value ohms measurements.

APPENDIX C

53A-522 LED ASSIGNMENTS

DC	Lit when function is DC volts.
AC	Lit when function is AC volts.
OHM	Lit when function is resistance.
4W	Lit when card is expecting a 4-wire ohms measurement.
AUTO	Lit when autoranging programmed.
R1 R2 R3 R4 R5 R6	See Section entitled RANGE LEDs.
ERR	Lit when card has been programmed with an improper command. Flashing when a calibration error has occurred.
CAL	Lit when the card is performing a calibration. Flashing when a calibration error has occurred.

APPENDIX D

ERROR CODES

CALIBRATION ERROR CODES

10 Input request occurred while processing calibration command.

11 C (CALIBRATION) command value not followed by trailing "C" character.

12 C (CALIBRATION) command value not formatted properly.

13 Calibration attempted in autorange.

14 C (CALIBRATION) command value not terminated by "L" character.

15 Calibration input value not between 315.0 and 699.9 volts for DC or AC voltage range 6.

17 C (CALIBRATION) command value is not consistent with programmed range.

18 C (CALIBRATION) command value is not within the required calibration values (.009 to .019999, .09 to .19999, etc.) for the range specified.

19 Calibration input level not reasonably close to input level specified in C command.

COMMAND ERROR CODES

51 Unexpected ASCII input character prior to completion of previous command agreement. (New command is processed and previous command ignored for this error condition).

53 Unexpected character as F command argument. F command not processed.

54 Unexpected character as R command argument. R command not processed.

55 Unexpected character as I command argument. I command ignored.

66 Input request prior to completion of previous command argument. (Input request is processed and previous command ignored).

APPENDIX E - APPLICATION NOTE I:

Using the 53A-522 Card with the 53A Scanner Card Family

INTRODUCTION

This example assumes that the analog signals to be measured and the 53A-522 Card Encode signals are routed from the 53A-331 Scanner Card to the 53A-522 Card via the 53A-002 or 63A-012 Card Cage backplane.

SWITCH SETTINGS

53A-331 Scanner Card:	Address Select Switch: Position 0.
53A-522 Card:	Address Select Switch: Position 9.
	Encode Source Switch: Rocker 1, open, rocker 2, closed.
	Scanner Enable Switch: Rockers 1, 2, and 3 closed.

EXAMPLE PROGRAM

The example program shown below, written in BASIC, reads the input voltage on channel one of the 53A-331 Scanner and prints the results on the local terminal.

10 PRINT "@09F1R4"	Selects the 53A-522 Card whose address is 9, located in Card Cage with ADDRESS 0, and programs DC volts Range 4 (20.000V).
20 PRINT "@001"	Closes channel 1 of the Scanner Card whose address is 0, located in card cage with ADDRESS 0. Before closing channel 1, the Scanner will automatically open any previously closed channels. After channel 1 is closed and the contact bounce has settled, the scanner will automatically issue an encode pulse to the 53A-522 Card.
30 PRINT "@09"	Address 53A-522 Card.
40 INPUT X	Reads the result of the measurement and assigns its value to the variable X.
50 PRINT X	Prints the value of the voltage on the local terminal.

INCREASING MEASUREMENT ACCURACY

The 53A-331 Scanners are specified with differential thermal offset voltage of <15 μv. This offset can be automatically calibrated out by placing a short across one scanner channel input, and then issuing a "C0CL" C (CALIBRATION) command to the 53A-522 Card. Having done so, the only differential thermal offset that will affect the accuracy of measurements is the variance in differential thermal offset from one scanner channel to the next. This variance will be less than 5 μv.

AC MEASUREMENTS WITH THE 53A-331 SCANNER CARD

AC measurements have a 1.2-second settling time to within 3 counts of final value. As a result, use of the scanner encode line to trigger a reading will cause the reading to be taken before the measurement has settled. When using the scanner for AC measurements, it is recommended that the Encode Source Switch, Rocker 2 be left OPEN and that the system controller wait for a period of 1.2 second between selection of the scanner channel and triggering the 53A-522 Card with a T (TRIGGER) command or an input request.

USE OF THE 53A-522 WITH OTHER SCANNER CARDS

Since the initial introduction of the 53A-522, Colorado Data Systems has introduced several additional scanner cards. To integrate these cards into the same system with the 53A-522, observe the following precautions.

The 53A-333 3-Wire Scanner Card may be used in the same manner as described above for the 53A-331 Card.

The 53A-332 2-Wire Scanner Card may be used as described above, except that Rocker 3 of the Scanner Enable Switch should be left open. The third wire connector (the Guard connection) results in less than 2 microvolts error on the 53A-522. Guarding on a card instrument is not as significant a requirement as in a stand-alone DMM where power supply magnetics are an integral part of the DMM instrument.

The 53A-336 High Voltage 2-Wire Scanner Card should be used in applications requiring voltage inputs requiring 20 VRMS or 50 VDC or greater. When using a 53A-336 for high voltage measurements, all scanner connections should be made through the front connector of the 53A-522 and all other scanner cards in the system. All Scanner Enable Switches on the 53A-522 and any scanner card in the system should be set for no connection to the 53/63 backplane scanner signals. Due to normal backplane capacitance, high voltage transients on the backplane may affect other 53/63 system operations.

The 53A-334 1-Wire Scanner Card may be used in applications where all signals are referenced to the same ground and the additional accuracy, noise immunity, and common mode rejection provided by the 53A-522 differential floating input is not required. Scanner Enable Switches 1 and 2 should be closed on the 53A-522 when used with the 53A-334. Rocker Switch 2 connects the 53A-522 low input to the common reference which the 53A-334 is designed to supply.

The 53A-310/311 FET Scanner System may be used with the 53A-522 DMM. Scanner Enable Switches 1 and 2 should be closed and the External Encode Switch closed. Since the 53A-310/311 provides an encode signal indicating measurement active rather than an encode pulse, the 53A-522 must be programmed to interrupt at measurement completion (see I command) to provide synchronization with the 53A-310. The system controller must be able to process the interrupt during the autozero phase of the following 53A-522 measurement (within 16.6 milliseconds) to guarantee that the next FET channel is selected and settled before the 53A-522 samples the next measurement. If the system controller cannot provide this performance, the FET scanner must be switched one channel at a time, followed by a 53A-522 input request. The Enable switch should be left open for this type of operation.

4-Wire Resistance Measurements with the 53A-331 4-Wire Scanner

To provide the 53A-522 with the capability of handling both voltage measurements and 4 wire resistance measurements through the scanner backplane with the same 53A-331 Scanner Card, a design modification was made to the 53A-522, starting with Revision Level -07-A. Prior to Revision Level -07-A either voltage measurements or 4 wire measurements could be made with the 53A-331, but not both within the same chassis. This design modification makes 4 wire scanner measurement systems designed with earlier revision level 53A-522s incompatible with later revision level 53A-522s. If this presents a problem in your application, please contact the factory.

APPENDIX F - APPLICATION NOTE II:

Using the 53A-522 Card with External Encode

An external encode line is provided at the 53A-522 Card front-edge connector to allow triggering of a measurement cycle based on an external event.

The external encode is treated the same as a T (TRIGGER) command to the 53A-522 Card. It initiates a measurement cycle. The measurement will be returned to the system controller when input is requested. If input is requested prior to completion of the measurement cycle, input will be returned when the measurement cycle is complete. To protect against accidental mode or range change commands being issued to the 53A-522 Card during a measurement cycle, any command to the 53A-522 Card besides an input request will terminate the measurement cycle. If no interim commands are issued, however, and input is requested, even at some later time, the 53A-522 Card will return the measurement caused by the last received External or T command encode.

Multiple encodes or a continuous low at the encode input will result in the successive new measurements being initiated, but only the last measurement initiated prior to an input request will be returned to the system controller. (The 53A-310/311 FET Scanner System supplies a continuous low during channel connection. To synchronize the FET Scanner System with the 53A-522, see Application Note I.)

The external encode, like the T command, may be used in conjunction with the I (INTERRUPT) command. The 53A-522 Card interrupt capability is first initiated using the I command. To determine when an external trigger has occurred and a valid measurement is available for the system controller, the system controller periodically polls the 53A-171 Control Card to determine if the 53A-522 Card has interrupted. When the 53A-522 Card interrupts, a valid measurement caused by the external encode is available.

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[redacted]

JUL 16 1990

FROM: Carl Glasow
Q.A. Manager
Colorado Data Systems, Inc.

DATE: 7/10/90

SUBJECT: Field Modification Notice for 53A-522 Digital Multimeter

Colorado Data Systems, Inc. (CDS) has identified a potential problem solved by a modification to the 53A-522 Digital Multimeter.

The 53A-522 card may have inaccuracies greater than the published specifications when used in the four wire ohms mode. Not all applications utilizing four wire ohms will be adversely affected. If your application utilizes the four wire ohms measurement mode with cable lengths or signal routings in excess of 10 feet, you should consider having this modification performed. Please contact CDS application engineering for assistance in determining applicability of this upgrade.

CDS will perform this modification at no charge to all 53A-522 cards with revision levels 8707-06-A or later. 53A-522 cards manufactured prior to 12-31-86 may be upgraded for a nominal charge. The amount of charge is dependent upon the age and condition of the 53A-522.

Our records show that you have purchased 53A-522 cards on the following dates at the following revision levels:

SHIP DATE	PO#	QTY	REVISION LEVEL
12590	1822	1	8903-08-A

[redacted]incerely,

Carl Glasow

Carl Glasow

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