S310/S320

MODULAR POWER SUBSYSTEM

USER'S MANUAL

NHR

Part No. 09-0243

REVISION H

December 16, 2005

Document History

Rev A	**ECO 14813**	**10/29/1998**	**B. H.**
Rev B	**ECO 14968**	**01/19/2000**	**T. F.**
Rev C	**ECO 15169**	**01/04/2001**	**S. H.**
Rev D	**ECO 15185**	**01/30/2001**	**J. A.**
Rev E	**ECO 15405**	**08/19/2001**	**J. A.**
Rev F	**ECO 15511**	**05/20/2002**	**T. F.**
Rev G	**ECO 15572**	**11/21/2002**	**J. W.**
Rev H	**ECO 16010**	**12/16/2005**	**H. D.**

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1. GENERAL INFORMATION

1.1 Overview

The S300 modular design offers a level of flexibility normally associated with custom design instruments. It has the revolutionary ability to control DC power supplies along with DC Dynamic loads within the same 5 ¼ chassis. The S300 is ideally suited to support the diversified requirements of ATE systems.

The S300 DC Modules easily install into one of the six available motherboard slots located in the S300 Power Subsystem Chassis. A maximum of 2,400 Watts can be delivered per chassis.

The S300 DC Modules are a "Constant Power" design, meaning that the module can deliver current up to 400w at any point within its operating envelope down to approximately 30% of full scale voltage. Constant power operation automatically extends the number of output voltage and current combinations available within the maximum power rating of the module.

The 4100 Series Modular Dynamic Load Modules also use a "Constant Power" design. These loads use a state-of-the-art thermal management system to achieve a power density of 300W per slot, for a maximum of 1800W per 5¼ inch S300 chassis. A unique multirange design is used to cover test requirements from 1.5V to 450V, and current from milliamps to 60A, in five different output ranges. The power handling capability can be expanded through paralleling additional modules.

The S300 System consists of a main chassis, which contains six usable slots, a microprocessor based CPU and front panel keyboard display. Up to six single DC Source or Dynamic Load Modules may be installed into the chassis. For larger power requirements, up to 64 channels can be controlled from the main 68000 based CPU. Slave chassis are required providing for a maximum of 25,600W total continuous DC power output, or 19,200W of Load power dissipation.

IEEE-488.2 - Native language complies with SCPI Version 1994.0.

MANUAL CONTROL - The instrument can be configured with front panel Keyboard/display. The majority of all functions that can be performed over the IEEE-488 bus can be performed manually using the keyboard/display.

1.1.1 Topology

The S300 DC Modules employ switching technology for high operational efficiency and power density. The filtering used achieves low noise performance comparable to linear converters.

The 4100 Series Loads employ a linear power design for fastest response time and quiet operation. Constant current, constant power, constant resistance, and constant voltage operating modes are provided, along with a true hardware SCR and relay crowbar-type short circuit mode. An advanced Texas Instruments DSP processor is used to tightly synchronize paralleled modules, as well as provide programmable output waveforms with unprecedented accuracy compared with older, more limited analog designs.

1.2 S300 System Specifications

1.2.1 Discrete Fault Indicator

Each system includes a single rear panel DFI connector in compliance with MATE guidelines. This generates a contact closure when an error occurs. This may be used in system to control hardware in the event of an error condition.

1.2.2 Remote Interlock

Each system includes a single rear panel connector for remote TTL output inhibit.

The DFI may be strapped to the interlock line to inhibit output when a fault occurs.

1.2.3 IEEE-488 Connection

A rear panel mounted IEEE-488 connector is provided to support IEEE488-2 remote control.

1.2.4 Input Power

The instrument can be ordered from the factory for either single phase 115 VAC, single phase 230 VAC or three phase 208 VL-L input power operation.

Single Phase Power 115 VAC	
Input Voltage Range	103 to 126 VAC
Frequency	47 to 440 Hz
Input Current	30 Amps Max
Maximum Output Power	1,200 Watts per Chassis
Single Phase Power 230 VAC	
Input Voltage Range	208 to 264 VAC
Frequency	47 to 440 Hz
Input Current	30 Amps Max
Maximum Output Power	2,400 Watts per Chassis
Three Phase Power 208 VAC L-L	
Input Voltage Range	187 to 228 VAC
Frequency	47 to 440 Hz
Input Current	20 Amps per Phase Max
Maximum Output Power	2,400 Watts per Chassis

1.2.5 Input Voltage Ranges - Extended (optional)

The instrument can be operated from the foreign power levels with the following deratings:

INPUT LEVEL	MAX OUTPUT POWER
Single Phase 90 VAC to 105 VAC:	1000W
Single Phase 180 VAC to 208 VAC:	2000W

1.2.6 Soft Start

Instrument includes soft start circuitry to limit turn-on surge current.

1.2.7 Physical

Size:	5 ¼ (h) x 19"(w) x 22"(d)
Weight:	Master Chassis: <26 lb. Modules: <6 lb.

Chassis slides: The instrument accommodates CHASSIS TRAK P/N CTHRS-1-18 slides.

1.2.8 Airflow

The cooling fans are located in the front of the S300 chassis. Air is drawn in from ventilation holes located in the front section of the top, side and bottom panels. The air exits through the rear panel.

1.2.9 Module Removal

The modules are easily removed/replaced by first uncovering the top cover and then extracting from the instrument.

1.2.10 Front Panel Controls

The front panel controls consist of a graphical LCD display with accompanying softkeys, cursor keys, a keypad for numerical input, and an adjust knob to quickly change those numeric values. This allows for a fully menu driven operation and configuration. Up to six modules may be monitored simultaneously on the display. All programmable functions can be accomplished via the front panel keyboard/display.

1.2.11 Rear Panel Connections

All I/O functions are accomplished using rear panel mounted connectors.

1.3 Firmware Capability

The S300 firmware contains an extensive command set for control of the instrument over the IEEE-488 bus interface and via an optional front panel interface. These commands include instrument settings as a stimulus, and readback instrumentation capability. Additionally, commands are available for diagnostics, software calibration and configuration/identification readings. Examples of configuration/identification functions are reading instrument model number, serial number and firmware version as well as define and/or review logical/physical settings. Refer to Section 4 for a description of front panel operation. Refer to sections 5, 6, and 7 for a description of SCPI commands.

1.3.1 Self-test and Built-In-Test

The instrument contains advanced on-command and continuous Built-in-test. Two levels of self diagnostics are supported:

CONTINUOUS BIT

The instruments firmware continuously monitors numerous fault flags. Should any failure or out-of-tolerance condition result the instrument will automatically alert the host computer and turn off the output, thus providing protection to the UUT. If the optional isolation relay is installed the output will be switched to a high impedance state. The fault flags are:

Fault	Load	DC Source
Over current	No	Yes
Over voltage	Yes	Yes
Under Voltage	No	Yes
Over temperature	Yes	Yes

SELF-TEST (OPTIONAL)

The self-test assures early detection of hardware problems and minimum time to repair when a failure does occur. A main status word (1 byte) summarizes the hardware status and firmware error detection flags. A discrete fault line is also provided. Should more detailed information be required, status registers provide complete status information on the performance and state of the hardware. These status words are available via the IEEE-488 bus. All output voltages shall be isolated from the output terminals via the isolation relay option during testing. If this option is not installed the set voltage and overvoltage tests are not performed. The test runs in less than 3 minutes and identifies over 90% of all possible faults.

1.3.2 Closed Cover Calibration

Software calibration is provided for the DC Source modules. The DC Source may be fully calibrated through the IEEE-488 interface bus - no internal adjustments are required.

Load calibration requires a Load Calibrator due to the high accuracy tolerance of the load.

Calibration parameters are stored on EEPROM, which resides on each module. Thus, replacing failed modules does not require recalibration of the instrument.

1.3.3 Discrete Fault Indicator

Each system includes a single rear panel DFI connector in compliance with MATE guidelines.

1.3.4 IEEE-488 Interface

The S300 has a 255 byte wrap around IEEE-488 input buffer. This allows the controlling device to transmit multiple commands to the S300 before the operation of the first command is complete. The exception to this is query commands. The S300 has a one message output buffer. If a second query is executed before the controller retrieves the message from the first query, the data from the first query is lost.

1.3.5 Background Measurement

The S300 load modules with firmware revisions of 1.04 or greater have the capability measure a voltage, current, or temperature signal continuously in background. When put in this mode with the "CONF:BACK" command (see section 7.4) the load module will continuously measure and store the latest value of the selected signal. The commander of the S300 can retrieve the latest measurement by issuing the "FETC:BACK?" query command (see section 7.5). The measurement cycle time of the A/D has not been reduced, but some of the overhead associated with initiating the measurement has been removed.

To measure transients the MEAS command should be used. The MEAS command will stop the background measurement and initiate the measurement on the selected signal {e.g. voltage if the command is MEAS:VOLT?.} A new A/D measurement cycle will start after the command measurement is complete.

1.4 Design and Construction

The instrument is designed and built to MIL-STD-28800C Type III hardware requirements for commercial off-the-shelf hardware as well as MIL-STD-45208 quality assurance standards.

1.4.1 Reliability

The fully loaded instrument with six 400W modules installed has a total system MTBF of 15,000 hours as a minimum.

1.4.2 Vibration and Environmental

The S300 meets the following requirements:

Temperature:

Temp (op):	-10 to 50 deg C (Max inlet air temperature)
Temp (non-op):	-40 to 85 deg C

Humidity:

95% @ 50 deg C, (Non condensing environments only)

Altitude:

Altitude (op):	6,000 ft
Altitude (non-op):	40,000 ft

Vibration:

3 g's in three planes for 15 minutes as follows:

Freq:	10-2000 Hz
Excursion:	0.015 inches

Shock:

15g's on three axis for 11mSec duration using half sinewave shock waveforms.

EMI/RFI:

The instrument is compliant with MIL-STD-461C.

1.5 Deliverable Documentation

NH Research delivers a manual with each instrument:

The User's Manual includes all documentation and procedures to install and interface the instrument. Included are initial inspection procedures, power and grounding requirements, safety and hazard warnings, environmental information, operating instructions and remote IEEE-488 software specifications.

1.6 Quality Provisions

NH Research designs and manufactures its instrumentation products to normal commercial practices and conforms to MIL-I-45208A quality assurance standards and MIL-STD-28800C performance requirements. Each instrument undergoes 100 hours of elevated temperature burn-in testing (50 deg C) prior to final acceptance testing and delivery. Written verification and performance data are delivered with each unit.

1.7 Applicable Specifications

The instrument complies with the following specifications:

MIL-STD-28800D Type III, Class 3
MATE Spec 2806763C
UL Compliant
IEC 435 Safety and Isolation
MIL-STD-461C EMI Part 7 (for commercial test equip.)

MIL-STD-45208 Quality Standards
VDE Compliant
CSA Compliant
IEC 380 Safety Requirements

1.8 Optional Features

The following feature is offered as options on the S300 chassis:

Chassis Slides
400 Hz Operation

The following features are offered as options for a DC module:

Reverse Polarity Relay
Fast Turn On
SCR crowbar Circuit
Isolation Relay (standard on 60v, 80v and 400v)

All load features are included as standard equipment. There are no hardware options.

2. CONTROL CABLING HOOKUP

2.1 Initial Inspection

The instrument is delivered as follows:

One or more boxes, each containing an S300 chassis.
One box containing miscellaneous accessories and cables.

The miscellaneous accessories and cables include:

Power cord for each S300 chassis.
Auxiliary chassis cables (as required)
Mating connector set
The S300 Power Analyzer User’s Manual

This instrument was carefully tested and inspected for mechanical and electrical defects prior to shipment. The instrument should be inspected for any visible damage that may have occurred in transit. If the shipping container is damaged, report any damage immediately to the carrier and our factory.

2.2 Operating Environment

*******WARNING*******

**TO PREVENT POTENTIAL ELECTRICAL OR FIRE HAZARD,
DO NOT EXPOSE EQUIPMENT TO RAIN OR MOISTURE**.

**TO MINIMIZE SHOCK HAZARD, THE INSTRUMENT AND CABINET
MUST BE CONNECTED TO AN ELECTRICAL GROUND.**

In order for the S300 to meet its specifications, the operating environment must be within the following limits:

Temperature	0 to +50 Degrees C
Relative Humidity	< 95% at 50 Degrees C (non-condensing)

2.2.1 Cooling System

The cooling fans are located in the front of the S300 chassis. Air is drawn in from ventilation holes located in the front section of the top, side and bottom panels. The air exits through the rear panel. When operating the instrument, provide at least 75mm (3 inches) of clearance at the rear of the instrument. Failure to allow adequate air circulation will result in excessive internal temperature, reducing the instrument's safe operating range.

2.2.2 Power Requirements

The S300 chassis power connection requires one of the following:

Single phase 115VAC (L-N) +/- 10%, 20A (6 modules, FL) Chassis DC sources limited to 1200W
Single phase 230VAC (L-N) +/- 10%, 20A (6 modules, FL)
Three phase 208VAC (L-L) +/- 10%, 10A/ph. (6 modules, FL)

The instrument is marked by the factory at the POWER INPUT connector on the rear panel. The marking indicates either a 115VAC or 208/230VAC input level. If 115VAC is indicated, than the single phase cable provided is used. If 208/230VAC is indicated, than single phase 230VAC versus 208VAC 3 ph is determined by the cabling being used.

*******WARNING*******

DO NOT CONNECT 230/208VAC SINGLE OR THREE PHASE TO THE S300

IF 115VAC IS INDICATED AT THE POWER INPUT CONNECTOR.

The POWER INPUT setting is selectable by a jumper inside the unit as described in section 2.3.1.

2.2.3 Rack Mounting

The S300 chassis can be rack mounted. Maintenance access and removal is enhanced by adding the optional rack mounting slide rails.

2.3 Cabling Hookup

******* WARNING *******

LOSS OF LIFE OR SERIOUS INJURY COULD

RESULT FROM UNSAFE OPERATION OF THIS POWER SYSTEM

Remove the instruments from the shipping crates and install the unit in the cabinet. Do the installation as follows:

Before an S300 may be powered on the chassis cabling setup must be made.

2.3.1 AC Power Connections

*******WARNING*******

TO PREVENT POTENTIAL ELECTRICAL OR FIRE HAZARD,

DO NOT EXPOSE EQUIPMENT TO RAIN OR MOISTURE.

*******WARNING*******
LOSS OF LIFE OR SERIOUS INJURY COULD
RESULT FROM UNSAFE OPERATION OF THIS UNIT.

TO MINIMIZE SHOCK HAZARD, THE INSTRUMENT AND CABINET
MUST BE CONNECTED TO EARTH GROUND.

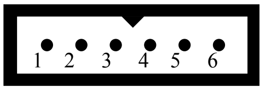
*******WARNING*******

THE GROUND PIN ON THE POWER CORD MUST BE CONNECTED TO EARTH GROUND DURING OPERATION OF THIS UNIT OR ELSE YOUR LIFE IS IN DANGER FROM SHOCK OR ELECTRICAL FIRE.

The S300 chassis comes pre-configured to operate from either:

a) 115VAC 1-ph
b) 230VAC 1-ph or 208VAC 3-ph

Power is connected to the S300 chassis using the power cord supplied with the unit. The cord mates to the blue 6 pin male connector located at the bottom of the S300 rear panel and labeled "INPUT POWER."



115VAC LINE*	230VAC LINE*	208VAC 3 PHASE*
1. HOT 120VAC	1. HOT 220VAC	1. A PHASE
2. NO CONNECTION	2. NO CONNECTION	2. C PHASE
3. NEUTRAL 120V	3. LOW 220VAC	3. B PHASE
4. NO CONNECTION	4. NO CONNECTION	4. NO CONNECTION
5. CHASSIS GROUND	5. CHASSIS GROUND	5. CHASSIS GROUND
6. CHASSIS GROUND	6. CHASSIS GROUND	6. CHASSIS GROUND

This configuration may be determined by looking at the factory setting that is labeled with a check mark next to the correct voltage setting.

*The line input may be changed by rewiring the line input connector wiring and moving a cable connector on the S300 motherboard inside the unit. Move the cable connector to P3 for 115VAC nominal or P4 for 230VAC/208VAC 3 PH nominal.

2.3.2 IEEE-488 Connection

An IEEE-488 compatible connection is standard on an S300 chassis. To connect to a host computer attach the IEEE cable to the S320 rear panel connector labeled "GPIB" and to the appropriate location on the host. The IEEE-488 address must be set in binary using the dip switch located within the far left side of the S300 rear panel.

2.3.3 COM INPUT & OUTUT Connection

1. Trigger Connection

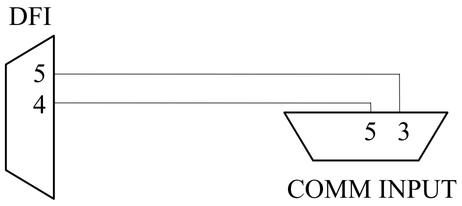
The external trigger line is connected to the S300 chassis at the male 15 pin D-sub located on the lower left corner of the rear panel and is labeled "COMM IN". This is a differential input pair with 10K ohm pull-up and pull-down. This input must be allowed to maintain greater than +200 mV differential at "TRIGIN+" relative to "TRIGIN-" during normal operation. After the external trigger circuit is "ARM'd" (see section 5.10 Trigger Subsystem) a minimum 50 msec low pulse is required to execute the external trigger function. The trigger input must receive a pulse more negative than -200 mV differential at "TRIGIN+" relative to "TRIGIN-". **This differential voltage must not exceed ±5 volts or trigger input circuitry will be damaged.** The Trigger input pins are:

pin 2: TRIGIN+
pin 13: TRIGIN-

2. Interlock Connection

The S300 chassis interlock inhibits module outputs. It is connected at the COMM IN connector. This signal enables S300 operation by shorting pins 3 and 5. When shipped the S300 has the connector installed with pins 3 and 5 shorted to avoid any start up problems. The short should be removed when wiring this interlock into a system.

This interlock could be wired to the DFI that would inhibit all outputs if an error was detected. The following connection could be made to achieve this:



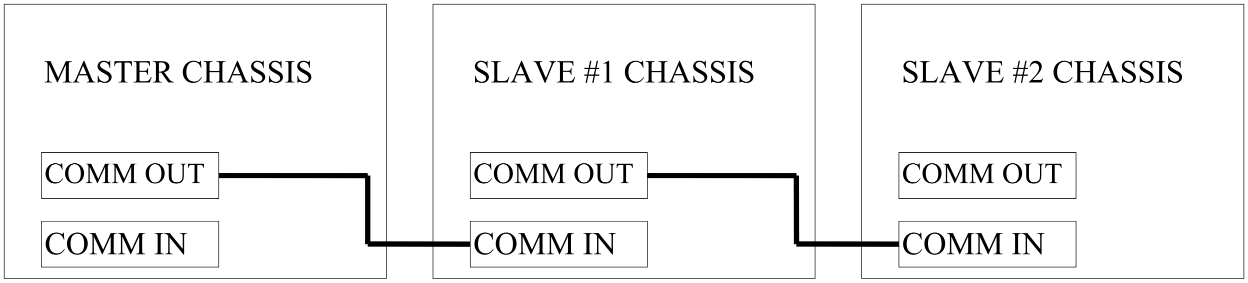
The interlock pins are:

pin 5: INTERLOCK
pin 3: GNDSYS

3. Auxiliary Chassis Connection

If an auxiliary chassis is being used, a cable is provided to connect the controlling S300 chassis to the auxiliary chassis. Connection is made from the connector labeled "COMM OUT" on the controlling chassis to the connector labeled "COMM IN" on the auxiliary chassis.

Additional auxiliary units can be daisy chained from auxiliary chassis #1 to auxiliary chassis #2 and so on in the same fashion.

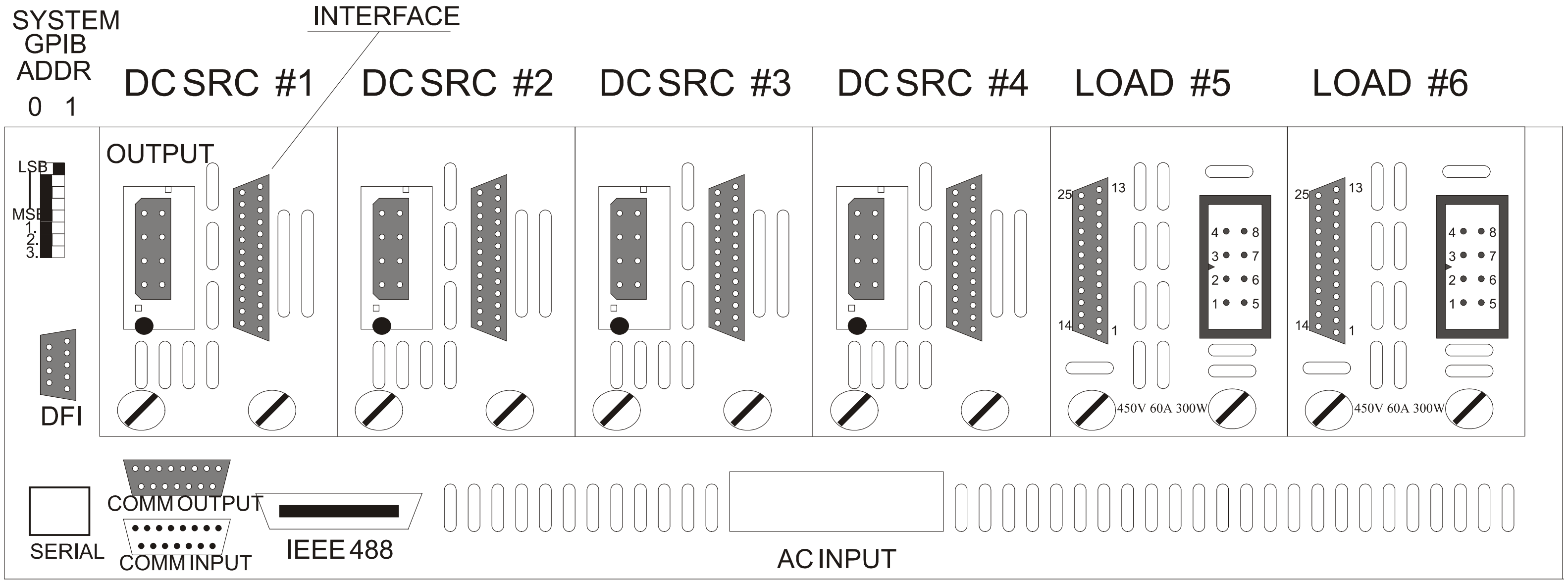


2.3.4 Discrete Fault Interface Connection {DFI}

The Discrete Fault Interface connector is a 9 pin female D-sub labeled "DFI" and has the following pin connections:

pin 4: NORMALLY OPEN DFI RELAY CONTACT
pin 5: COMMON DFI RELAY CONTACT
pin 9: NORMALLY CLOSED DFI RELAY CONTACT

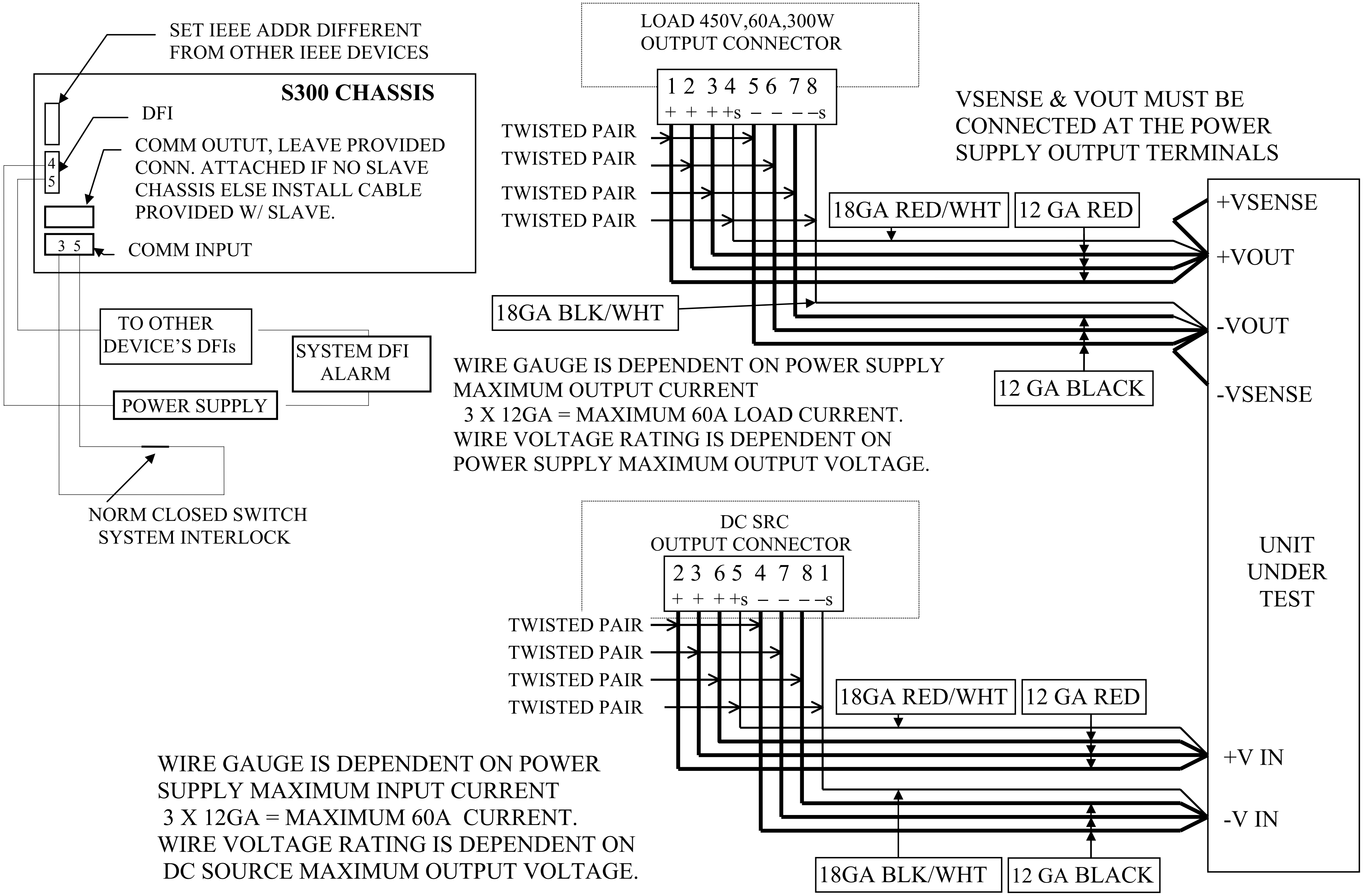
The DFI relay is activated at power up. Therefore under normal operation pins 4 & 5 are shorted and pins 5 & 9 open. An error will cause the DFI relay to be cleared as per Supported SCPI Error Codes and 10.3 S300 Specific Error Codes. To set the DFI relay after an error has occurred you must issue a SYST:ERR? or STAT:QUE? or *RST command. See 5.7 System Subsystem and Status Subsystem.



NOTE: SYSTEM INTERLOCK OF THE COMM INPUT
PINS 3 & 5 MUST BE SHORTED TOGETHER
TO ALLOW SYSTEM OPERATION.

1. S6000 Emulation Mode Enable
2. Macro Operator Mode
3. Flash download and Calibrate Enable

S6000rer.cdr



VSENSE & VOUT MUST BE CONNECTED AT THE POWER SUPPLY OUTPUT TERMINALS

WIRE GAUGE IS DEPENDENT ON POWER SUPPLY MAXIMUM OUTPUT CURRENT
3 X 12GA = MAXIMUM 60A LOAD CURRENT.
WIRE VOLTAGE RATING IS DEPENDENT ON POWER SUPPLY MAXIMUM OUTPUT VOLTAGE.

WIRE GAUGE IS DEPENDENT ON POWER SUPPLY MAXIMUM INPUT CURRENT
3 X 12GA = MAXIMUM 60A CURRENT.
WIRE VOLTAGE RATING IS DEPENDENT ON DC SOURCE MAXIMUM OUTPUT VOLTAGE.

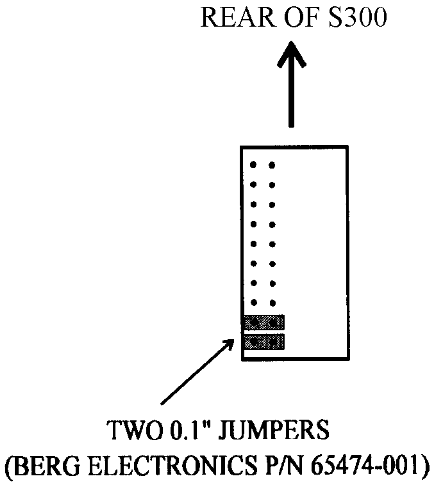
2.4 Module Installation and Removal

Before a module is inserted into the S300 chassis, the MODULE ADDRESS needs to be set. The address must be a unique number (for a given controller chassis) between hexadecimal 1 and 3F (decimal 1 and 63). This address is programmed into the module using the dip switch. On DC source modules, this switch is located in the front (air entry end) of the module; on load modules it is located near the rear of the module, at the bottom edge. To set a binary zero, press the corresponding switch down, to set a one, leave the switch up.

Each S300 module has two connectors which plug into the motherboard inside the S300 chassis. Mate modules with the motherboard from the rightmost slot toward the leftmost with respect to the S300 front panel. If there is a filler panel in that slot, remove it first by unscrewing the two holding screws. Once the module has been placed firmly into the S300 slot, align and tighten the thumbscrews located on the rear of the DC module.

If it is desired to leave a slot blank, two bus continuation connectors must be placed in each slot that is to be skipped.

NOTE: You must not leave a blank slot between paralleled load modules.



See 5.13.6 Adding a Module and Deleting a Module through IEEE-488 programming.

2.5 Mating Connector Part Descriptions

2.5.1 Chassis DFI Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER
6202014	DSUB 9PIN SOCKET	1	DE9P	ITT CANNON
6201698	DSUB SHELL	1	DE24657	ITT CANNON
6201309	DSUB SCREW LOCK	2	D20419-21	ITT CANNON

2.5.2 Chassis COMM IN Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER
6200844	DSUB 15 SOCKET PLUG	1	DA15S	ITT CANNON
6200800	DSUB SHELL	1	DA24658	ITT CANNON
6201309	DSUB SCREW LOCK	2	D20419-21	ITT CANNON

2.5.3 Chassis COMM OUT Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER
6200799	DSUB 15 PIN SOCKET	1	DA15P	ITT CANNON
6200800	DSUB SHELL	1	DA24658	ITT CANNON
6201309	DSUB SCREW LOCK	2	D20419-21	ITT CANNON

2.5.4 Manufactures Description

POSITRONICS INDUSTRIES, INC.
423 N. CAMPBELL AVE.
P.O. BOX 8247
SPRINGFIELD, MO. 65801
PH# 417-866-2322 FAX# 417-866-4115

CANNON ITT
10550 TALBERT AVE.
P.O. BOX 8040
FOUNTAIN VALLEY, CA. 92708
PH# 714-964-7400

3. OPERATING INSTRUCTIONS

Operation of the S300 requires a proper cabling setup as per Chapter 2. Protection circuits are available for protection of both the S300 module and the Unit Under Test (UUT). If more power is required, multiple modules may be used in parallel. These operations are described fully in this section.

3.1 Power Up Sequence

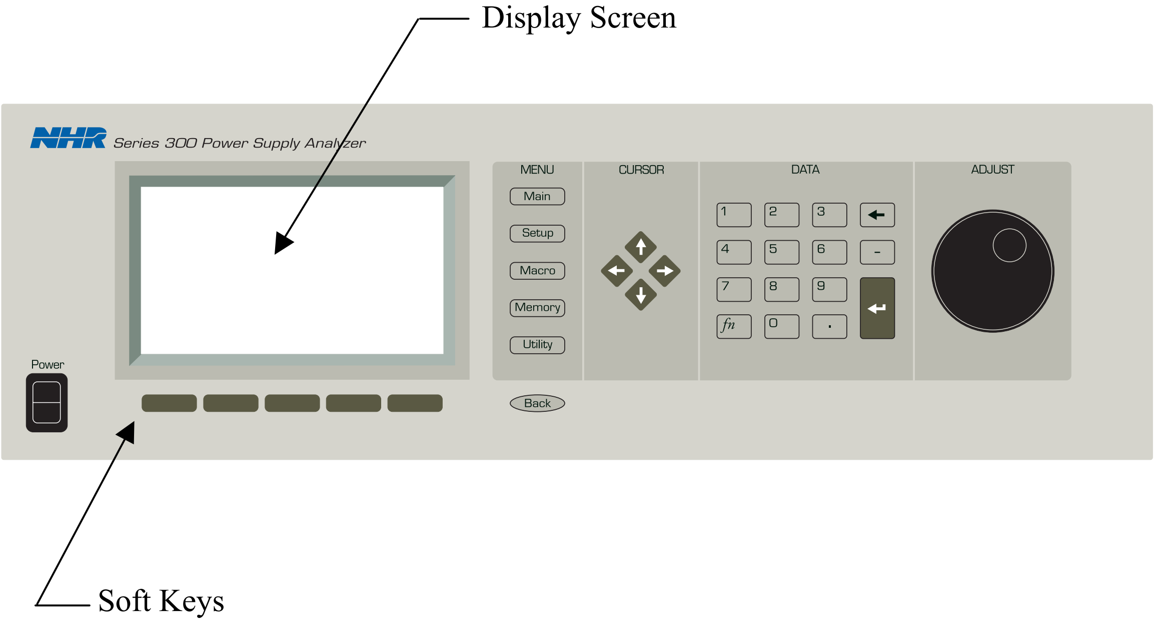
Turn the front panel power switch to "ON" on each auxiliary chassis first. Next turn on the front panel power switch of the controller. Observe the green power light and listen for the fans. The splash screen should be displayed, followed by the main menu.

4. FRONT PANEL PROGRAMMING

All system functions are accessed on the S300's front panel display. The front panel includes the power switch, a LCD display screen, and various keys designed to make the S300 easy to use and to operate. The function ability of these various keys are the use of soft keys, menu keys, cursor keys, a numeric keypad, and an adjust knob are designed to help navigate you through the S300's various options as well as being used for all programmable functions.

Up to six modules can be monitored simultaneously on the display screen. This includes sources, loads, and the S300's chassis.

This section will describe how to use those functions. The first subsection will describe the use of the different front panel components; while the following subsections will focus in on the different capabilities available through the menu system.


Display Screen

Soft Keys

4.1 Front Panel Components

The front panel has seven different components. In order from left to right these components are the power switch, display screen, softkeys, menu keys, movement keys, numeric data keys, and the adjust knob.

POWER SWITCH - turns on the power to the S300 Power Supply Analyzer. The first screen to be displayed will be the NH Research splash screen. If no errors are detected in a few seconds the Main Menu screen will then come up. (If an error is detected the string "INITIALIZING" will be replaced with "INITIALIZE FAILURE" and a list of power-up error codes, see Section 9 System & Module ERRORs for a description of the error codes. The Enter key must be pressed to proceed to the Main Menu.)

DISPLAY SCREEN - the display screen gives a status report of all features. This includes attached devices, their descriptions, volts, amps, and a multitude of options. Often times the fifth option (located at the bottom right of the display screen) will say "MORE." The "MORE" option simply means that there are "more" options than can fit the screen. If "MORE" is selected another lists of options will appear at the bottom of the screen, or if you have navigated through all the options already, it will take you back to your previous screen. All functions on the display screen are controlled by five softkeys located directly below the screen.

SOFTKEYS - the keypad consists of five keys located right below the display screen. These keys allow you to select any of the five given options located at the bottom of the display screen. By pressing a key it will activate the corresponding option on the display screen. Soft keys are context sensitive and change as different menus or devices are selected.

MENU OPTIONS - the menu options allows you to control and configure all the key features of the S300. The Menu choices are Main, Setup, Macro, Memory, Utility, and Back (to the previous screen). These options will be fully described in Section 4.2 through Section 4.7.

CURSOR - cursor movement on the display screen is controlled with right, left, up and down arrows. The cursor will auto-repeat its movement if you hold a given arrow key down

<u>Function (*fn*)</u>: the function key allows you to scroll quickly through a list of items or to activate alternate key functions. To utilize the function key first press the *fn* key and then use the up or down cursor arrow to direct which way in the given list you want to travel.

DATA (numeric keypad) - the numeric keypad is numbered 0 through 9 and also contains a decimal, minus sign, backspace, enter, and function (*fn)* keys.

<u>0 through 9 numerical keys</u>: are used to input numeric data.

backspace: allows you to delete the last character inputted. If the key is held down it will delete character spaces until released.

<u>Minus Sign (-):</u> allows you to input negative numbers.

<u>Enter</u>: the 'Enter' key is used to enter accepted data and menu options input with the numerical keys. If no menu selection is inputted and the 'Enter' key is pressed, the menu tree will be traversed up one level. However, if you are located on the main menu the 'Enter' key will select the setup menu only.

<u>Decimal (.)</u>: allows you to input numerical data below whole numbers.

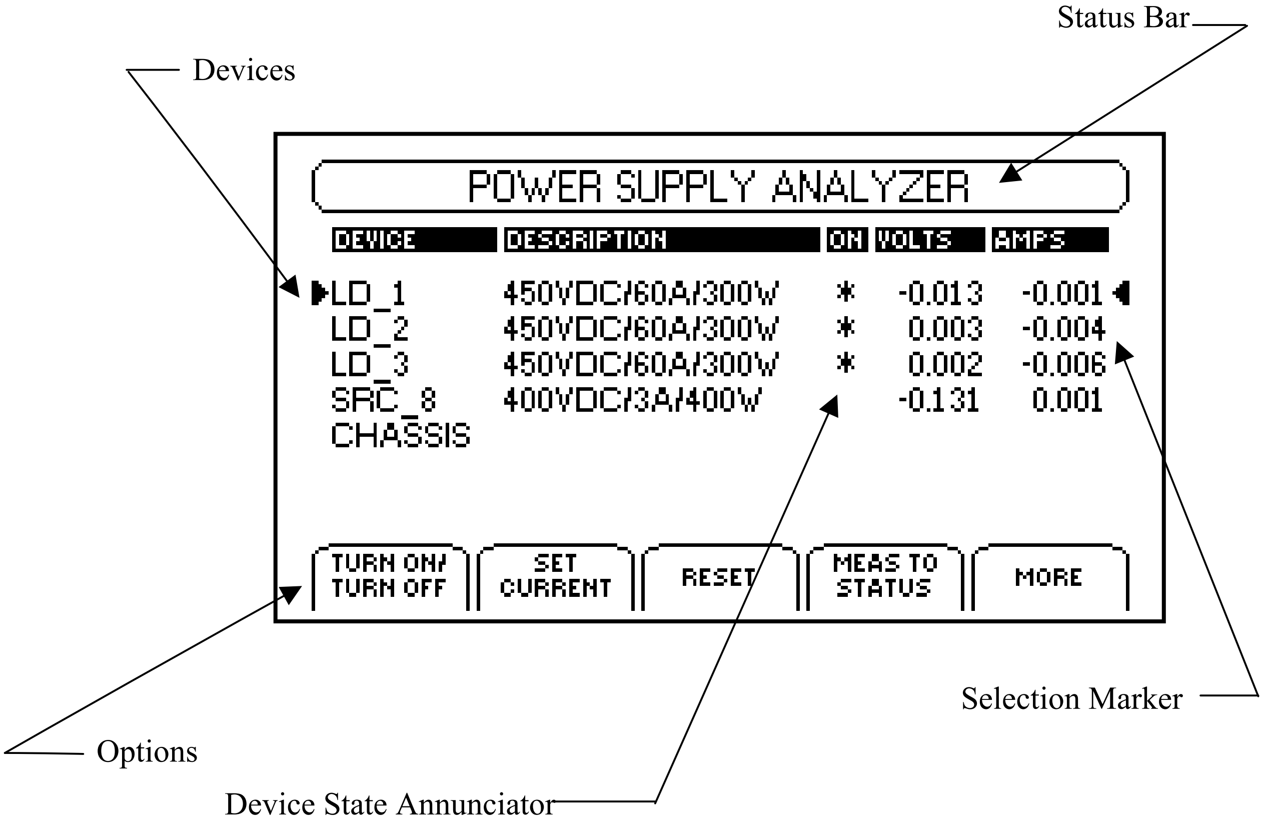
ADJUST KNOB - the adjust knob is used to quickly adjust an inputted numeric value. If you turn the knob to the right the numeric value will go higher, while if you turn it to the left the numbers will go lower. The adjust knob can also be used as an 'Enter' key. To utilize this function just press in the knob and your value will be accepted.

4.2 Menu System

The S300's Menu System will be described in the following subsections. Each subsection will show a picture of the screen and then describe its contents.

4.3 Main Menu Screen

After the Power-On Self-test (POST) the Main Menu screen will be displayed. This self-test checks for different possible power-up errors. If such an error occurs check Section 9 for a description of the error code. The Main Menu screen displays a Status Bar at the top of the screen, information about all connected devices in the center of the screen and device specific options at the bottom of the screen.



POWER SUPPLY ANALYZER

DEVICE	DESCRIPTION	ON	VOLTS	AMPS
▶LD_1	450VDC/60A/300W	*	-0.013	-0.001 ◀
LD_2	450VDC/60A/300W	*	0.003	-0.004
LD_3	450VDC/60A/300W	*	0.002	-0.006
SRC_8	400VDC/3A/400W		-0.131	0.001
CHASSIS				

4.3.1 Status Bar

The Status Bar is located at the top of the Main Menu screen. This bar can display the voltage and current measurements of up to two selected devices at once. Upon power-up the Status Bar will say "Power Supply Analyzer." To switch to measurement display select your chosen device(s) with the cursor and then select the Meas(urement) to Status option . If no measurements are displayed the main title will be left in its place.

4.3.2 Device Information

Current information about different connected modules as well as the analyzer's chassis is located in the middle of the Main Menu screen. The information displayed will be connected devices, device description, voltage, and amps.

DEVICE - the device heading will display whether a given module is considered a Source (SRC), a Load (LD) or the S300's Chassis. Also for example, if you have two different source modules by default they will be numbered as SRC_1 and SCR_2. However, you can change the names to whatever you like. If you have more than six connected devices you can scroll through your list using the cursor keys located in the middle of the front panel.

DESCRIPTION - the description of the given devices will display its voltage, whether it is an AC and/or DC source, and its maximum amps as well as wattage.

DEVICE STATE ANNUNCIATOR – if there is an error associated with a given device or the chassis an "E" will appear under the ON column. An asterisk (*) will appear if the device is ON and there will be a blank space if the device is OFF. For further details See Section 9 System and Module Errors.

VOLTS - displays the voltage measurement of a given device.

AMPS - displays the amp measurement of a given device.

SELECTION MARKERS – a selection marker is displayed by an arrow that points at the current selected device or option.

4.3.3 Main Menu Options

The Main Menu options are the five outlined buttons located on the bottom of the display screen. These buttons are activated by the keys located right underneath the display screen. These options are as follows:

TURN ON/OFF - allows you to turn on and off the selected device.

SET VOLTAGE - allows you to set the voltage for the currently selected device. This will take you to a screen where you can input the desired voltage with either the data keys or the adjust knob.

RESET - resets the selected device.

MEASUREMENT TO STATUS - the current volts and amps measurement of the selected device in the Status Bar that is placed at the top of the display screen. With this option only two devices can be placed on the Status Bar at once.

CLEAR STATUS - allows you to clear the device measurements in the Status Bar. (Displayed after pressing the "MORE" option.)

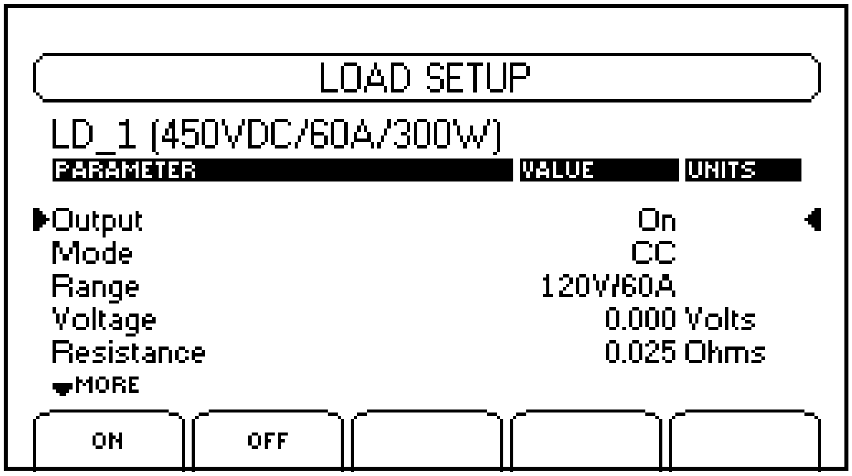
TOGGLE STATUS - allows you to toggle between the device measurements and menu title mode. (Displayed after pressing the "MORE" option.)

VIEW ERROR LOG – displays the most recent logged error for the selected device. See Section 9 System and Module Errors for further details.

4.4 Setup Menu

4.4.1 Load Setup

The Load Setup Menu is the load specific Setup Menu. This menu can be reached by selecting a load device from the Main Menu and then pressing SETUP. The Load Setup Menu allows you to change the value of every load module parameter. These different parameters are as follows:



LOAD SETUP

LD_1 (450VDC/60A/300W)

PARAMETER	VALUE	UNITS
▶Output	On	◀
Mode	CC	
Range	120V/60A	
Voltage	0.000	Volts
Resistance	0.025	Ohms

▼MORE

1. OUTPUT - allows you to toggle the module's ON/OFF state as well as the state of its isolation relay if installed.

The default/reset value of this parameter is the ON state.

2. MODE - Allows you to change the mode of a stand alone or master load module. Refer to S300 Hardware Reference Manual 09-0257 Section 1.4.3 for a description of the load modules operating mode. These different modes are as follows:

Constant Current (CC) - sets the load into Constant Current Mode.

Constant Resistance (CR) - sets the load into Constant Resistance.

Constant Voltage (CV) - sets the load into Constant Voltage.

Constant Power (CP) - sets the load into Constant Power.

Auto - sets the load into Auto Mode.

Short Circuit (SC) - sets the load into Short Circuit Mode. Selecting any other mode after short circuit has been programmed will transition the load out of Short Circuit Mode.

Pulse - sets the load into Pulse mode.

3. **RANGE -** allows you to set the load working voltage and current range. Default/reset value is 120v/60a, 80v/60a.

4. **VOLTAGE –** allows you to set the voltage level for constant voltage mode operation. Default/reset value is 0 volts.

5. **RESISTANCE -** sets the resistance level for the Constant Resistance Mode (CR) in ohms. The unit must be in Constant Resistance Mode when setting. Current must first be programmed. Calculate the current by dividing (Max. Voltage)/(Desired Resistance). Enter this calculated current. Next enter the desired Resistance. Keep in mind that the Max. Voltage must be equal to or less than the maximum voltage for the range.

The default/reset value for this parameter is 1 ohm. The minimum input value is based upon the present operating range and the voltage parameter; see Section 1.4.3 of the S300 Hardware Reference Manual 09-0257 for a table of resistance to range values. The maximum input value is the maximum resistance level for the present range setting.

6. **CURRENT** - allows you to set the current parameter. You will be prompted to change the value to a new current level. In Constant Resistance operation current must be entered before resistance. In Constant Resistance Mode program current changes do not take effect until the resistance is entered.

The default/reset value of this parameter is 0 amps. The maximum input value is the maximum current for the module type as is specified in Section 11.1 under Module Types.

7. **POWER -** allows you to set the power level for constant power mode or auto mode. Default/reset value is 0 watts.

8. **RISE TIME** - the rise time parameter programs, in seconds, the time to transition the current from the present level to a higher level.

The default/reset value for this parameter is 10 µsec. The minimum input value is 10 µsec. The maximum input value is 8.0 seconds. The resolution is 2 µsec.

9. **FALL TIME** - the fall time parameter programs, in seconds, the time to transition the current from the present level to a lower level.

The default/reset value for this parameter is 10 µsec. The minimum input value is 10 µsec. The maximum input value is 8.0 seconds. The resolution is 2 µsec.

NOTE: For further details on Pulse Mode Operation see Section 1.4.4 of the S300 Hardware Reference Manual 09-0257.

10. PULSE ORDER - specifies the sequenced order of states for Pulse Mode operation. 1, 2, and 3 are pulse states and 0 causes Pulse Mode operation to halt. Pulse Mode always starts from state 3, the nominal amps, and transitions to state 1. Select the soft key corresponding to the desired sequence.

Below are listed the legal pulse sequences.

Sequence	Description
1,0	Current step from nominal
1,2,0	Single shot two level pulse - nominal goes to state #2 amps
1,3,0	Single shot two level pulse - nominal is unaffected
1,2,3,0	Single shot three level pulse - nominal unaffected
1,3,2,0	Single shot three level pulse - nominal goes to state #2 amps
1,2,1	Continuous two level pulse
1,3,1	Continuous two level pulse
1,2,3,1	Continuous three level pulse
1,3,2,1	Continuous three level pulse
1,2,3,2	Continuous two level pulse with starting transient
1,3,2,3	Continuous two level pulse with starting transient

For single shot pulses the nominal current level will updated to the final state of the pulse sequence. When continuous Pulse Mode operation is halted the current level returns to nominal.

11. PULSE 1 AMPLITUDE - sets the current level for Pulse Mode State 1.

The default/reset value for this parameter is 0 amps. The minimum input value is 0 amps. The maximum input value is the maximum current level for the present range setting.

12. PULSE 2 AMPLITUDE - sets the current level for Pulse Mode State 2.

The default/reset value for this parameter is 0 amps. The minimum input value is 0 amps. The maximum input value is the maximum current level for the present range setting.

13. PULSE DWELL 1 - sets the dwell time, in seconds, for the Pulse Mode State 1.

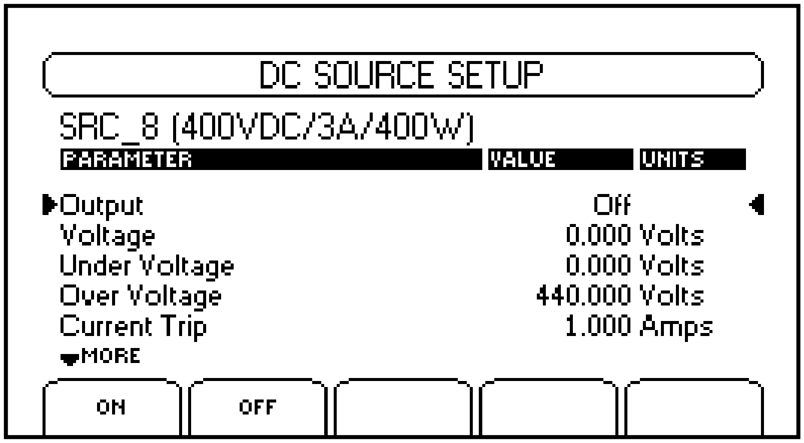
The default/reset value for this parameter is 1 msec. The minimum input value is 20 μsec. The maximum input value is 8.0 seconds. The resolution is 2 μsec.

14. PULSE DWELL 2 - dwell time for Pulse Mode State 2.
The data range is the same as Pulse Mode State 1.

15. PULSE DWELL 3 - dwell time for Pulse Mode State 3.
The data range is the same as Pulse Mode State 1.

16. MODULATION STATE: Default Off - allows you to set the power level for constant power mode or auto mode. Default/reset value is "OFF".

4.4.2 Source Setup



```
DC SOURCE SETUP
SRC_8 (400VDC/3A/400W)
PARAMETER                  VALUE     UNITS

▶Output                      Off       ◀
 Voltage                   0.000 Volts
 Under Voltage             0.000 Volts
 Over Voltage            440.000 Volts
 Current Trip              1.000 Amps
 ▼MORE
```

The Source Setup Menu allows parameter viewing and modification for a stand alone or master DC Source module. To access the Source Setup Menu, first move the cursor to your desired source and input your selection with the Enter key or press SETUP.

Module parameter values and states are programmed by selecting the appropriate menu option and entering any required data when prompted. When the menu parameters are programmed the displayed values are updated to the programmed values.

The following options are available from the Source Setup Menu:

1. OUTPUT - toggles the module ON/OFF state as well as the state of its isolation relay if installed.

The default/reset value of this option is the OFF state.

Before setting up a voltage and turning on the output the protection options should be setup. During the setup of these options, limit the module to work in a specific range in order to prevent damage to the UUT.

2. VOLTAGE - sets the output voltage parameter in volts. You will be prompted to input the new voltage level.

The default/reset value of this parameter is 0 volts. See Section 11.1 Module Types for further details. The maximum input value is the maximum voltage for the module type as specified in Module Types. The minimum input value is 0 volts, unless the module includes the reverse polarity option. If the module includes the reverse polarity option the minimum input voltage is the negative of the maximum voltage.

3. UNDER VOLTAGE - sets under voltage error level, in volts. If the module detects an absolute voltage level less then the under voltage trip parameter it will shutdown and generate an Module Voltage Error. To disable under voltage checking enter the value 0 when prompted for the under voltage parameter. This parameter should be disabled while the output is off.

The default/reset value of this parameter is 0 volts in the OFF state. The maximum input value is the maximum voltage for the module type as specified in Module Types. The minimum input value is 0 volts. For modules, which include the reverse polarity option, this parameter is an absolute value.

4. OVER VOLTAGE - sets the over voltage trip parameter, in volts. If the module detects an absolute voltage level greater then the over voltage trip parameter it will shutdown and generate a Module Voltage Error. To toggle over voltage checking between on and off, enter the value -1 when prompted for the overvoltage parameter.

The default/reset value of this parameter is 110% of the maximum voltage for the module type as specified in Module Types. The maximum input value is 110% of the maximum voltage. The minimum input value is 0 volts. For modules, which include the reverse polarity option, this parameter is an absolute value.

5. CURRENT TRIP - sets current trip parameter, in amps. If the module detects a current output greater then the current trip parameter the S300 will shutdown and generate a Module Current Error.

The default/reset value of this parameter is 110% of maximum current for the module type as specified in Module Types. The maximum input value may be slightly higher or lower than 110% depending on which type of module you have loaded. The minimum input value is 0 amps.

6. TRIP DELAY - sets the time delay, in milliseconds, before a current trip will generate a Module Current Error.

The default/reset value of this parameter is 65.535 seconds. The maximum input value is dependent to which type of module you currently have loaded, but it will usually be around the default setting of 65.535 seconds. The minimum input value is 0.001 seconds.

7. CURRENT LIMIT - sets the current limit parameter in amps. You will be prompted to input the new current limit level.

The default/reset value of this parameter is the modules maximum power divided by its maximum voltage, in amps. The maximum input value is the maximum current for the module type as specified in Module Types. The minimum input value is 0 amps.

8. SENSE STATE - sets the sense relay state between local and remote.

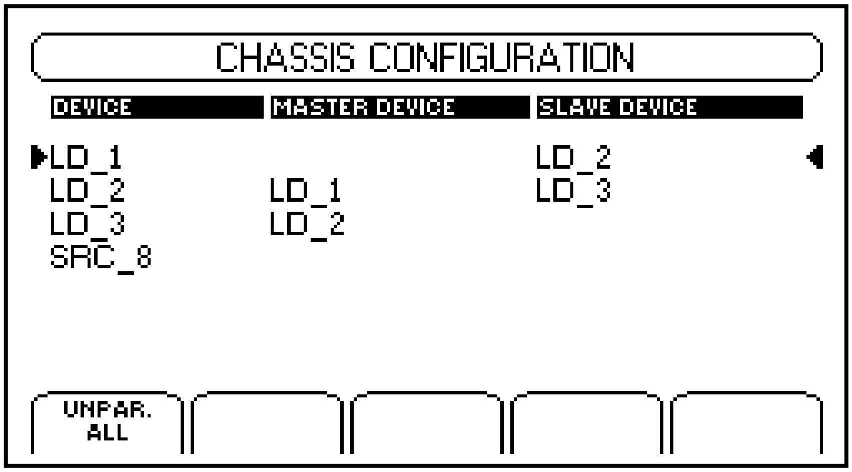
The default/reset value of this parameter is local.

4.4.3 Chassis Configuration

This submenu allows you to modify the S300's chassis configuration. To reach this option, select the chassis device from the Main Menu and then press SETUP.

The user may parallel modules to create a master module, which has increased module limits for power handling. To parallel a group of modules the configuration menu is selected by selecting the chassis device and selecting SETUP menu. Only modules of the same type may be paralleled together. When modules are paralleled only the resulting master module will appear on the instrument device menus until the modules are unparalleled.

The S300 chassis has several restrictions on paralleling modules, which are enforced by the menu logic. Only like modules will appear on the Slave Select menu and only modules, which are down, stream in the communication bus will appear. For more information on Paralleling modules refer to Section 2.5 Parallel Modules Connections.



CHASSIS CONFIGURATION

DEVICE	MASTER DEVICE	SLAVE DEVICE	
▶LD_1		LD_2	◀
LD_2	LD_1	LD_3	
LD_3	LD_2		
SRC_8			

UNPAR. ALL

The options that are available through the S300's chassis configuration are as follows:

PARALLEL MODULE - to parallel a group of modules the configuration of the master device must be modified first. The slave modules are added in sequence after the master. Only modules of the same type may be paralleled together. For example, sources can only be paralleled with other like sources and loads with other like loads.

When modules are paralleled only then can the master device be programmed. Commands, other then unparalleling, sent to the slave device cause an unknown module error to be added to the modules error queue. See Section 2.5 for further details.

UNPARALLEL MODULE - to unparallel a group of modules the configuration of the last slave device must be modified first. The modules will be removed from the group in sequence up to the master module. See Section 2.5 for further details.

UNPARALLEL ALL - this softkey will remove all virtual modules created as well as returning all modules to stand alone operation.

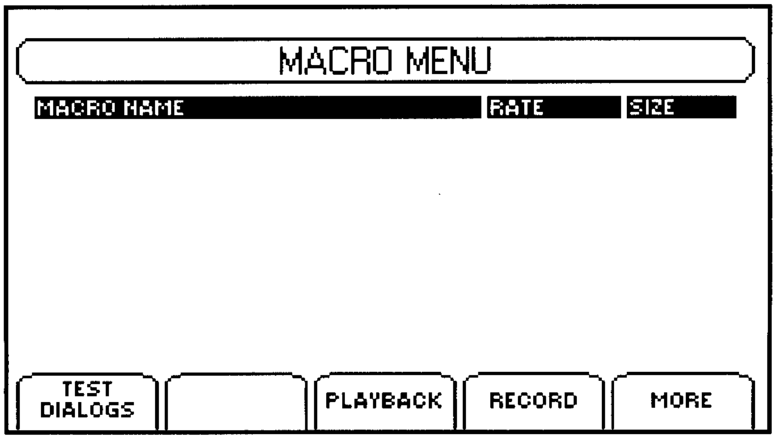
SELECT SLAVE – this option appears only during the process of paralleling modules. It will display a list of possible slave devices of which you have the option to SELECT or to EXIT to the previous screen.

4.5 Macro Menu

The Macro Menu allows you to record and playback sequential sequences of instrument operation and tests. Once you create the macros you can store these subroutines and multifaceted tests into nonvolatile memory. There is available memory storage of up to 128 macros using a maximum of 1 megabyte of memory.

The Macro Menu shows the stored macros available for playback. Select the desired macro and select the playback softkey. All user keystrokes and interaction with modules are played back sequentially. Wait for the playback to complete or if necessary select the abort softkey while playback is in progress to stop the macro playback prematurely.

NOTE: if macro playback is aborted the instrument state is unknown. Turn off modules and/or reset modules as necessary to restore the instrument to a known state.



4.5.1 Macro Displays

The different options you can perform or monitor with the Macro Menu are as follows:

MACRO NAME - allows you to name your newly created macro or rename an existing one. You can use a maximum of 25 character spaces for your name.

RATE - allows you to toggle between normal and fast rates.

SIZE - displays the amount of memory in bytes that your particular macro requires.

4.5.2 Macro Options

TEST DIALOGS - allows for two types of tests. The two types of tests are Voltage Tests and Current Tests. Both tests display a pass/fail dialog as well as allowing you to input minimum and maximum ranges to be tested. If a macro is recording the test placed into the sequence of macro events and will test the measured parameter when the macro is played.

PLAYBACK - allows you to playback a chosen macro. It does not matter if the macro is just one quick simple test or is an overall test comprised of a multitude submacro routines, either way each aspect will be played back to you.

RECORD - the Record Option allows you to create a macro and save it into memory. The macro can be one routine or a whole series of routines. There is no limit to how many subroutines you can incorporate into a macro. Your macro will also be saved at the same rate and have the same parameters you recorded it at. However, you can increase the rate of your macro's playback with the Toggle Rate Option. For instruction on how to create a macro See Section 4.8.2

STOP RECORDING - the Stop Recording Option will only appear once you are actually recording a macro. Once you have completed recording your macro, select this option and your macro will be complete. From there, displays will then come up for you to save your macro and then to name it.

TOGGLE RATE - allows you to toggle the time rate of a given macro between normal and fast. The normal time rate indicates the same timing at which the macro was recorded, while the fast rate will have your macro playback at the fastest speed possible.

DELETE - allows you to delete a macro that you want to discard. Simply select the macro you want to delete and then a display screen will come up to ask if you are sure. If you are you sure you want to delete the selected macro choose ACCEPT VALUE and if you made an error select CANCEL. Once you accept to delete a macro you will be unable to retrieve it.

4.6 Memory Menu

The Memory Menu is activated by selecting the Memory button located under the MENU column on the front panel of the S300.

The instrument state includes all module parameter settings for each installed module. This allows a quick method to setup the instrument in a predetermined configuration. When saving the instrument records all information regarding the chassis setup, and installed modules to a memory restore file that is given a descriptive name and then appears in the memory menu list. When restoring an instrument state, the appropriate restore file is selected and the RECALL softkey will restore the instrument state. The instrument will consistently restore the chassis configuration first then load modules in increasing address order and then source module in increasing address order. Caution is advised as restoring an instrument state may change source voltages and turn on outputs that were previously off.

The options for the Memory Menu are as follows:

RECALL STATE - displays a directory of the different macros stored in the chassis. There is enough storage area to hold up to 128 different macros.

SAVE STATE - allows you to save a macro into memory. Once saved, you will be prompted to name the memory state file.

RENAME - allows you to rename any existing macro. Use the Adjust Knob to scroll through the different letters, numbers, and symbols.

DELETE - allows you to delete any macro of your choosing from non-volatile memory. If you select this option a Warning Screen will first be displayed to make sure that you truly want to delete the selected macro. If you select OK your macro will be deleted forever.

If the instrument determines that modules have been removed from the instrument that was installed when the memory state was saved, an error message will be displayed. The user may attempt a partial instrument state restore by ignoring the missing module or abort the restore completely. Note that if errors are indicated during restore that the instrument state may not be restored to the state that is desired. Replace the missing module or delete the memory state file to prevent future errors.

4.7 Utility Menu

The Utility Menu allows access to module diagnostics as well as to the pertinent information for a selected load, source, or the chassis. The Utility Menu can be activated by selecting the Utility button located under the MENU column of the S300's front panel.

The headings displayed on the Utility Menu is as follows:

DEVICE - the device heading will display whether a given module is considered a Source (SRC), a Load (LD) or the S300's Chassis. If you also, for example, have two different source modules they will be numbered as SRC_1 and SCR_2. If you have more than six connected devices you can scroll through your list using the cursor keys located in the middle of the front panel.

VERSION - the manufacturer's version number of a given source, load, or the S300's chassis.

PART NUMBER - displays the part number of the connected modules.

SERIAL NUMBER - displays the serial numbers of the connected modules. In the display box for the Utility Menu this number will be listed under the heading S/N**.**

BUILT - displays the month and the year the module or chassis was created in.

The options available under the Utility Menu if a load or source is selected are**:**

SELFTEST - the self-test option initiates a system or module self-test. If an error is detected it will be displayed. For Load modules an error detected during the self-test will also be displayed. For DC Source the rear panel LED will flash an error code. See Section 9 System and Module Errors for further details.

CALIBRATE – this function executes the calibration sequence for DC Source type modules. During calibration the user is required to connect external measurement equipment and input measured values. See Section 4.8.1 Calibrating A Module for further details.

CHANGE NAME - allows you to change the name of the module or chassis. There is a limit of eight character spaces. Use the Adjust Knob to select the letters, numbers, and symbols of your choosing.

VIEW ERROR LOG – displays the most current error in the module's or chassis' error quene. See Section 9 System and Module Errors for further details.

The following additional options are available under the Utility Menu if the S300's Chassis is selected:

UPDATE FIRMWARE - allows the instruments embedded firmware to be updated. You need only update the firmware if you have received a S300 firmware update file from customer support or downloaded from the NH Research web site. The number of times you can update the firmware is limited, so you should do it only when necessary. In order to update firmware the S300 Download Utility is also required. The S300 Download Utility is available from customer support or the NH Research web site. This is a Windows 95© application program, which will guide the user through the update procedure and transfer the S300 firmware update file to the S300 instrument via a RS-232 serial cable or the IEEE-488.2 port.

CAUTION: Because of the potential loss of instrument functionality, it is extremely important to follow the firmware update procedure provided with the S300 Download Utility. Please read this procedure before attempting to update your firmware.

CAUTION: To prevent loss of firmware, do not attempt to update the firmware when your electrical power is in danger, that is, during a weather storm or similar situation. Once you have started the update process, do not switch off power to your S300 until you are prompted to do so.

WARNING: If the S300 loses power during the update firmware procedure, it is no longer functional. Refer to the update firmware procedure to restore instrument firmware or contact customer support for more information.

BIOS VERSION - the version of the S300 BIOS EPROM that is currently installed in the instrument.

GPIB ADDRESS - displays rear panel DIP switch setting for IEEE address.

SYSTEM DATE AND TIME – gives the current date and time. You have the ability to change the day, date, month, hour, minute, and year. Upon initial power up, the display is set to 1-1-70, 00:00:00.

GPIB REMOTE – gives a warning of whether the instrument is under remote control or not. Press the OK button to return the instrument under local control.

4.8 Front Panel Examples

4.8.1 Calibrating a Module

Front panel calibration is a DC Source module function only. The calibration sequence is positive voltage by positive current. The sequence can be stopped before the current is calibrated and only the voltage calibration data can be updated.

To perform the voltage calibration an external calibrated 5.5 digit DMM with an accuracy of better than .004% of module full scale voltage must be connected across the outputs. **There must be no load on the DC Source output.**

If current calibration is desired then a load must be attached to the module's output, which is capable of sinking full load current. Short circuiting the output is acceptable. A current measuring device capable of measuring the full load current must be placed in series with this load. This may be accomplished using a calibrated shunt connected to a DMM in 200 millivolt (or similar) range from which load currents is calculated (Vdmm/Rshunt).

From the Utility Menu screen perform the following steps:

1. Select the module to calibrate.
2. Setup the output connection for voltage calibration per section 2.
3. Select the CALIBRATE softkey.
4. When prompted, input the 10% FS voltage value, as measured by the external DMM.
5. When prompted, input the 90% FS voltage value, as measured by the external DMM.
6. If the operator is going to do current calibration, setup the output connections per section 2.
7. To perform the current calibration, when prompted input 1 and go to step 8, else input 0 and go to step 10.
8. When prompted, input the 10% FS current value, as measured by the external DMM.
9. When prompted, input the 90% FS current value, as measured by the external DMM.
10. If module is a 400 volt module with reverse polarity option, complete steps 12 - 18.
11. If the operator is going to do negative calibration, setup the output connections per section 2.
12. To perform the negative calibration, when prompted input 1 and go to step 13, else input 0 and go to step 20.
13. When prompted, input the 10% FS negative voltage value, as measured by the external DMM.
14. When prompted, input the 90% FS negative voltage value, as measured by the external DMM.
15. If the operator is going to do current calibration, setup the output connections per section 2.
16. To perform the negative current calibration, when prompted input 1 and go to step 18, else input 0.
17. When prompted, input the 10% FS negative current value, as measured by the external DMM.
18. When prompted, input the 90% FS negative current value, as measured by the external DMM.
19. When prompted, select OK to write the data to the controller's EEPROM.

4.8.2 Creating A Macro

1. Press the Macro Button under the Main Menu on the Front Panel of the S300.
2. Select the Record Option when you are ready to begin.

NOTE: once activated you will be recording your macro until you decide to press the Stop Recording Button. Also, as a reminder, the Status Bar will flash a RECORDING message to indicate that you are still recording.

3. Record in sequence the step(s) as well as the desired timing of the test(s) that you want your macro to perform.

4. Press the Macro Button.
5. Once you have completed the sequence of tests that you want your macro comprised of, select the Stop Recording Button. This will end the recording of the macro.
6. Now that the recording of your macro is complete, you now have the options to Save or Abort Macro.
7. If you were happy with the way your macro turned out and you have already saved it into memory, then the final step is to enter the name of what you would like to call the macro and then accept value. From that point, your macro will be saved unless, at some later point, you decide to delete it. You can use a maximum of 25 character spaces to name your macro.

4.8.3 Macro Examples

4.8.3.1 Begin A Macro

To begin a Macro, press the **"MACRO"** button on the **"MENU"** panel. The operator is presented with three options for the Soft Keys.

4.8.3.2 Recording A Macro

Press the Soft Key below the **"RECORD"** option. If there are Macros recorded in the S300, use the Soft Key labeled **"MORE"** to display the set of Soft Keys containing the **"RECORD"** option. Once the **"RECORD"** option has been selected, the operator will be placed in the **"MAIN"** screen.

4.8.3.3 Entering the content of the MACRO

- Setting a specific event or condition:

  EXAMPLE:

  From the **"MAIN MENU"** screen use **"UP"** or **"DOWN"** arrow (or dial) to select the instrument.

  Press "SETUP" from the **"MENU"** panel. Press **"UP"** or **"DOWN"** arrow (or dial) to select the instrument.

  Select desired function value from the Soft Keys or select **"CHANGE VALUE"** Soft Key and **"ACCEPT VALUE"** for the newly entered value.

- Use of a TEST DIALOG

  EXAMPLE:

  Press the "MACRO" button on the **"MENU"** panel.

  Select **"TEST DIALOGS"** from the Soft Keys.

  Use **"UP"** or **"DOWN"** arrow (or dial) to select the instrument.

  From the displayed Soft Key dialogs select a Test Dialog.

Enter values for the Test Routine Parameters by Selecting **"CHANGE VALUE"** Soft Key and **"ACCEPT VALUE"** for the newly entered value.

(For some, pressing the **"CHANGE VALUE"** Soft Key will cycle the available options).

(For some, there is an **"ENABLE/DISABLE"** Soft Key to disable the test parameters).

The Test Dialog MUST be run with the **"TEST NOW"** before it will be included in the **MACRO**.

- Recursive **MACRO**

  EXAMPLE:

  While recording a **MACRO,** the setting of a specific condition or event may be included.

  While recording a **MACRO,** an existing **MACRO** may be included.

  At anytime during the process of recording a **MACRO** the operator may select the **"MACRO MENU"** screen by pressing the **"MACRO"** button on the **"MENU"** panel, selecting the **MACRO** to be included and playing the selected **MACRO** back with the **"PLAYBACK"** Soft Key.

  Once a **MACRO** has been included, it must remain available to the higher level **MACRO.**

  The included **MACRO** can be erased, re-created (perhaps edited) and given the same name, making the edited version available to the higher level **MACRO**.

4.8.3.4 Completing the MACRO

- Complete any Test Dialogs in process.
- Once you have completed the sequence of tests that you want your macro comprised of, press the **"MACRO"** button on the **"MENU"** panel.
- Use the Soft Key labeled **"STOP RECORDING"** at the completion of the **MACRO.**
- Following the directions on the screen, select the **"OK"** Soft Key to save the **MACRO.** (Pressing **"CANCEL"** will abort the recording of the **MACRO.**)
- On the following screen, name the **MACRO** and press the Soft Key **"ACCEPT VALUE"**. (Pressing the **"CANCEL INPUT"** will abort the recording of the **MACRO.**)
- The last screen will advise the operator "Macro saved".
- Press the Soft Key **"OK".**
- The **"MACRO MENU"** screen will display all **MACROS,** including the one just created.

  The macro will be saved unless, at some later point, you decide to delete it. You can use a maximum of 25 character spaces to name your macro.

5. IEEE-488 SYSTEM COMMANDS

5.1 S300 SCPI Command Index

5.2 S300 SCPI Implementation

The S300 system conforms to ANSI/IEEE Std 488.2-1992 and *Standard Commands for Programmable Instruments (SCPI)* Version 1994.0. Commands not included in the SCPI standard are included in the S300 standard command set to accommodate features of the S300 system, which are not covered in the specification. Complete syntax diagrams of all commands are given so that compatibility with test programs for other SCPI instruments may be determined.

5.2.1 Syntax Notation

The following is a list of characters used to denote syntactical items in SCPI syntax description charts, which are given below.

Character	Description
::	"is defined as"
<>	syntactic element
()	group
[]	optional element(s)
|	"or"
..	zero or more of immediate previous syntactic element
NIL	"nothing"

SCPI Command Syntax:

<lf>::	ASCII new-line (0x0A)
<dp>::	ASCII decimal point (0x2E)
<common cmd header>::	ASCII asterix (0x2A)
<data separator>::	ASCII comma (0x2C)
<cmd header> ::	ASCII colon (0x3A)
<separator>::	ASCII semi-colon (0x3B)
<mnemonic>::	One of the mnemonics described below in "S300 SCPI Language Functional Description"
<compound hdr>::	([<common cmd header>|<cmd header> | NIL] <mnemonic>)..
<eoi>::	IEEE-488.2 End Or Identify
<terminator>::	(<lf>|<eoi>|<lf><eoi>)
<wht spc chr> ::	ASCII char in set {0x00..0x09,0x0B..0x20}
<char> ::	ASCII char in set {0x21..0x7E}
<digit>::	ASCII char in set {0x30..0x39}
<white space> ::	<wht spc char>[<wht spc chr>..]|NIL
<boolean>::	("ON"|"OFF"|1|0)
<non-dec numeric>::	("DEF"|"MIN"|"MAX")
<digits>::	<digit>[<digit>..]|NIL
<string>::	<char>[<char>..]
<mantissa>::	[+|-][<digits>]<dp>[<digits>]
<exponent>::	E|e[<white space>][+|-][<digits>]
<numeric data>::	(<mantissa>[<white space>] [<exponent>]) | <non-dec numeric>
<integer data> ::	<digits>
<data element>::	[<white space>](<boolean>|<digits>|<numeric data>|<integer data>)[<white space>]
<data> ::	(<data element>[(separator><data element>)..]) NIL
<pmu> ::	<compound hdr><mnemonic><data>
<program message>::	<pmu>[(<separator><pmu>)..]<terminator>
<rmu> ::	<data>
<response message>::	<rmu>[(<separator><rmu>)..]<lf><eoi>

5.3 S300 SCPI Language Functional Description

Below is a description of the SCPI commands, which have been implemented in the S300. Examples are given for commands, which are relevant for S300 programming, and syntax description charts are listed for the purpose of software compatibility with other SCPI instruments. The S300 also accepts all required IEEE-488.2 commands mandated by the SCPI specification.

When the splash screen is displayed the S300 is ready to receive commands from the GPIB bus.

Each SCPI command has a mnemonic associated with it. For example, the mnemonic for the MEASure command is MEAS. For clarity the mnemonics are presented in capital letters and the non-mnemonic letters in lowercase. When writing a SCPI program only the mnemonic letters or the entire command are accepted as valid input.

The S300 system controller logical address is zero. The logical address of the modules within the S300 master and slave chassis are set on the module dip switch.

5.4 Mandatory Commands

Command	Description
*CLS	Clear status registers
*ESE[?] | i	Event Status Register Enable
*ESR?	Event Status Register Query
*IDN?	Identification Query
*OPC[?]	Operation Complete
*RST	Reset, Set DFI Relay
*SRE[?] | i	Service Request Enable
*STB?	Status Byte Query
*TRG	Trigger Command
*TST?	Self-test Query
*WAI	Wait-to-Continue Command

SCPI Command Data Types

b	-	boolean
f	-	floating point
i	-	integer
s	-	string

***CLS:** The *CLS command clears the event status register, the system error queue, the module error queues, and all bits in the Serial Poll register except the MAV bit. The system is placed in the Operation Complete Idle state. This command has no parameters and has no query form. The contents of enable registers specified by *ESE and *SRE are unaffected by this command.

***ESE I:** The *ESE command sets the Standard Event Status Enable register. The value in the Standard Event Status Enable register is an integer representation of a binary number. Setting a bit to one enables the corresponding bit in the Standard Event Status Register. Clearing a bit disables logging the corresponding event in the Standard Event Status Register. The value of this register at power-up is 0x00.

***ESE?:** This command returns the integer value of the Event Status Register bit mask.

***ESR?:** The *ESR? query reads and clears the Standard Event Status register. The value in the Standard Event Status register is an integer representation of a binary number.

Bit	Bit Weight	Description
0	1	Operation Complete bit; this bit is set at the completion of an IEEE-488.2 Program Message.
1	2	Request Control bit; not used.
2	4	Query Error bit; this bit is set if an IEEE-488.2 query error occurs.
3	8	Device Dependent Error; see section 10 for a list of device dependent errors.
4	16	Execution Error bit; this bit is set if an IEEE-488.2 execution error occurs.
5	32	Command Error bit; this bit is set if an IEEE-488.2 execution error occurs.
6	64	User Request bit; not used.
7	128	Power On bit; this bit is set at initial power up.

Standard Event Status Register

***IDN?:** Returns the string 'NH RESEARCH,S300,0,' + the installed firmware version string.

***OPC:** Upon receipt of the *OPC message, the S300 will transition from the Operation Complete Command Idle State to the Operation Complete Command Active State. This enables bit 0 of the Standard Event Status Enable register to be set upon completion of pending program messages.

The system will return to the Operation Complete Command Idle State when the No Operation Pending flag is sensed true or upon receipt of a IEEE488.1 device clear, or a system reset, or the *CLS command. The system reset can be accomplished by either the command *RST or SYST:CPON 0.

***OPC?:** The *OPC query returns a "1" when all pending operations are complete.

***RST:** The *RST command resets the system to the power-up state. Any configurations which have not been saved with the 'DIAG:CONF 0,SAVE' command will be lost. The DFI Relay will be set.

***SRE:** The *SRE command sets the Service Request Enable register. The value in the Service Request Enable register is an integer representation of an 8 bit binary number. Setting a bit to one enables the corresponding bit in the status byte. Clearing a bit disables the corresponding bit in the status byte. The value of this register at power-up is 0x00.

***SRE?:** This command returns the integer value of the Service Request Enable mask.

***STB?:** The *STB? query returns the contents of the Status Byte Register. The value in the Status Byte Register is an integer representation of a binary number.

Bit	Bit Weight	Description
0	1	Trigger Mode ARM. This bit is set if the system trigger mode is ARM. This bit is the device-defined summary bit for trigger arm status.
1	2	Operation Not Pending. If no operations are pending this bit will be set. This bit is the device-defined summary bit for Operation-Not-Pending status.
2	4	System Error. This bit is set if there is a error pending in the system error queue. This bit is the device-defined summary bit for system error status.
3	8	not used
4	16	MAV - Message Available bit indicates that a response message is available in the system response queue.
5	32	ESB - Event Status Summary bit is a logical OR of all enabled bits in the Standard Event Status Register.
6	64	MSS - Master Summary Status bit is an inclusive OR of the bitwise combination (excluding bit 6) of the Status Byte Register and the Service Request Enable Register. This will indicate if the S300 has a service request pending. This bit is returned in response to the *STB command. -or- RQS - The Request Service bit is the same as the MSS bit except that it is return in response to a Serial Poll, and it is cleared after the Serial Poll.
7	128	not used

Status Byte Register

***TRG:** The *TRG causes the software trigger event to occur if the trigger source is BUS. If the trigger source is not BUS an execution error is logged. See section 5 for a description of the trigger commands.

***TST?:** The *TST? query runs a test of the system computer and each installed module, as described in the SCPI TEST command. If self-test passed the string "OK" will be returned, else the string "ERROR" will be returned and errors will be logged to the system and/or module error queues. See section 10 for a list of errors.

***WAI:** The *WAI command halts the S300 from executing further commands until all previously requested operations are complete. Since the S300 executes commands sequentially the execution of this command is transparent.

5.5 Device Dependent Commands

The Device Dependent commands are required by IEEE-488.2 to control device specific summary bits in the Status Byte Register. See section 5.4 for a description of the Status Byte Register.

Command	Description
STBE[?] | i	Status Byte Register Enable

SCPI Command Data Types

I - integer

STBE I: The STBE command sets the Status Byte Register Enable register for the device-defined summary message bits. The value in this register is an integer representation of an 8 bit binary number. Setting a bit to one enables the corresponding device-defined bit in the status byte. Clearing a bit disables the corresponding device-defined bit in the status byte. Only device-defined bits can be masked with this command. An error will be log if this command tried to mask bits other than the device-defined bits, and the Status Byte Register Enable register will not be updated. The value of this register at power-up is 0x07.

STBE?: This command returns the integer value of the Status Byte Register Enable register.

5.6 Instrument Subsystem

The INSTrument command allows the user to select the module to be programmed or queried either by logical address or name (channel ID).

S300 SCPI	Description
INSTrument[?] s INSTrument[SELect][?] s	Select address by ID
INSTrument:NSELect[?] i	Select address by logical address
INSTrument:STATe[?] b	Set address on/off

INST s: Sets the logical address of the module with ID 's' to be the currently selected address for programming.

INST?: Returns the ID of the currently selected address.

INST:NSEL I: Sets the logical address 'i' to be the currently selected address for programming. If 'i' is 0 the chassis will be selected.

The default/reset value of this parameter is 0.

INST:NSEL?: Returns the logical address of the module currently selected for programming.

5.7 System Subsystem

The SYSTem command allows the user to access and control GPIB address, language, date, time, power on reset, system error, and firmware version functions.

S300 SCPI	Description
SYSTem:COMMunicate:GPIB:ADDRess[?] l	Set GPIB address
SYSTem:CPON l	Reset one or all modules
SYSTem:DATE[?]i,i,i	Set system date
SYSTem:ERRor?	Return top of error queue, activate DFI relay
SYSTem:TIME[?] i,i,i	Set system time
SYSTem:VERSion?	Returns the SPCI version of compliance

SYST:COMM:GPIB:ADDR I: Sets the GPIB address of the system to 'i'. NOTE: The usage of this command is discouraged since the S300 GPIB address is programmed by setting a dip switch located on the rear panel.

SYST:COMM:GPIB:ADDR?: Returns the GPIB address of the system.

SYST:CPON l: Commands logical address 'i' to reset to the powered up state.

SYST:DATE i_1,i_2,i_3: Set the system date to 'i_1'th month {1-12}, 'i_2'th day, and 'i_3'th year. The day parameter must be legal for the month entered or a parameter error will be added to the modules error queue.

SYST:DATE?: Returns the system date in the format 'mm/dd/yyyy'.

SYST:ERR?: Returns the top entry in the system error queue and moves the queue up one entry. This command also clears the DFI relay to the power up state.

SYST:TIME i_1,i_2,i_3: Set the system time to 'i_1'th hour {0-23}, 'i_2'th minute{0-59}, and 'i_3'th second {0-59}.

SYST:TIME?: Returns the system time in the format "hh:mm:ss".

SYST:VERS?: Returns the system SCPI version of compliance.

5.8 Test Subsystem

The TEST command performs a specified number of self test options for the system controller and for individual modules. See Section RESET AND SELF-TEST FUNCTIONAL Description.

S300 SCPI	Description
TEST 0	Perform confidence test.

TEST 0: Perform a confidence test on system controller CPU and hardware. The status of the self-test may be found by reading SYST:ERR? query. Note that it take approximately 10 seconds to self-test a module.

5.9 Status Subsystem

The STATus command returns the top error in the selected module's error queue. The INST command (See Section 5.6 Instrument Subsystem) must be used to select the address of the module to be queried.

5.10 Trigger Subsystem

The S300 CPU TRIGger subsystem allows the test programmer to preset the S300 and it's devices to a certain state without executing immediately. This allows for internal or external synchronization of events through either hardware or software triggers.

When the S300 is initialized and while it is not processing remote or local commands or status checking it is in the IDLE state. In order to enable the S300 to respond to trigger information, the INITitiate command is sent. This command places the device in the "Wait for ARM" state. At this time the "Trigger Arm Control" enable message is broadcast to all modules on the bus.

When the S300 is in the "Wait for ARM" state GPIB commands sent to the CPU are parsed and transmitted immediately. These commands include device specific commands relative to the state of the relays, voltage level, and trigger setup commands. Any command sent to any module will be parsed and transmitted when received as usual. Because the "Trigger Arm Control" is enabled the module will setup per the received commands but not execute until ARMed and a TRIGger event occurs.

When the user has sent all desired commands to the modules, the "ARM" SCPI command is sent. This causes all DC modules to arm and await a trigger event. Note that once the trigger is armed, the module will no longer receive setup commands until after the trigger event.

S300 SCPI	Description
INITiate INITiate[:IMMediate]	Enable Trigger
ARM	Arm Trigger sequence
ABORt	Abort Trigger sequence
TRIGger[?] TRIGger:[IMMediate][?]	Initiate Trigger
TRIGger:SOURce? TRIGger:[IMMediate]:SOURce?	Returns the Trigger source.

INIT: Enable Trigger Mode and issue an Enable Trigger broadcast command to the modules.

INIT:CONT?: Return the currently set Trigger Mode ("ON" - "CONTINUOUS" or "OFF" - "SINGLE TRIGGER").

ARM: Arm the Trigger sequence in the CPU and issues a Trigger Arm broadcast command to the modules.

ABOR: Disarm the Trigger sequence in the CPU and issues an Abort Trigger broadcast command to the modules.

TRIG: Trigger Sequence will be executed.

TRIG?: Return the state of the Trigger Sequence. If the INIT command has not been sent the response will be "IDLE". If the INIT command has been sent the response will be "WAIT FOR ARM". The ARM command has been sent the response will be "WAIT FOR TRIGGER".

TRIG:SOUR?: Returns the currently set Trigger Source; "IMMEDIATE".

5.11 Diagnostic Subsystem

The DIAGnostic command allows the user access to S300 configuration data.

Upon command receipt the S300 will update the configuration setting of the parameter 's' for the logical address 'i_1' to the value 'i_2'. If there is not a module at logical address 'i_1' error 241, "Hardware Missing", will be added to the system error queue. The use of the Diagnostic commands by the end user is discouraged. These commands are used for factory configuration and internally during calibration.

Upon query receipt the S300 will returns the current configuration setting of the parameter 's' for the logical address 'i_1'. If there is not a module at logical address 'i_1' error 241, "Hardware Missing", will be added to the system error queue.

The range for the logical address parameter 'i_1', unless otherwise stated, is 1 through 63. Logical address 0 is reserved for the S300 CPU.

S300 SCPI	Description
DIAGnostic:CONFigure[? i,s] i,s,i	Configure CPU/module EEPROM parameters

DIAG:CONF i_1,TYPE,i_2: Sets the module type for the logical address 'i_1' to the value 'I_2'. To store this data to EEPROM issue the command 'DIAG:CONF 0,SAVE' before resetting or cycling power.

DIAG:CONF? i,: Returns the module type for the logical address 'i'. See Module Types for a table of modules type codes.

DIAG:CONF? i,OPTS: Returns the module options for the logical address 'i'. The option parameter is a 16 bit unsigned integer where each bit, if set, represents an installed option. The returned value is in base 10 format and should be converted to base 16 to display the individual bits. To store this data to EEPROM issue the command 'DIAG:CONF 0,SAVE' before resetting or cycling power.

DIAG:CONF i_1,OPTS,i_2: Sets the module options for the logical address 'i_1' to 'i_2'. See Section Module Options for a table of option codes.

DIAG:CONF? i,ID: Returns the module ID for the logical address 'i'. The Module ID is a string up to 8 bytes long that represents the identifier to which the module will respond.

DIAG:CONF i,ID,s: Sets the module ID for the logical address 'i' to 's'. The ID 's' is a character string of up to 8 characters. To store this data to EEPROM issue the command 'DIAG:CONF 0,SAVE' before resetting or cycling power.

DIAG:CONF? i,MAXV: Returns the maximum voltage for the module at logical address 'i'. MAXV is a floating point number representing the maximum voltage the module can be programmed to.

DIAG:CONF? i,MAXI: Returns the maximum current for the module at logical address 'i'. MAXI is a floating point number representing the maximum current the module can be programmed to.

DIAG:CONF? i,MAXP: Returns the maximum power for the module at logical address 'i'. MAXP is a floating point number representing the maximum power the module can be programmed to.

DIAG:CONF i_1,MPAR,i_2: This command removes module 'i_1' from a group of parallel modules. The parameter 'i_2' must be 0, if not error "-241 Hardware Missing" will be added to the modules error queue. To store this data to EEPROM issue the command 'DIAG:CONF 0,SAVE' before resetting or cycling power.

DIAG:CONF? i,MPAR: Returns the logical address of the module which is the master of module 'i'. If the return value is zero then module 'i' is either a master or a stand alone module, not in a parallel group.

DIAG:CONF? i,SPAR: Returns the logical address of the module which is the slave of master module 'i'. If the return value is zero then module 'i' is either the last slave in a group of modules or not in a parallel group.

DIAG:CONF i_1,SPAR,i_2: This command adds module 'i_2' as a slave to module 'i_1'. Modules 'i_2' and 'i_1' must be of the same type or error "-241 Hardware Missing" will be added to the modules error queue. If the module cannot be paralleled an "-200 Execution Error" will be added to the modules error queue. For Load modules no more than two sets of parallel groups can have their physical location mixed within the S300 chassis. To store this data to EEPROM issue the command 'DIAG:CONF 0,SAVE' before resetting or cycling power.

DIAG:CONF i,SAVE: Saves the system configuration to EEPROM. The parameter 'i' must be 0 or error "-220 Parameter Error" will be added to the modules error queue and the command will not be executed. For DC Source modules, if calibration has been performed since the last SAVE, their calibration factors are stored to the module.

DIAG:CONF i,KILL: Deletes module 'i' from RAM memory. To delete module 'i' from EEPROM this command should be followed by the command 'DIAG:CONF 0,SAVE' to save the new configuration.

DIAG:CONF i,PRGE: Clear EEPROM memory. The parameter 'i' must be 0 or, an error will be added to the modules error queue and the command will not be executed. This command takes approximately five seconds to complete.

DIAG:CONF? i,MODN: Returns the model number for the module at logical address 'i'.

DIAG:CONF? i,HREV: Returns the hardware revision number for the module at logical address 'i'.

DIAG:CONF? i,BLD: Returns the build date for the module at logical address 'i'.

DIAG:CONF? i,SER: Returns the serial number for the module at logical address 'i'.

DIAG:CONF? 0,SYTM: Returns a comma delimited list of module logical addresses contained in the S300 system.

DIAG:CONF? i,MOD: Returns with the complete configuration of the module at logical address 'i'. The response will be a comma delimited list with the following format:

Packet	Description
2	Module Logical Address
3	Module Physical Address
4	Module Type
5	Module Slave Address
6	Module Master Address
7	Module State

The slave address parameter is the logical address of the module's slave. The master address parameter is the logical address of the module's master. The state of the module will be as follows:

	Description
0	Single - no master or slaves
1	Master
2	Slave
3	Foreign - module configuration has not been saved
4	Missing - module was not found at power-up

DIAG:MENU:OUTP i_1,i_2: This command controls the information displayed on the DISPLAY OUTPUTS screen. The module address is specified by the parameter i_1. This parameter must be a legal module address or 65. If the parameter is 65 status of the system CPU is displayed. The display row is specified by parameter i_2. This parameter must be in the range zero to six, inclusive. If the parameter is from one to six, the module specified in parameter $i_1$will be displayed on row i_2. If i_2 is zero the module specified in $i_1$will be removed from the display.

DIAG:VERS? I: Returns the firmware version number for the module at logical address 'i'. If 'i' = 0 the firmware version number of the chassis is returned.

DIAG:PREV? s,I: This command will return previous program or responses messages. Up to a maximum of five messages will be returned. Each message will be enclosed in quotes if more than one message is returned, the messages will be comma separated. The maximum length of the response is 255 bytes.

If s is the string "CMD" program messages will be returned. If s is the string "RSP" response messages will be returned. If s is not "CMD" or "RSP" an argument error will be generated.

The parameter i specifies the number of messages to return. If i is less than one or greater then five and argument error will be generated. If less than i messages exist, all the existing messages will be returned.

5.12 Display Subsystem

The DISPlay command allows the user limited control over the front panel display via the SCPI command set.

S300 SCPI	Description
DISPlay:MENU s	Front panel menu to display.

DISP:MENU s: This command will cause the front panel to display the screen specified in parameter s. The only option available is to display the DISPLAY OUTPUTS menu, parameter s must be the string "OUTP".

5.13 System Programming Examples

5.13.1 Power-up

Upon receipt of the response to the *OPC? command the S300 can be queried for its' status and be setup for issuing service requests. All of the modules are in their default states.

Command Sequence	Command Description
DELAY 3 SECOND	Delay 3 seconds for the system to initialize it's GPIB handler.
*OPC?	Synchronize the GPIB controller with the S300 with the *OPC? command. The S300 will response to this command with the string "1" after it has completed power-on reset.

5.13.2 Reset

The following sequence will clear all event and error queues, reset all modules to the power-up configuration state and synchronize the S300 with the GPIB controller.

Command Sequence	Command Description
*CLS	Clear Status Queues
*RST	Reset system and Set DFI Relay
*OPC?	Synchronize the GPIB controller with the S300 with the *OPC? command. The S300 will response to this command with the string "1" after it has completed power-on reset.

5.13.3 Setting up S300 for Service Request

The following sequence will enable the S300 to issue a service request upon detection of any error in the system. If the only error was due to a SCPI syntax error the error can be cleared by sending the command query "SYST:ERR?". The service request is cleared after the error is cleared and the S300 is serial polled.

Command Sequence	Command Description
*SRE 4	Enable the S300 to generate a service request if the system error bit (bit 2) in the Status Byte Register becomes set.

The following sequence will enable the S300 to issue a service request upon detection of a any error in the system. The errors will be logged to both the Status Byte Register and the Standard Event Status Register. If the only error was due to a SCPI syntax error the error is cleared by sending the command queries "SYST:ERR?" and "*ESR?". The "SYST:ERR?" command will clear the error queue. The "*ESR?" will clear the Standard Event Status Register. The service request is cleared after the error is cleared, and the Standard Event Status Register is cleared, and the S300 is serial polled.

Command Sequence	Command Description
*ESE 60	Enables all of the error bits (bits 2,3,4,and 5) of the Standard Event Status Enable Mask.
*SRE 4	Enables the S300 to generate a service request if the system error bit (bit 2) in the Status Byte Register becomes set.

Note that since the Status Byte contains a system error bit and a operation not pending bit, programming complexity is reduced if the service request is based upon the contents of the Status Byte instead of the Standard Event Status Register.

5.13.4 Viewing System Configuration

The command "DIAG:CONF? i,MOD" should be repeated for each module 'i' found in the system by the command "DIAG:CONF? 0,SYTM".

Command Sequence	Command Description
DIAG:CONF? 0,SYTM	Return a list of modules
DIAG:CONF? i,MOD	returns module configuration - repeat for each module in system.

5.13.5 Module/System Status

Use the commands listed below in the following algorithm to read all errors out of the system.

1) Issue the command SYST:ERR? to read, and pop off top error in system error queue.

2) If the returned error code is a generic module error code (101 - 163), select that module with the INST:NSEL command.

    2A) Read module error queue with the command STAT:QUE?

    2B) Repeat 2A) until all module errors have cleared {or you feel that it is time to give up}.

3) Repeat 1) until all system errors have cleared {or you feel that it is time to give up}.

Command Sequence	Command Description
SYST:ERR?	Query system error queue
INST:NSEL X	Select module X.
STAT:QUE?	Query module error queue

5.13.6 Adding a Module

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
DIAG:CONF 1,TYPE, 1	Set module at logical address 1 to type 1.
DIAG:CONF 1,OPTS, 6	Set the options for module at logical address 1 include the Polarity Reversal Relay and the Isolation Relay.
DIAG:CONF 1,ID,CH1	Set the module ID for logical address 1 to 'CH1'.
DIAG:CONF 0,SAVE	Save the new system configuration.
DIAG:CONF? 1,TYPE	Query the module type
DIAG:CONF? 1,OPTS	Query the module options.
DIAG:CONF? 1,ID	Query the module ID.

5.13.7 Deleting a Module

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
DIAG:CONF 1,KILL	Deletes module at logical address 1.
DIAG:CONF 0,SAVE	Save the new system configuration.

5.13.8 Paralleling Modules

To parallel a group of modules the configuration of the master must be modified first. The slave modules are added in sequence after the master. Only modules of the same type may be paralleled together. When modules are paralleled only the master can be programmed. Commands, other then unparalleling, sent to the slave cause an unknown module error to be added to the modules error queue.

In the following example three 10 volt DC Source will be paralleled. The logical address of the master is 2, the first slave is 3, and the third slave is 1.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
DIAG:CONF 2,SPAR,3	Set module 3 to be the slave of module 2
DIAG:CONF 3,SPAR,1	Set module 1 to be the slave of module 3
DIAG:CONF 0,SAVE	Save the new system configuration.

5.13.9 Unparalleling Modules

To unparallel a group of modules the configuration of the last slave must be modified first. The modules will be removed from the group in sequence up to the master module.

In the following example three 10 volt DC Source will be unparalleled. The logical address of the master is 2, the first slave is 3, and the third slave is 1.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
DIAG:CONF 1,MPAR,0	Removes module 1 from the parallel group.
DIAG:CONF 3,MPAR,0	Removes module 3 from the parallel group.
DIAG:CONF 0,SAVE	Save the new system configuration.

6. IEEE-488 DC SOURCE COMMANDS

This section contains those commands, which are specific to the control of the S300 DC Source.

6.1 Test Subsystem

The TEST command performs a specified number of self test options for the system controller and for individual modules. See section RESET AND SELF-TEST FUNCTIONAL Description.

S300 SCPI	Description
TEST i	Perform confidence test.

TEST i: Perform a confidence test on logical address 'i'. The Status of the module Self-test may be found by selecting the module with the INST:NSEL i command and reading the response to the STAT:QUE? query.

If STAT:QUE? returns error “-330, Self-test Failed”, the module has detected an internal error. The rear panel LED will flash X number of time for the error detected. There is an approximate 1 second pause between error flashes

Flash Count	Error
1	Module EPROM checksum error
2	Module RAM error
3	Module EEPROM checksum error
4	Self-test voltage output error
5	Self-test over voltage DAC error
15	Bad calibration data

For parallel modules, a failure of any module within the group will cause a Self-test failure. The actual module in the group that failed may still be determined by checking the LEDs at the rear of the modules.

6.2 Diagnostic Subsystem

The DIAGnostic command allows the user access to S300 configuration data.

Upon command receipt the S300 will update the configuration setting of the parameter 's' for the logical address 'i_1' to the value 'i_2'. If there is not a module at logical address 'i_1' error 241, "Hardware Missing", will be added to the system error queue. The use of the Diagnostic commands by the end user is discouraged. These commands are used for factory configuration and internally during calibration.

Upon query receipt the S300 will returns the current configuration setting of the parameter 's' for the logical address 'i_1'. If there is not a module at logical address 'i_1' error 241, "Hardware Missing", will be added to the system error queue.

The range for the logical address parameter 'i_1', unless otherwise stated, is 1 through 63. Logical address 0 is reserved for the S300 CPU.

S300 SCPI	Description
DIAGnostic:CONFigure[? i,s] i,s,f	Configure CPU/module EEPROM parameters

DIAG:CONF? i,CVO: Returns the calibration voltage offset for the module at logical address 'i'. Voltage Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Calibration Gain to derive a corrected value when calibration is enabled.

DIAG:CONF? i,CVG: Returns the calibration voltage gain for the module at logical address 'i'. Voltage Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,CIO: Returns the calibration current offset for the module at logical address 'i'. Current Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Calibration Gain to derive a corrected value when calibration is enabled.

DIAG:CONF? i,CIG: Returns the calibration current gain for the module at logical address 'i'. Current Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,RCVO: Returns the readback calibration voltage offset for the module at logical address 'i'. Voltage Readback Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Readback Calibration Gain to derive a corrected value when calibration is enabled.

DIAG:CONF? i,RCVG: Returns the readback calibration voltage gain for the module at logical address 'i'. Voltage Readback Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Readback Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,RCIO: Returns the readback calibration current offset for the module at logical address 'i'. Current Readback Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Readback Calibration Gain to derive a corrected value when calibration is enabled

DIAG:CONF? i,RCIG: Returns the readback calibration current gain for the module at logical address 'i'. Current Readback Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Readback Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,OVO: Returns the calibration over voltage offset for the module at logical address 'i.

DIAG:CONF? i,OVG: Returns the calibration over voltage gain for the module at logical address 'i'.

DIAG:CONF? i,NCVO: Returns the negative calibration voltage offset to the value 'f' for the 400 VDC module at logical address 'i'. Voltage Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Calibration Gain to derive a corrected value when calibration is enabled.

DIAG:CONF? i,NCVG: Returns the negative calibration voltage gain to the value 'f' for the 400 VDC module at logical address 'i'. Voltage Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,NCIO: Returns the negative calibration current offset to the value 'f' for the 400 VDC module at logical address 'i'. Current Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Calibration Gain to derive a corrected value when calibration is enabled.

DIAG:CONF? i,NCIG: Returns the negative calibration current gain to the value 'f' for the 400 VDC module at logical address 'i'. Current Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,NRCVO: Returns the negative readback calibration voltage offset to the value 'f' for the 400 VDC module at logical address 'i'. Voltage Readback Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Readback Calibration Gain to derive a corrected value when calibration is enabled.

DIAG:CONF? i,NRCVG: Returns the negative readback calibration voltage gain to the value 'f' for the 400 VDC module at logical address 'i'. Voltage Readback Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Voltage Readback Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF? i,NRCIO: Returns the negative readback calibration current offset to the value ‘f’ for the 400 VDC module at logical address 'i'. Current Readback Calibration Offset is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Readback Calibration Gain to derive a corrected value when calibration is enabled

DIAG:CONF? i,NRCIG: Returns the negative readback calibration current gain to the value ‘f’ for the 400 VDC module at logical address 'i'. Current Readback Calibration Gain is a floating point real number which is one of the values determined during the calibration cycle. This value is used in conjunction with Current Readback Calibration Offset to derive a corrected value when calibration is enabled.

DIAG:CONF i_1,SYNC, i_2: This command enable/disable sync output for module at logical address i_1. If i_2 is 1 the sync will be enabled, if it is 0 the sync will be disabled.

The sync signal will only be output for a voltage level change. The sync signal will be normally low, but will go high for 1 msec upon voltage change.

DIAG:CONF? i_1,SYNC: This query command will respond with the state of the sync signal; "ENABLED" or "DISABLED".

6.3 Measure Subsystem

The MEASure command allows the user to read output voltage, output load current, and heatsink temperature. Before the MEASure command is executed, the INST command must be used to select the correct module channel to be measured. The MEASure command performs all of the functions of the CONF,READ,FETC combination.

S300 SCPI	Description
MEASure:VOLTage?	Measure a voltage value
MEASure:CURRent?	Measure a current value
MEASure:TEMPerture?	Measure a temperature value

MEAS:VOLT?: For the selected logical address the CPU configures itself for a voltage measurement, commands the module to take the voltage measurement {READ}, and then commands the module to respond with the measured voltage value {FETCH}.

MEAS:CURR?: For the selected logical address the CPU configures itself for a current measurement, commands the module to take the current measurement {READ}, and then commands the module to respond with the measured current value {FETCH}.

MEAS:TEMP?: For the selected logical address the CPU configures itself for a temperature measurement, commands the module to take the temperature measurement {READ}, and then commands the module to respond with the measured temperature value {FETCH}.

6.4 Configure Subsystem

Configures the S300 controller to prepare to take a measurement.

S300 SCPI	Description
CONFigure[?]	Returns the current configuration state.
CONFigure:VOLTage	Configure for voltage measurement
CONFigure:CURRent	Configure for current measurement
CONFigure:TEMPerture	Configure for temperature measurement

CONF?: Returns the current configuration state. If in voltage configuration this command returns “VOLTAGE”, if in current configuration this command returns “CURRENT”, if in temperature configuration this command returns “TEMPERATURE”, and if nothing has been configured this command will return “NONE”. The default state is “NONE”.

CONF:VOLT: For the selected logical address the CPU configures itself for a voltage measurement.

CONF:CURR: For the selected logical address the CPU configures itself for a current measurement.

CONF:TEMP: For the selected logical address the CPU configures itself for a temperature measurement.

6.5 Fetch Subsystem

Causes the S300 controller to command the module to respond with the latest measured value. Before the FETCh command is executed, the INST:NSEL command must be used to select the correct module channel from which to get data.

S300 SCPI	Description
FETCh?	Fetch the configured measurement
FETCh:VOLTage?	Fetch voltage measurement
FETCh:CURRent?	Fetch current measurement
FETCh:TEMPerture?	Fetch temperature measurement

FETC?: The CPU commands the module at the selected logical address to respond with the latest measured value for the configured signal. If the system has not been configured for any measurement, error “-100, Command Error”, will be set.

FETC:VOLT? The CPU commands the module at the selected logical address to respond with the latest measured voltage value. If the system has not been configured for a voltage measurement, error "-100, Command Error", will be set.

FETC:CURR? The CPU commands the module at the selected logical address to respond with the latest measured current value. If the system has not been configured for a current measurement, error "-100, Command Error", will be set.

FETC:TEMP? The CPU commands the module at the selected logical address to respond with the latest measured temperature value. If the system has not been configured for a temperature measurement, error "-100, Command Error", will be set.

6.6 Read Subsystem

Causes the S300 controller to command the module to measure a value. Before the READ command is executed, the INST:NSEL command must be used to select the correct module channel.

S300 SCPI	Description
READ?	Reads the configured measurement
READ:VOLTage?	Read voltage measurement
READ:CURRent?	Read current measurement
READ:TEMPerture?	Read temperature measurement

READ? The CPU commands the module at the selected logical address to measure the configured signal. If the system has not been configured for any measurement, error "-100, Command Error", will be set.

READ:VOLT? The CPU commands the module at the selected logical address to measure the voltage. If the system has not been configured for a voltage measurement, error "-222, Data out of Range", will be set.

READ:CURR? The CPU commands the module at the selected logical address to measure the current. If the system has not been configured for a current measurement, error "-222, Data out of Range", will be set.

READ:TEMP? The CPU commands the module at the selected logical address to measure the temperature. If the system has not been configured for a temperature measurement, error "-222, Data out of Range", will be set.

6.7 Calibrate Subsystem

6.7.1 CAL

The CALibration command allows the user to calibrate a channel with external measurement equipment. Voltage and current or just voltage may be calibrated. The process may be aborted at any time. Before the CAL command is executed, the INST command must be used to select the correct channel to be calibrated.

S300 SCPI	Description
CALibrate?	Initiate calibration procedure
CALibrate:DATA f	Input calibration data
CALibrate:STATe[?] b	Set calibration calculation enable state

CAL? Initiate the calibration procedure.

CAL:DATA f Input calibration data 'f' for the given step in the module calibration procedure.

CAL:STAT ON | 1: Enables the calibration factor correction. This is the default state.

CAL:STAT OFF | 0; Disables the calibration factor correction.

CAL:STAT? Returns the state of the calibration correction factors, either "ON" or "OFF".

6.7.2 Calibrating a DC Source

The calibration sequence is voltage followed by current. The sequence can be stopped before the current is calibrated and only the voltage calibration data can be updated. Modules may be calibrated in parallel if desired. Parallel calibration will affect the master module calibration parameters only. If you switch back to nonparallel operation the master module should be recalibrated individually.

To perform the voltage calibration an external calibrated 5.5 digit DMM with an accuracy of better than .004% of module full scale voltage must be connected across the outputs.

If current calibration is desired then a load must be attached to the module's output, which is capable of sinking full load current. Short circuiting the output is acceptable. A current measuring device capable of measuring the full load current must be placed in series with this load. This may be accomplished using a calibrated shunt connected to a DMM in 200 millivolt (or similar) range from which load currents is calculated (Vdmm/Rshunt).

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
INST:NSEL 1	Select Module at logical address 1
STAT:QUE?	Query the selected modules status Queue and set DFI relay
CAL?	Start Voltage Calibration Sequence
CAL:DATA xxx.xxx	Input 10% FSV read from DMM
CAL:DATA xxx.xxx	Input 90 FSV read from DMM
CAL?	Start Current Calibration Sequence
CAL:DATA xxx.xxx	Input 10% FSIread from DMM
CAL:DATA xxx.xxx	Input 90 FSIread from DMM
	If the module is a 400 VDC Source with the negative polarity option complete the next 6 steps, else go to the last line.
CAL?	Start Negative Voltage Calibration Sequence
CAL:DATA xxx.xxx	Input 10% FSV read from DMM
CAL:DATA xxx.xxx	Input 90 FSV read from DMM
CAL?	Start Negative Current Calibration Sequence
CAL:DATA xxx.xxx	Input 10% FSIread from DMM
CAL:DATA xxx.xxx	Input 90 FSIread from DMM
DIAG:CONF 0,SAVE	Save Calibration data to modules

6.8 Current Subsystem

S300 SCPI [SOURce:]	Description
CURRent[?] f CURRent:AMPLitude[?] f CURRent:IMMediate:AMPLitude[?] CURRent:LEVel:AMPLitude[?] f CURRent:LEVel:IMMediate:AMPLitude[?] f	Set current limit.
CURRent:HIGH f CURRent:IMMediate:HIGH f CURRent:LEVel:HIGH f CURRent:LEVel:IMMediate:HIGH f	Increment current limit.
CURRent:LOW f CURRent:IMMediate:LOW f CURRent:LEVel:LOW f CURRent:LEVel:IMMediate:LOW f	Decrement current limit.
CURRent:LIMit[?] f CURRent:LIMit:AMPLitude[?] CURRent:LIMit:MAXimum:AMPLitude[?] f	Set programmable current limit.
CURRent:LIMit:HIGH f CURRent:LIMit:MAXimum:HIGH f	Increment programmable current limit.
CURRent:LIMit:LOW f CURRent:LIMit:MAXimum:LOW f	Decrement programmable current limit.
CURRent:LIMit:STATus[?] b CURRent:LIMit:MAXimum:STATus[?]	Enable/Disable use of programmable current limit.
CURRent:PROTection[?] f CURRent:PROTection:MAXimum[?] CURRent:PROTection:LEVel[?] f CURRent:PROTection:LEVel:MAXimum[?] f	Set current trip level.
CURRent:PROTection:TIME[?] f	Set current time (msec).
CURRent:PROTection:STATus[?]	Enable/Disable use of current trip.
CURRent:PROTection:TRIP?	Query current trip state.
CURRent:PROTection:CLE	Clear current trip condition.

CURR f: Sets the module current limit to the value 'f'.

If, during operation, the module detects a current output of greater than the current limit, the module will go into Current Limit Mode.

The default/reset value of this parameter is 0 amps. The maximum input value is the maximum current for the module type as specified in Module Types. The minimum input value is 0 amps.

If the input value is greater than the maximum current limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

CURR?: Returns the module current limit.

CURR:HIGH f: Increments the module current limit by the value 'f'.

If the sum of the input value and the present current limit is greater than the maximum current limit for the module type, error 222 "Data out of range" will be added to the module error queue.

CURR:LOW f: Decrements the module current limit by the value 'f'.

If the sum of the present current limit minus the input value is zero or less error 222 "Data out of range" will be added to the modules error queue.

CURR:LIM f: Sets the module programmable current limit to the value 'f'. This parameter is enabled with CURR:LIM:STAT command. It is a programmable current limit is used in place of the maximum current limit for data out of range testing with the CURR, and CURR:HIGH commands.

The default/reset value of this parameter is the maximum input value. The maximum input value is the maximum current for the module type as specified in Module Types. The minimum input value is 0 amps.

If the input value is greater than the maximum current limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

CURR:LIM?: Returns the module programmable current limit.

CURR:LIM:HIGH f: Increments the module programmable current limit by the value 'f'.

If the sum of the input value and the present programmable current limit is greater than the maximum current limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

CURR:LIM:LOW f: Decrements the module programmable current limit by the value 'f'.

If the sum of the present programmable current limit minus the input value is zero or less error 222 "Data out of range" will be added to the modules error queue.

CURR:LIM:STAT ON | 1: Enables the use of the programmable current limit as the current limit used for range checking on parameters input with the CURR command.

CURR:LIM:STAT OFF | 0: Disables the use of the programmable current limit as the current limit used for range checking on parameters input with the CURR command. When the CURR:LIM is disabled the maximum current limit as defined by the modules type is used for range checking.

CURR:LIM:STAT?: Returns "ON" if the programmable current limit is enabled or "OFF" if the programmable current limit is disabled.

The default/reset value of this parameter is “OFF”.

CURR:PROT f: Sets the module current protection level to the value 'f'. This command is used in conjunction with the CURR:PROT:TIME command. If enabled, the module output current can go above the current protection level for the time specified in CURR:PROT:TIME. If the current does go above the level for greater than the specified time, the module will shutdown and error 10 "Module Current Error" will be added to the modules error queue.

The default/reset value of this parameter is the maximum current for the module type as specified in Module Types. The maximum is 110% of the maximum current. The minimum input value is 0 amps.

If the value input is greater than the maximum current limit for the module type, error 222 "Data out of range" will be added to the module error queue.

CURR:PROT?: Returns the current protection level.

CURR:PROT:STAT ON | 1: Enables the use of the programmable current protection level.

CURR:PROT:STAT OFF | 0: Disables the use of the programmable current protection level.

CURR:PROT:STAT?: Returns "ON" if the current protection is enabled or "OFF" if the current protection is disabled.

The default/reset value of this parameter is “ON”.

CURR:PROT:TIME f: Sets the trip delay time, in milliseconds, used in the CURR:PROT command. The range of the protection time is 65535 milliseconds.

The default/reset value of this parameter is 100 msec. The maximum input value is 65535 msec. The minimum input value is 10 msec.

If the value input is greater than the maximum current limit for the module type, error 222 "Data out of range" will be added to the module error queue.

CURR:PROT:TIME?: Returns the trip delay time, in milliseconds, used in the CURR:PROT command.

CURR:PROT:TRIP?: Returns the current trip status, either "TRIPPED" or "CLEAR".

CURR:PROT:CLE: Clears the current trip by resetting the module.

6.9 Voltage Subsystem

S300 SCPI [SOURce:]	Description
VOLTage[?] f VOLTage:AMPLitude[?] f VOLTage:IMMediate:AMPLitude[?] VOLTage:LEVel:AMPLitude[?] f VOLTage:LEVel:IMMediate:AMPLitude[?] f	Set voltage level.
VOLTage:HIGH f VOLTage:IMMediate:HIGH f VOLTage:LEVel:HIGH f VOLTage:LEVel:IMMediate:HIGH f	Increment voltage level.
VOLTage:LOW f VOLTage:IMMediate:LOW f VOLTage:LEVel:LOW f VOLTage:LEVel:IMMediate:LOW f	Decrement voltage level.
VOLTage:LIMit[?] f VOLTage:LIMit:AMPLitude[?] VOLTage:LIMit:MAXimum:AMPLitude[?] f	Set programmable voltage limit.
VOLTage:LIMit:HIGH f VOLTage:LIMit:MAXimum:HIGH f	Increment programmable voltage limit.
VOLTage:LIMit:LOW f VOLTage:LIMit:MAXimum:LOW f	Decrement programmable voltage limit.
VOLTage:LIMit:STATus[?] f VOLTage:LIMit:MAXimum:STATus[?] f	Enable/Disable use of programmable voltage limit.
VOLTage:PROTection[?] f VOLTage:PROTection:MAXimum[?] VOLTage:PROTection:LEVel[?] f VOLTage:PROTection:LEVel:MAXimum[?] f	Set overvoltage protection trip point.
VOLTage:PROTection:MINimum[?] VOLTage:PROTection:LEVel:MINimum[?] f	Set undervoltage protection trip point.

VOLTage:PROTection:STATus[?]	Enable/Disable use of overvoltage protection.
VOLTage:PROTection:TRIP?	Query voltage trip state.
VOLTage:PROTection:CLE	Clears voltage trip condition.

VOLT f: Sets the source voltage to the value ‘f’.

The default/reset value of this parameter is 0 volts. The maximum input value is the maximum voltage for the module type as specified in Module Types. The minimum input value is 0 volts, unless the module includes the reverse polarity option. If the module includes the reverse polarity option the minimum input voltage is the negative of the maximum voltage.

If the input value is greater than the maximum voltage limit for the module type, error 222 "Data out of range" will be added to the module error queue.

VOLT?: Returns the programmed setting of the voltage level.

VOLT:HIGH f: Increments the module voltage by the value 'f'.

If the sum of the input value and the present voltage level is greater than the maximum voltage level for the module type, error 222 "Data out of range" will be added to the modules error queue.

VOLT:LOW f: Decrements the module voltage by the value 'f'.

If the sum of the present voltage level minus input value is less than the minimum allowable voltage error 222 "Data out of range" will be added to the module error queue.

VOLT:LIM f: Sets the module programmable voltage limit to the value 'f'. If enabled, the programmable voltage limit is used for the maximum voltage limit when the module voltage level is modified (see VOLT, VOLT:HIGH, and VOLT:LOW).

The default/reset value of this parameter is the maximum input value. The maximum input value is the voltage limit for the module type as specified in Module Types. The minimum input value is 0 volts.

If the input value is greater than the maximum voltage limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

VOLT:LIM?: Returns the module programmable voltage limit.

VOLT:LIM:HIGH: Increments the module programmable voltage limit by the value 'f'. If the sum of the input value and the present programmable voltage limit is greater than the maximum voltage limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

VOLT:LIM:LOW: Decrements the module programmable voltage limit by the value 'f'. If the sum of the present programmable voltage limit minus the input value is less than the minimum allowable voltage error 222 "Data out of range" will be added to the modules error queue.

VOLT:LIM:STAT ON | 1: Enables the use of the programmable voltage limit as the voltage limit used for range checking on parameters input with the VOLT command

VOLT:LIM:STAT OFF | 0: Disables the use of the programmable voltage limit as the voltage limit used for range checking on parameters input with the VOLT command. When the VOLT:LIM is disabled the maximum voltage limit as defined by the modules type is used for range checking.

VOLT:LIM:STAT?: Returns "ON" if the programmable voltage limit is enabled or "OFF" if the programmable voltage limit is disabled.

The default/reset value of this parameter is “OFF”.

VOLT:PROT f: Sets the module overvoltage protection level to the value 'f'. If the value input is greater than the maximum voltage limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

The default/reset value of this parameter is 110% of the maximum voltage limit for the module type as specified in Module Types. The maximum input is the default. The minimum input value is 0 volts.

If the absolute value of the output voltage goes above the overvoltage protection level the module will shutdown and error 5 "Module Voltage Error" will be added to the modules error queue.

VOLT:PROT?: Returns the overvoltage protection level.

VOLT:PROT:STAT ON | 1: Enables the use of the overvoltage protection.

VOLT:PROT:STAT OFF | 0: Disables the use of the overvoltage protection.

VOLT:PROT:STAT?: Returns "ON" if the overvoltage protection is enabled or "OFF" if the over voltage protection is disabled.

The default/reset value of this parameter is “ON”.

VOLT:PROT:MIN f: Sets the module undervoltage protection level to the value 'f'. If the value is zero the undervoltage protection will be disabled. If the value input is greater than the maximum voltage limit for the module type, error 222 "Data out of range" will be added to the modules error queue.

The default/reset value of this parameter is 0 volts; therefore disabled. The maximum input is voltage limit for the module type as specified in Module Types. The minimum input value is 0 volts.

If the undervoltage protection is enabled and the absolute value of the output voltage goes below the undervoltage protection level the module will shutdown and error 5 "Module Voltage Error" will be added to the modules error queue.

VOLT:PROT:MIN?: Returns the undervoltage protection level.

VOLT:PROT:TRIP?: Returns the voltage protection trip status, either "TRIPPED" or "CLEAR".

VOLT:PROT:CLE: Clears the voltage protection trip by resetting the module.

6.10 Output Subsystem

The OUTPut command allows the user to control whether the output terminals of the selected S300 module are opened or closed.

S300 SCPI	Description
OUTPut[?] b OUTPut:STATus[?] b	Open/Close output relay.

OUTP ON | 1: Closes the output relay.

The default/reset state of this parameter is open.

OUTP OFF | 0: Opens the output relay.

OUTP?: Queries the state of the output relay. Returns "ON" or "OFF".

6.11 Sense Subsystem

The SENSe command allows the user to select either internal or external sense as the source of the voltage level control feedback.

S300 SCPI	Description
SENSe? SENSe:VOLTage? SENSe:VOLTage:REFerence?	Queries the state of the external sense relay.
SENSe:VOLTage:REFerence:STATe b	Sets the state of the external sense relay.

SENS?: Queries the state of the external sense relay. Returns “INTERNAL” or “EXTERNAL.” The default state of the relay is INTERNAL.

SENS:VOLT:REF:STAT ON | 1: Sets the sense relay to EXTERNAL.

SENS:VOLT:REF:STAT OFF | 0: Sets the sense relay to INTERNAL.

6.12 DC Source Programming Examples

For each example listed below, the first four commands reset the system to a known state. They are not needed in the continuous operation of the S300 unless the system needs to be returned to a known state.

6.12.1 Programming Module Output

The following is a typical turn on and initialization sequence for setting up and using an S300 10 Volt DC Source Module.

Before setting up a voltage and turning on the output, the protection options should be setup. When setup these options will limit the module to work in a specific range and prevent damage to the UUT.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
INST:NSEL 1	Select Module at logical address 1
STAT:QUE?	Query the selected modules status Que.
VOLT:LIM 10	Set the voltage programming limit to 10 volts
CURR:LIM 60	Set the programming current limit to 60 amps
VOLT:PROT 10	Set the Overvoltage Protection level to 10 volts
VOLT:PROT:STAT ON	Enable Overvoltage protection
VOLT:PROT:MIN 0	Disable undervoltage protection (0 disables this function)
CURR:PROT 60	Set the current protection to 60 amps
CURR:PROT:TIME 100	Set the Overcurrent trip delay to 100 msec
CURR:PROT:STAT ON	Enable Overcurrent protection
VOLT 5	Set voltage to 5 volts
CURR 5	Set current limit to 5 amps
OUTP ON	Turn the output on
STAT:QUE?	Query the selected modules status Queue
SYST:ERR?	Query System Error Queue
MEAS:VOLT?	Measure output voltage
MEAS:CURR?	Measure output current
MEAS:TEMP?	Measure module temperature

6.12.2 Trigger

The following is the sequence of commands needed to trigger a voltage step change. Assume the source is a 10 module, and the trigger will come from an external device.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
INST:NSEL 1	Select Module at logical address 1
OUTPUT ON	Close output relay
INIT	Put system into Trigger INIT Mode
VOLT 5	Program output voltage to 5 volts
ARM	Put system into Trigger ARM Mode
TRIG	Generate Trigger, Trigger Mode returns to IDLE
MEAS:VOLT?	Measure voltage, s/b~5 volts

7. IEEE-488 LOAD COMMANDS

This section contains those commands, which are specific to the control of the S300 Load Module.

7.1 Test Subsystem

The TEST command performs a specified number of self test options for the system controller and for individual modules. See section RESET AND SELF-TEST FUNCTIONAL Description.

S300 SCPI	Description
TEST i	Perform confidence test.

TEST I: Perform a confidence test on logical address 'i'. The Status of the module Self-test may be found by selecting the module with the INST:NSEL i command and reading the response to the STAT:QUE? query.

If STAT:QUE? returns error “-330, Self-test Failed”, the module has detected an internal error. The rear panel LED will flash at an approximate 2 Hz rate. This LED normally flashes at approximately 1/2 Hz rate.

For parallel modules, a failure of any module within the group will cause a Self-test failure. The actual module in the group that failed may still be determined by checking the LEDs at the rear of the modules.

7.2 Diagnostic Subsystem

The DIAGnostic command allows the user access to S300 configuration data.

Upon command receipt the S300 will update the configuration setting of the parameter 's' for the logical address 'i_1' to the value 'i_2'. If there is not a module at logical address 'i_1' error 241, "Hardware Missing", will be added to the system error queue. The use of the Diagnostic commands by the end user is discouraged. These commands are used for factory configuration and internally during calibration.

Upon query receipt the S300 will returns the current configuration setting of the parameter 's' for the logical address 'i_1'. If there is not a module at logical address 'i_1' error 241, "Hardware Missing", will be added to the system error queue.

The range for the logical address parameter 'i_1', unless otherwise stated, is 1 through 63. Logical address 0 is reserved for the S300 CPU.

S300 SCPI	Description
DIAGnostic:CONFigure[? i,s] i,s,f	Configure CPU/module EEPROM parameters

DIAG:CONF i_1,SYNC, i_2: This command enable/disable sync output for module at logical address i_1. If i_2 is 1 the sync will be enabled, if it is 0 the sync will be disabled.

The sync signal will be output for a current step, start of Pulse Mode, and Mode Change. The sync signal will be normally high, but will go low for approximately 11 µsec.

DIAG:CONF? i_1,SYNC: This query command will respond with the state of the sync signal; "ENABLED" or "DISABLED".

7.3 Measure Subsystem

The MEASure command allows the user to read voltage, load current, heatsink temperature, and power. Before the MEASure command is executed, the INST:NSEL command must be used to select the correct module channel to be measured. The MEASure command performs all of the functions of the CONF,READ,FETC combination.

The power measurement is a convenience function. They are generated from load current and voltage measurements.

S300 SCPI	Description
MEASure:VOLTage?	Measure the load voltage
MEASure:CURRent?	Measure the load current
MEASure:TEMPerture?	Measure the load temperature
MEASure:POWER?	Measure the load power

MEAS:VOLT?: For the selected logical address the CPU configures itself for a voltage measurement, commands the module to take the voltage measurement {READ}, and then commands the module to respond with the measured voltage value {FETCH}.

MEAS:CURR?: For the selected logical address the CPU configures itself for a current measurement, commands the module to take the current measurement {READ}, and then commands the module to respond with the measured current value {FETCH}.

MEAS:TEMP?: For the selected logical address the CPU configures For the selected itself for a temperature measurement, commands the module to take the temperature measurement

{READ}, and then commands the module to respond with the measured temperature value {FETCH}.

MEAS:POW?: For the selected logical address the CPU takes, as described above, a voltage measurement and a current measurement, as described above, and returns the product of the voltage response multiplied by the current response. The CONF:, READ:, and FETC: commands are not implemented for the power measurement.

7.4 Configure Subsystem

Configures the S300 controller to prepare to take a foreground or background measurement. See section 1.3.5 for a description of the background measurement. Before the CONFigure command is executed, the INST:NSEL command must be used to select the correct module channel to be configured.

S300 SCPI	Description
CONFigure?	Returns the current configuration state.
CONFigure:VOLTage	Configure for voltage measurement
CONFigure:CURRent	Configure for current measurement
CONFigure:TEMPerture	Configure for temperature measurement
CONFigure:BACKground?	Returns the current background measurement configuration state.
CONFigure:BACKground:VOLTage	Configure for background voltage measurement
CONFigure:BACKground:CURRent	Configure for background current measurement
CONFigure:BACKground:TEMPerture	Configure for background temperature measurement

CONF?: Returns the current configuration state. If in voltage configuration this command returns “VOLTAGE”, if in current configuration this command returns “CURRENT”, if in temperature configuration this command returns “TEMPERATURE”, and if nothing has been configured this command will return “NONE”. The default state is “NONE”.

CONF:VOLT: For the selected logical address the CPU configures itself for a voltage measurement.

CONF:CURR: For the selected logical address the CPU configures itself for a current measurement.

CONF:TEMP: For the selected logical address the CPU configures itself for a temperature measurement.

CONF:BACK?: Returns the current background measurement configuration state. If in voltage configuration this command returns “VOLTAGE”, if in current configuration this command returns “CURRENT”, if in temperature configuration this command returns “TEMPERATURE”, and if nothing has been configured this command will return “NONE”. The default state is “NONE”.

CONF:BACK:VOLT: For the selected logical address the CPU configures itself for a background voltage measurement.

CONF:BACK:CURR: For the selected logical address the CPU configures itself for a background current measurement.

CONF:BACK:TEMP: For the selected logical address the CPU configures itself for a background temperature measurement.

7.5 Fetch Subsystem

Causes the S300 controller to command the module to respond with the last foreground or background measured value. Before the FETCh command is executed, the INST:NSEL command must be used to select the correct module channel from which to get data.

S300 SCPI	Description
FETCh?	Fetch the configured measurement
FETCh:VOLTage?	Fetch voltage measurement
FETCh:CURRent?	Fetch current measurement
FETCh:TEMPerture?	Fetch temperature measurement
FETCh:BACKground?	Fetch the configured background measurement
FETCh:BACKground:VOLTage	Fetch the background voltage measurement
FETCh:BACKground:CURRent?	Fetch the background current measurement
FETCh:BACKground:TEMPerture?	Fetch the background temperature measurement

FETC?: The CPU commands the module at the selected logical address to respond with the last measured value for the configured signal. If the system has not been configured for any measurement, error “-100, Command Error”, will be set.

FETC:VOLT?: The CPU commands the module at the selected logical address to respond with the last measured voltage value. If the system has not been configured for a voltage measurement, error “-100, Command Error”, will be set.

FETC:CURR?: The CPU commands the module at the selected logical address to respond with the last measured current value. If the system has not been configured for a current measurement, error “-100, Command Error”, will be set.

FETC:TEMP?: The CPU commands the module at the selected logical address to respond with the last measured temperature value. If the system has not been configured for a temperature measurement, error "-100, Command Error", will be set.

FETC:BACK?: The CPU commands the module at the selected logical address to respond with the latest background measured value for the configured signal. If the system has not been configured for any measurement, error "-100, Command Error", will be set.

FETC:BACK:VOLT?: The CPU commands the module at the selected logical address to respond with the latest background measured voltage value. If the system has not been configured for a voltage measurement, error "-100, Command Error", will be set.

FETC:BACK:CURR?: The CPU commands the module at the selected logical address to respond with the latest background measured current value. If the system has not been configured for a current measurement, error "-100, Command Error", will be set.

FETC:BACK:TEMP?: The CPU commands the module at the selected logical address to respond with the latest background measured temperature value. If the system has not been configured for a temperature measurement, error "-100, Command Error", will be set.

7.6 Read Subsystem

Causes the S300 controller to command the module to measure a value. Before the READ command is executed, the INST:NSEL command must be used to select the correct module channel.

S300 SCPI	Description
READ?	Reads the configured measurement
READ:VOLTage?	Read voltage measurement
READ:CURRent?	Read current measurement
READ:TEMPerture?	Read temperature measurement

READ?: The CPU commands the module at the selected logical address to measured the configured signal. If the system has not been configured for any measurement, error "-100, Command Error", will be set.

READ:VOLT?: The CPU commands the module at the selected logical address to measured the voltage. If the system has not been configured for a voltage measurement, error "-222, Data out of Range", will be set.

READ:CURR?: The CPU commands the module at the selected logical address to measured the current. If the system has not been configured for a current measurement, error "-222, Data out of Range", will be set.

READ:TEMP?: The CPU commands the module at the selected logical address to measured the temperature. If the system has not been configured for a temperature measurement, error "-222, Data out of Range" will be set.

7.7 Mode Subsystem

This subsystem allows the operator to setup the load's mode. The Mode Subsystem is an extension to the SCPI, 1990 version of compliance, command dictionary. At reset and range change the Load Mode will go to Constant Current Mode.

This command cannot be sent if the module is in Pulse Mode, the system armed, or a mode command has been programmed while the system's Trigger Mode is INIT. If any of these conditions occur a error 200: Execution Error" will be added to the module error queue.

S300 SCPI [SOURce:]	Description
MODE[?] CC|CV|CP|CR|SC|AUTO|OFF	Set the Load Mode.

MODE CC: Set the load module to Constant Current Mode at the level programmed via the CURRent command.

MODE CV: Set the load module to Constant Voltage Mode at the level programmed via the VOLTage command.

MODE CP: Set the load module to Constant Power Mode at the level programmed via the POWer command.

MODE CR: Set the load module to Constant Resistance Mode at the level programmed via the RESistance and VOLTage:NOMinal commands.

MODE SC: Sets the load module into Short Circuit Mode. Note: Short Circuit Mode can not be triggered for parallel loads.

MODE AUTO : Sets the load module into Auto Mode In this mode the operator can update the loads voltage, current, power, and nominal voltage parameters.

MODE OFF: Sets the load module into Constant Current Mode at zero amps, with all of the internal FETs turned off.

MODE?: Returns the mode; "CC", "CV", "CP", "CR", "SC", "AUTO", or "OFF".

7.8 Current Subsystem

Sets up the current amplitude parameters

S300 SCPI [SOURce:]	Description
CURRent[?] f CURRent:AMPLitude[?] f CURRent:IMMediate:AMPLitude[?] CURRent:LEVel:AMPLitude[?] f CURRent:LEVel:IMMediate:AMPLitude[?] f	Set current level used for Constant Current Mode.
CURRent:REFerence:STATe[?] b	Selects external current modulation.
CURRent:RANGe[?] f	Selects the current range
CURRent:MODE[?] FIXed | LIST	Selects current amplitude control.
CURRent:RTIMe[?] f	Sets the rise time
CURRent:FTIMe[?] f	Sets the fall time

CURR f: If the module is in CC Mode the current limit is set to 'f'. If the module is not in CC Mode the value is stored until CC Mode is selected with the MODE command.

This command cannot be sent if the module is in Pulse Mode or the system armed. If any of these conditions occur an error -100 "Command error" will be added to the modules error queue.

The default/reset value for this parameter is 0 amps. The minimum input value is 0 amps. The maximum input value is the maximum current level for the present range setting. If the input value is not within the limits error -222 "Data out of range" will be added to the modules error queue.

CURR?: Returns the programmed current value.

CURR:REF:STAT ON | 1: Enables external current modulation.

The default/reset state of external modulation is disabled.

If in Pulse Mode this command will be aborted and err -100 "Command error" will be added to the modules error queue.

CURR:REF:STAT OFF | 0: Disables external current modulation.

If in Pulse Mode this command will be aborted and err -100 "Command error" will be added to the modules error queue.

CURR:REF:STAT?: Returns "ON" if external modulation is enables else it returns "OFF".

CURR:RANG f: Sets the load working range for current in amps. When this parameter is programmed the software selects the smallest range, which contains the input value.

When this command is executed the following parameter are set to their default values:

Parameter	Default
CURR	0 amps
CURR:RTIM	10 µsec
CURR:FTIM	10 µsec
VOLT	0 volts
VOLT:NOM	0 volts
POW	0 watts
RES	1 MΩ
LIST:CURR	0 amps, 0 amps, 0 amps
LIST:DWEL	1 msec, 1 msec, 1 msec
LIST:GEN	DSEQ
LIST:SEQ	1,2,3,1
MODE	CC

If the programmed voltage range is not within the specification for the input current range, the programmed voltage range will be changed to the maximum possible value for the input current range parameter.

If the value 'f' outside of the maximum range the error -222 "Data out of range" will be added to the module error queue.

The default/reset value of this parameter is 60 amps.

CURR:RANG?: Returns the current range parameter.

CURR:MODE FIXED: Sets the current amplitude control to Fixed Mode. In Fixed Mode the current maximum level is controlled by the CURR command or the external modulation if it is enabled. This command will halt Pulse Mode operation.

This command cannot be sent if the system armed. If this condition occurs an error -100 "Command error" will be added to the modules error queue.

The default/reset value for CURR:MODE state is FIXED

CURR:MODE LIST: Sets the current amplitude control to Pulse Mode. In Pulse Mode the current level is controlled by the parameter specified in the LIST command. This command will start Pulse Mode operation.

When this command is input the compatibility between the dwell and rise/fall times is checked. The programmed dwell time for any state must be at least 10 µsec greater than the programmed rise or fall time used to reach the state.

If there is an error in the compatibility between the dwell and rise/fall times specified by the LIST command error -100 "Command error" will be added to the modules error queue.

This command can only be sent if the load is in CC Mode. Error-100 "Command error" will be added to the modules error queue.

CURR:MODE?: Returns the selected mode "FIXED" or "LIST"

CURR:RTIM f: Sets the rise time, in seconds, to the input value 'f'. This parameter specifies the time to transition the current from the present level to a higher level for both the CURR command and in Pulse Mode.

The default/reset value for this parameter is 10 µsec. The minimum input value is 10 µsec. The maximum input value is 8.0 seconds. The resolution is 2 µsec. If the input value is out of range an error -222 "Data out of range" will be added to the modules error queue.

CURR:RTIM?: Returns the programmed rise time.

CURR:FTIM f: Sets the fall time, in seconds, to the input value 'f'. This parameter specifies the time to transition the current from the present level to a lower level for both the CURR command and in Pulse Mode.

The default/reset value for this parameter is 10 µsec. The minimum input value is 10 µsec. The maximum input value is 8.0 seconds. The resolution is 2 µsec. If the input value is out of range an error -222 "Data out of range" will be added to the modules error queue.

CURR:FTIM?: Return the programmed fall time

7.9 Voltage Subsystem

Sets up the voltage parameters

S300 SCPI [SOURce:]	Description
VOLTage[?] f VOLTage:AMPLitude[?] f VOLTage:IMMediate:AMPLitude[?] VOLTage:LEVel:AMPLitude[?] f VOLTage:LEVel:IMMediate:AMPLitude[?] f	Set voltage level used for Constant Voltage Mode.
VOLTage:NOMinal[?] f VOLTage:AMPLitude:NOMinal[?] f VOLTage:IMMediate:AMPLitude:NOMinal[?] VOLTage:LEVel:AMPLitude:NOMinal[?] f VOLTage:LEVel:IMMediate:AMPLitude:NOMinal[?] f	Set nominal voltage level.
VOLTage:RANGe[?] f	Selects the voltage range

VOLT f: If the module is in CV Mode the load voltage is set to 'f'. If the module is not in CV Mode the value is stored until CV Mode is selected with the MODE command.

This command cannot be sent if the module is in Pulse Mode or the system armed. If any of these conditions occur an error -100 "Command error" will be added to the modules error queue.

The default/reset value for this parameter is 0 volts. The minimum input value is 0 volts. The maximum input value is the maximum voltage level for the present range setting. If the input value is not within the limits error -222 "Data out of range" will be added to the modules error queue.

VOLT?” Returns the module programmed voltage.

VOLT:NOM f: If the module is in CR Mode the load nominal voltage is set to 'f'. If the module is not in CR Mode the value is stored until CR Mode is selected with the MODE command.

This command cannot be sent if the module is in Pulse Mode or the system armed. If any of these conditions occur an error -100 "Command error" will be added to the modules error queue.

The default/reset value for this parameter is 0 volts. The minimum input value is 0 volts. The maximum input value is the maximum voltage level for the present range setting. If the input value is not within the limits error -222 "Data out of range" will be added to the modules error queue.

VOLT:NOM?: Returns the module nominal voltage value.

VOLT:RANG f: Sets the load working range for voltage in volts. When this parameter is programmed the software selects the smallest range that contains the input value.

When this command is executed the following parameter are set to their default values:

Parameter	Default
CURR	0 amps
CURR:RTIM	10 µsec
CURR:FTIM	10 µsec
VOLT	0 volts
VOLT:NOM	0 volts
POW	0 watts
RES	1 MΩ
LIST:CURR	0 amps, 0 amps, 0 amps
LIST:DWEL	1 msec, 1 msec, 1 msec
LIST:GEN	DSEQ
LIST:SEQ	1,2,3,1
MODE	CC

If the programmed current range is not within the specification for the input voltage range, the programmed current range will be changed to the maximum possible value for the input voltage range parameter.

If the value 'f' outside of the maximum range the error -222 "Data out of range" will be added to the module error queue. The default/reset value of this parameter is 120 volts.

VOLT:RANG?: Returns the voltage range parameter.

7.10 Power Subsystem

Sets up the power parameters

S300 SCPI [SOURce:]	Description
POWer[?] f POWer:AMPLitude[?] f POWer:IMMediate:AMPLitude[?] POWer:LEVel:AMPLitude[?] f POWer:LEVel:IMMediate:AMPLitude[?] f	Set power limit.
POWer:RANGe[?] f	Selects the power range

POW f: If the module is in CP Mode the load power is set to 'f'. If the module is not in CP Mode the value is stored until CP Mode is selected with the MODE command.

This command cannot be sent if the module is in Pulse Mode or the system armed. If any of these conditions occur an error -100 "Command error" will be added to the modules error queue.

The default/reset value for this parameter is 0 watts. The minimum input value is 0 watts. The maximum input value is the maximum power level for the present range settings. If the input value is not within the limits error -222 "Data out of range" will be added to the modules error queue.

POW?: Returns the programmed power limit for CP Mode.

POW:RANG I: Sets the load into range 'i', for a single load.

	120v/450v Load		8v/80v Load	
i	Voltage (V)	Current (A)	Voltage (V)	Current (A)
1	120.0	0.6	8	6
2	120.0	6.0	8	60
3	120.0	60.0	80	0.6
4	450.0	0.6	80	6.0
5	450.0	6.0	80	60.0

For parallel modules the current range is a multiple of the number of loads in the parallel group.

POW:RANG?: Returns the maximum power level for the combination of the programmed voltage and current ranges.

7.11 Resistance Subsystem

Sets up the resistance parameters

S300 SCPI [SOURce:]	Description
RESistence[?] f RESistence:AMPLitude[?] f RESistence:IMMediate:AMPLitude[?] RESistence:LEVel:AMPLitude[?] f RESistence:LEVel:IMMediate:AMPLitude[?] f	Set resistance level.

RES f: If the module is in CR Mode the load resistance is set to 'f'. If the module is not in CR Mode the value is stored until CR Mode is selected with the MODE command.

This command cannot be sent if the module is in Pulse Mode or the system armed. If any of these conditions occur an error -100 "Command error" will be added to the modules error queue.

The default/reset value for this parameter is 1 MΩ. The minimum input value is based upon the present operating range and the NOM:VOLT value. The maximum input value is the maximum resistance level for the present range setting. Note that the resistance range limits are divided by the number of power boards controlled by the module. If the input value is not within the limits error -222 "Data out of range" will be added to the module error queue.

RES?: Returns the programmed resistance value.

7.12 List Subsystem

The LIST subsystem is used to setup and define the current Pulse Mode. Pulse Mode is sequenced in the Load module by a dedicated DSP. The Pulse Mode cycle can have two or three dwell periods. Using the LIST subsystem the current amplitudes, dwell periods, and sequence order can be specified. Pulse Mode is started and stopped with the CURR:MODE command.

S300 SCPI [SOURce:]	Description
LIST:CURRent[?] | f,f	Set the pulse levels.
LIST:DWELl[?] |f,f,f	Sets the dwell times for the list points.
LIST:GENeration[?] DSEQuence | SEQuence	Specifies how the list is applied.
LIST:SEQuence[?] i[,i]	Defines the sequence for stepping through the list.

LIST:CURR f_1,f_2: Specifics the current levels for states 1, and 2 of Pulse Mode in amps. The state 1 level is 'f_1', state 2 level is 'f_2'. The state 3 level is not programmable with this command. It is the same level, which is programmed with the CURR command. For Pulse Mode operation this amplitude is the nominal amplitude.

If 'f1' or 'f2' is greater than the maximum current limit an error -222 "Data out of range" will be added to the modules error queue.

The default/reset value for all current levels is 0 amps. The minimum input value is 0 amps. The maximum input value is the maximum current level for the present range setting.

LIST:CURR?: Returns the current levels programmed for dwell periods 1, 2, and 3. The return parameters will be comma delimited.

LIST:DWEL f_1,f_2,f_3: Specifies the length of the dwell periods for states 1, 2, and 3 of Pulse Mode in seconds. State 1 dwell is specified by 'f1', state 2 dwell is specified by 'f2', and state 3 dwell is specified by 'f3'.

The default/reset value for this parameter is 1 msec. The minimum input value is 20 µsec. The maximum input value is 8.0 seconds. The resolution is 2 µsec.

If 'f1', 'f2', or ‘f3’ is not within range an error -222 "Data out of range" will be added to the module error queue.

LIST:DWEL?: Returns the programmed for dwell times for periods 1, 2, and 3. The return parameters will be comma delimited.

LIST:GEN DSEQ: Commands the Pulse Mode to continuously cycle through all of the points in the list.

LIST:GEN SEQ: Commands the Pulse Mode to cycle through the list specified by the LIST:SEQ command.

LIST:GEN?: Returns programmed generation parameters, either "DSEQ" or "SEQ".

LIST:SEQ i_1,i_2[,i3][,i4]: Specifies the sequence of states for Pulse Mode operation. The range of input values is from 0 to three, where 1, 2, and 3 are states and 0 causes Pulse Mode operation to halt. Pulse Mode always start from state 3, the nominal amplitude, and transitions to state #1. The operator will be queried for the next state after state #1. If the operator does not input 0, the system will query for the next state. This will continue until the operator inputs a 0 to signify a single shot pulse or a repeated state to signify continuous Pulse Mode. Below are listed the legal pulse sequences.

Sequence	Description
1,0	Current step from nominal
1,2,0	Single shot two level pulse - nominal goes to state #2 amplitude
1,3,0	Single shot two level pulse - nominal is unaffected
1,2,3,0	Single shot three level pulse - nominal unaffected
1,3,2,0	Single shot three level pulse - nominal goes to state #2 amplitude
1,2,1	Continuous two level pulse
1,3,1	Continuous two level pulse
1,2,3,1	Continuous three level pulse
1,3,2,1	Continuous three level pulse
1,2,3,2	Continuous two level pulse with starting transient
1,3,2,3	Continuous two level pulse with starting transient

The operator can not input successive identical states. For single shot pulses the nominal current level will updated to the final state of the pulse sequence. When continuous Pulse Mode operation is halted the current level returns to nominal.

LIST:SEQ?: Returns the list point sequence to be executed. The return parameters will be comma delimited

7.13 Load Programming Examples

7.13.1 Programming Load Soft Start

To prevent the Load from saturating the UUT at turn-on, start up in CR Mode. When the UUT has fully turned on switch into the mode needed for the current test.

In the following example the output to be tested is a 5 volts 2 amp output.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
INST:NSEL 1	Select Module at logical address 1
CURR:RANG 6	Select 6 amp working current range
CURR 2	Set load current for CC Mode to 2 amps
RES 2.5	Set resistance for CR Mode to 2.5 ohms.
VOLT:NOM 5	Set nominal voltage for CR Mode to 5 volts
MODE CR	Set load into CR Mode
⟨turn on supply⟩	
MODE CC	Set load into CC Mode for test

7.13.2 Trigger

The following is the sequence of commands needed to trigger a current step change. Assume the load is a 10 module, and the trigger will come from an external device.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
INST:NSEL 1	Select Module at logical address 1
MODE CC	Set Mode to constant current
INIT	Put system into Trigger INIT Mode
CURR 5	Program output current to 5 amps
ARM	Put system into Trigger ARM Mode
TRIG	Generate Trigger, Trigger Mode returns to IDLE
MEAS:CURR?	Measure current, s/b~5 amps

7.13.3 Programming Pulse Mode

The following example setups up the load module to simulate a turn on transient.

Command Sequence	Command Description
*CLS	Clear Status
*RST	Reset system and set DFI relay
*STB?	Query System Event Status Register
SYST:ERR?	Query System Error Queue and set DFI relay
INST:NSEL 1	Select Module at logical address 1
CURR:RANG 6	Select 6 amp working current range
CURR:RTIM 0.001	Set current rise time to 1 msec
CURR:FTIM 0.002	Set current fall time to 2 msec
LIST:CURR 6,2	Set peak current (state 1) to 6 amps and final current (state 2) to 2 amps
LIST:DWEL 0.001012, 1,0.001012	Set dwell for state 1 to be 12 usec greater than rise
LIST:SEQ 1,2,0	Set sequence to go from 0 amps (starting level) to 6 amps and stop at 2 amps. The new nominal will be 2 amps.
LIST:GEN SEQ	Program load to use defined sequence
CURR:MODE LIST	Go to Pulse Mode. The load will return to LIST Mode after 1 sec at state 2, and the new nominal current level will be 2 amps.

8. RESET AND SELF-TEST FUNCTIONAL DESCRIPTION

8.1 S300 Reset Operation

reset display

reset keypad

reset system flags

reset error queues

reset system to configuration stored in EEPROM

reset modules

set DFI

8.2 S300 Self-test Operation

RAM Test

EEPROM Test

S300 Reset

9. SYSTEM & MODULE ERRORS

9.1 Error Handling

The system error queue and each module error queue is ten entries deep. When a command is received to read an error queue, the top error is popped off of the queue and all entries are moved up. If the error queue becomes full, nine errors, and a tenth is detected, the tenth slot will be loaded with error -350 Error Queue Overflow. All subsequent errors will be lost until the queue is popped. Error codes are not repeated in the queue to prevent flooding.

When an error is detected at the system level, e.g. input data out of range, the error code is put into the system error queue. These errors are retrieved with the SYST:ERR? command query.

When a module reports an error back to the system, e.g. overvoltage, an error is placed into the modules error queue and a generic module error is put into the system error queue. The generic module error is the modules logical address plus 100. Module errors are retrieved by issuing the INST:NSEL i command to select the module in question The command STAT:QUE? will retrieve the modules top error and pop it off the queue. When the module queue becomes empty the generic module error in the system error queue will automatically be deleted.

At power-up if a module is detected has not been saved to chassis EEPROM a foreign module detected error code will be placed in the system error queue. The error code is 300 plus the logical address of the foreign module. To make the module not foreign send command DIAG:CONF 0,SAVE, so that at next power-up the module will be fully configured into the system. There are no restrictions on the use of foreign modules

Also at power-up, if a module whose data has been saved to chassis EEPROM cannot be found a missing module error code will be placed in the system error queue. The error code is 200 plus the logical address of the missing module. To remove the error from the next power-up issue the commands DIAG:CONF i,KILL and DIAG:CONF 0,SAVE where i is the logical address of the missing module.

All errors will set a bit, if enabled, in the Event Status Register. This will set the ESB bit, if enabled, to be set in the serial poll register. A suggested method monitoring errors is:

1) After power-up or reset enable the OPC bit with the *OPC command.

2) Disable the power-on bit of the ESR with the command *ESE 127.

3) Serial poll S300 to determine operation complete/error status.

4) If bit 1 of serial poll response is 0 operation is not complete and no errors have been detected.

5) If bit 2 of serial poll response is 1 an error has been detected.

6) If an error has occurred issue SYST:ERR? to read, and pop off top error in system error queue.

7) If the returned error code is a generic module error code, select that module with the INST:NSEL command.

8) Read module error queue until errors clear or repeat {or you feel that it is time to give up}.

9) Record all errors, the command used to retrieve them, and the order in which they occurred. This will facilitate determining the problem.

9.2 Supported SCPI Error Codes

These errors conform to the ANSI/IEEE Std 488.2-1992 and *Standard Commands for Programmable Instruments (SCPI)* Version 1994.0. If they are reported back by the SYST:ERR? command, they are chassis errors. If they are reported back by the STAT:QUE? command, they are errors associated with the currently selected module. Note the command INST:NSEL 0 will select the chassis.

Code	Error	Description	How Handled
-100	Command Error	This error is reported if the command is illegal for the selected module.	current command aborted
-102	Syntax Error	This error is reported if the command cannot be parsed.	current command aborted
-200	Execution Error	This error is reported if the command cannot be executed due to the state of the device.	current command aborted
-220	Parameter Error	This error is reported when the format of the program message is wrong.	current command aborted
-222	Data out of Range	This error is reported if one of the data elements is out of range for the current state of the device.	current command aborted
-241	Hardware Missing	This error is reported if a selected module does not exist.	reported
-330	Self-test Failed	This error is reported if a module detected an error during self-test.	module reset, DFI cleared
-350	Error Queue Overflow	This error is reported if more errors are added to the queue than the queue can handle	reported
-360	GPIB Communication Error	This error is set if the S300 detects an error in transmitting a Response Message.	reported
-363	GPIB Input	This error is set if the input buffer	reported

	buffer overrun	overflows.	
-410	Query Interrupted	This error is reported if a Response Message is not read by the controller before it sends another Program Message.	Output buffer is clear and MAV bit in Serial Poll Register is reset
-420	Query Unterminated	This error is reported if the controller commands the S300 to talk when it has nothing to say.	Output buffer is clear and MAV bit in Serial Poll Register is reset
-430	Query Deadlocked	This error is set if the output buffer overflows.	Output buffer is clear and MAV bit in Serial Poll Register is reset

9.3 S300 Specific Error Codes

All errors except those marked N/A are reported to the respective error queues. Errors marked N/A are not applicable to the module.

Code	**Error**	**Description**	**How Handled:** **DC Source**	**How Handled:** **Load**
0	No Error	Default return value if there are no errors	N/A	N/A
4	Module CPU Low Power	Power to module CPU fell below threshold	module reset, DFI cleared	module reset, DFI cleared
5	Module Over Voltage Error	Measured voltage greater than programmed overvoltage protection limit	module reset, DFI cleared	module reset, DFI cleared
6	Module Under Voltage Error	Measured voltage less than programmed undervoltage protection limit	module reset, DFI cleared	N/A
10	Module Current Error	Measured current greater than programmed protection limit for longer than current trip delay.	module reset, DFI cleared	N/A

25	Module Temperature Error	Measured temperature greater than internal limit	module reset, DFI cleared	module reset, DFI cleared
50	Memory Device Error	S300 chassis RAM test error	N/A	N/A
51	Memory Allocation Error	S300 chassis memory allocation error	N/A	N/A
55	EEPROM Error	S300 chassis EEPROM test error	N/A	N/A
56	EEPROM Timeout	S300 chassis EEPROM communication error	N/A	N/A
60	RS Bus Timeout	Error waiting for message byte from module		
61	RS Bus Error	Error communicating with modules		
62	RS Checksum Error	Module response message checksum error		
63	Module Timeout Error	Module not setting OPC within time limit.		
65	Module/EEPRO M Mismatch	Unexpected module type at power-up		
66	Module EEPROM Write Error	Load module EEPROM error	N/A	module reset, DFI cleared

Code	Error	Description	How Handled: DC Source	How Handled: Load
70	Module Input Buffer Overrun	Overrun of module input buffer.	N/A	
71	Module Output Buffer Overrun	Overrun of module output buffer.	N/A	
72	Module Command Checksum Error	Checksum error in command sent to module from chassis.	N/A	
73	Module RAM Error	Module RAM test error.	N/A	module reset, DFI cleared
74	Module DSP Error	Load module DSP communication error	N/A	module reset, DFI cleared
75	Module A/D Error	Load module A/D communication error	N/A	module reset, DFI cleared
76	Module Power Board Error	Load module power board communication error	N/A	module reset, DFI cleared
77	Module Temperature Warning	Load module temperature warning	N/A	reported - module internal power limit derated
78	Module ROM Error	Load module ROM test error	N/A	module reset, DFI cleared
79	Slave Module Position Error	System error - Load module slave in incorrect physical position	N/A	N/A
81	Local Bus Error	System error - intermingling more than two load parallel groups at power-up	N/A	N/A
85	DC Source Self-test EPROM Error	This error is reported if the EPROM checksum does not match the checksum stored in the EPROM	module reset, DFI cleared, Self-test Error Reported	N/A

Code	Error	Description	How Handled: DC Source	How Handled: Load
86	DC Source Self-test RAM Error	This error is reported if a RAM pattern test fails.	module reset, DFI cleared, Self-test Error Reported	N/A
87	DC Source Self-test EEPROM Error	This error is reported if the EEPROM checksum does not match the checksum stored in the EEPROM	module reset, DFI cleared, Self-test Error Reported	N/A
88	DC Source Self-test Voltage Output Error	This error is set if the internal voltage readback is not within 10% of the set value.	module reset, DFI cleared, Self-test Error Reported	N/A
89	DC Source Self-test OV DAC Error	This error is reported if an Overvoltage error does not occur within 5% of the programmed setting.	module reset, DFI cleared, Self-test Error Reported	N/A
90	DC Source Self-test Calibration Data Out of Range	This error is reported if the module EEPROM data is not within a specfic range.	module reset, DFI cleared, Self-test Error Reported	N/A
101-163	Generic Module Error	System error queue only - any module error	N/A	N/A
201-263	Generic Module Missing Error	System error queue only - module missing at power up	N/A	N/A
301-363	Generic Foreign Module Error	System error queue only - foreign module detected at power-up	N/A	N/A

10. IEEE488.2 PROGRAMMING EXAMPLE

10.1 Example System IEEE Setup

National Instruments AT-GPIB/TNT Board configuration

Primary GPIB Address	0
Secondary GPIB Address	NONE
Timeout setting	10sec
Terminate Read on EOS	No
Set EOI with EOS on Write	No
Type of compare on EOS	7-Bit
EOS byte	00h
Send EOI at end of Write	Yes
System Controller	Yes
Assert REN when SC	No
Enable Auto Serial Polling	Yes
Enable CIC Protocol	No
Bus Timing	500nsec
Parallel Poll Duration	Default
Use this GPIB board	Yes
Board Type	PCII
Base I/O Address	02B8h
DMA Channel	1
Interrupt Level	NONE

National Instruments AT-GPIB/TNT Device configuration

Primary GPIB Address	1
Secondary GPIB Address	NONE
Timeout setting	10sec
Serial Poll Timeout	1sec
Terminate Read on EOS	No
Set EOI with EOS on Writes	No
Type of compare on EOS	7-Bit
EOS byte	00h
Send EOI at end of Write	Yes
Enable Repeat Addressing	No

The following sections contain the Visual Basic code listing for S6KEXAMP.EXE {NHR P/N 1904166}, the sample S300 code provided on disk. The following GLOBALS are used throughout the sample code:

```
Global S6k As Integer              ' GPIB handle for S300
Global DevStr As String            ' GPIB device string for S300
Global NL As String                ' Newline variable (contains chr$(13))
Global S6k_Response As String      ' response message from S300
Global SP_Response As Integer      ' Serial Poll response
Global OPC_Enabled As Integer      ' flag: if true, OPC in serial poll
                                   '   response as been enabled
Global TimerFlag As Integer        ' timer flag for GPIB timeouts
Global TimerValue As Long          ' timeout value
Global SelectedModule As Integer   ' module address selected before tests
Global Const S6k_Response_len = 256 ' length of response message
' definition for bits in the serial poll register
Global Const SP_TRIGER_ARM = &H1   ' if set Trigger Mode is arm
Global Const SP_OPC = &H2          ' if set operation is complete; see *OPC
Global Const SP_ERR = &H4          ' if set S300 has an error
Global Const SP_MAV = &H10         ' if set S300 has message pending
Global Const SP_ESB = &H20         ' if set then there is a bit set in the ESR
Global Const SP_MSS = &H40         ' if set S300 has a service request
Global Const RET_ERR = 1
Global Const RET_OK = 0
Global Const MaxModules = 63        ' maximum number of module in system
```

10.2 DC Source Output Subroutine

```
' Illustrate a simple turn-on sequence:
' 1) Setup the selected DC module
   ' 2) Turn on the output and measure voltage, current and power
   ' 3) Turn off the output
    Sub DCOutput ()
    Dim rtn As Integer
    Dim volts As Single, amps As Single, watts As Single
    Dim outp As String, msg As String
    NL = Chr$(13)
    ' Display warning message prior to executing routine
    msg = "This routine will set the output voltage of this DC source" & NL
    msg = msg & "to 5 volts, with a current limit of 1.5 amperes." & NL & NL
    msg = msg & "Are you sure you wish to continue?"
    rtn = MsgBox(msg, MB_YESNO + MB_ICONQUESTION, "DC Source (Addr " &
    SelectedModule & ")")
    If rtn = IDNO Then Exit Sub
    rtn = S6k_Write("SYST:CPON " & SelectedModule)  'reset the module
    rtn = S6k_Write("INST:NSEL " & SelectedModule)  'select the module
    rtn = S6k_Write("VOLT:PROT 7.5")                'set OV protection to 7.5V
    rtn = S6k_Write("VOLT:PROT:STAT ON")            'turn on OV protection
    rtn = S6k_Write("VOLT:PROT:MIN 0")              'turn off undervoltage
    protection
    rtn = S6k_Write("SENS:VOLT:REF:STAT OFF")       'set sense relay to
    INTERNAL
    rtn = S6k_Write("CURR:PROT 1")                  'set overcurrent protection
    to 1A
    rtn = S6k_Write("CURR:PROT:TIME 100")           'set overcurrent trip delay
    to 100ms
    rtn = S6k_Write("CURR:PROT:STAT ON")            'turn on overcurrent
    protection
    rtn = S6k_Write("VOLT 5")                       'set voltage to 5V
    rtn = S6k_Write("CURR 1.5")                     'set current limit to 1.5A
    rtn = S6k_Write("OUTP ON")                      'turn on the output
    rtn = S6k_Write("MEAS:VOLT?")                   'measure the voltage
    If rtn = RET_OK Then
        rtn = S6k_Read()
        volts = Val(S6k_Response)
    End If
    rtn = S6k_Write("MEAS:CURR?")                   'measure the current
    If rtn = RET_OK Then
        rtn = S6k_Read()
        amps = Val(S6k_Response)
    End If
    rtn = S6k_Write("MEAS:POW?")                    'measure the power
    If rtn = RET_OK Then
        rtn = S6k_Read()
        watts = Val(S6k_Response)
    End If
    rtn = S6k_Write("OUTP?")                        'query the output state
    If rtn = RET_OK Then
        rtn = S6k_Read()
        outp = S6k_Response
    End If
    ' Display results of commands to operator
    msg = "Output is " & outp & NL & "Voltage: " & volts & "V" & NL
    msg = msg & "Current: " & amps & "A" & NL
    msg = msg & "Power: " & watts & "W"
    MsgBox msg, MB_ICONINFORMATION, "DC Source (Addr " & SelectedModule & ")"
    rtn = S6k_Write("OUTP OFF")                     'turn off the output
    rtn = S6k_Write("MEAS:VOLT?")                   'measure the voltage
    If rtn = RET_OK Then
        rtn = S6k_Read()
        volts = Val(S6k_Response)
    End If
    rtn = S6k_Write("MEAS:CURR?")                   'measure the current
    If rtn = RET_OK Then
        rtn = S6k_Read()
        amps = Val(S6k_Response)
    End If
    rtn = S6k_Write("MEAS:POW?")                    'measure the power
    If rtn = RET_OK Then
        rtn = S6k_Read()
        watts = Val(S6k_Response)
    End If
       rtn = S6k_Write("OUTP?")                        'query the output state
    If rtn = RET_OK Then
```

```
    rtn = S6k_Read()
    outp = S6k_Response
End If
' Display results of commands to operator
msg = "Output is " & outp & NL & "Voltage: " & volts & "V" & NL
msg = msg & "Current: " & amps & "A" & NL
msg = msg & "Power: " & watts & "W"
MsgBox msg, MB_ICONINFORMATION, "DC Source (Addr " & SelectedModule & ")"
End Sub
```

10.3 DC Source Trigger Subroutine

```
' Illustrate a simple triggered turn-on sequence:
' 1) Setup the selected DC module
' 2) Initialize the trigger sequence, and set the output voltage to 5V.
Note that commands
'    sent after INIT are not executed until the chassis has been armed and
triggered.
' 3) Issue the trigger and measure the output voltage
' 4) Turn off the output
Sub DCTrigger ()
Dim rtn As Integer
Dim volts As Single
Dim outp As String, trig As String, msg As String
NL = Chr$(13)
' Display warning message prior to executing routine
msg = "This routine will set the output voltage of this DC source" & NL
msg = msg & "to 5 volts, with a current limit of 1.5 amperes." & NL & NL
msg = msg & "Are you sure you wish to continue?"
rtn = MsgBox(msg, MB_YESNO + MB_ICONQUESTION, "DC Source (Addr " &
SelectedModule & ")")
If rtn = IDNO Then Exit Sub
rtn = S6k_Write("SYST:CPON " & SelectedModule)  'reset the module
rtn = S6k_Write("INST:NSEL " & SelectedModule)  'select the module
rtn = S6k_Write("VOLT 0")                       'set voltage to 0V
rtn = S6k_Write("CURR 1.5")                     'set current limit to 1.5A
rtn = S6k_Write("OUTP ON")                      'turn on the output
rtn = S6k_Write("INIT")                         'initialize the trigger
sequence
rtn = S6k_Write("VOLT 5")                       'set voltage to 5V
rtn = S6k_Write("MEAS:VOLT?")                   'measure the voltage
```

```
If rtn = RET_OK Then                            ' (S/B 0V)
    rtn = S6k_Read()
    volts = Val(S6k_Response)
End If
rtn = S6k_Write("ARM")                          'arm the trigger sequence
rtn = S6k_Write("TRIG?")                        'query the trigger state
 If rtn = RET_OK Then                            ' (S/B WAIT FOR TRIGGER)
    rtn = S6k_Read()
    trig = S6k_Response
End If
' Display results of commands to operator
msg = "Trigger state: " & trig & NL & "Voltage: " & volts & "V" & " (0V)"
MsgBox msg, MB_ICONINFORMATION, "DC Source (Addr " & SelectedModule & ")"
rtn = S6k_Write("TRIG")                         'generate the trigger
rtn = S6k_Write("TRIG?")                        'query the trigger state
 If rtn = RET_OK Then                            ' (S/B IDLE)
    rtn = S6k_Read()
    trig = S6k_Response
End If
rtn = S6k_Write("MEAS:VOLT?")                   'measure the voltage
If rtn = RET_OK Then                            ' (S/B 5V)
    rtn = S6k_Read()
    volts = Val(S6k_Response)
End If
' Display results of commands to operator
msg = "Trigger state: " & trig & NL & "Voltage: " & volts & "V" & " (5V)"
MsgBox msg, MB_ICONINFORMATION, "DC Source (Addr " & SelectedModule & ")"
rtn = S6k_Write("VOLT 0")                       'set voltage to 0V
rtn = S6k_Write("OUTP OFF")                     'turn off the output
End Sub
```

10.4 Load Pulse Subroutine

```
' Illustrate a continuous two-level pulse.  Note that current rise and fall
times are
' performed within the programmed dwell time -- in this example, 2ms of
rise time and
' 8ms of steady state, then 4ms of fall time and 6ms of steady state.
' Modifying the LIST:SEQ command to "1,2,0" will simulate a turn-on current
transient of
' 0 amps (starting level) to 2 amps, then falling to 1 amp.  The new
nominal current will
' be 1 amp.
Sub LoadPulse ()
Dim rtn As Integer
rtn = S6k_Write("SYST:CPON " & SelectedModule)  'reset the module
rtn = S6k_Write("INST:NSEL " & SelectedModule)  'select the module
rtn = S6k_Write("CURR:RANG 6")                  'select the 6A range
rtn = S6k_Write("CURR:RTIM .002")               'set current rise time to 2
msec
rtn = S6k_Write("CURR:FTIM .004")               'set current fall time to 4
msec
rtn = S6k_Write("LIST:CURR 2,1")                'set current dwell levels
(in amps)
rtn = S6k_Write("LIST:DWEL .01,.01,1")          'set Pulse Mode dwell times
of 10 msec
rtn = S6k_Write("LIST:SEQ 1,2,1")               'continuous 2-level pulse
rtn = S6k_Write("LIST:GEN SEQ")                 'use programmed sequence
{not default}
rtn = S6k_Write("CURR:MODE LIST")               'go to Pulse Mode
MsgBox "Now pulsing between 1 and 2 amps...", MB_ICONINFORMATION, "Load
(Addr " &

SelectedModule & ")"
rtn = S6k_Write("CURR:MODE FIXED")              'disable Pulse Mode
rtn = S6k_Write("CURR 0")                       'set current to 0A
End Sub
```

10.5 Load Soft Start Subroutine

```
' To prevent the Load from saturating the UUT at turn-on, start up in
Constant Resistance
' Mode.  When the UUT has fully turned on switch into the desired mode (in
this example,
' Constant Current Mode).
Sub LoadSoftStart ()
Dim rtn As Integer
Dim curr As Single
Dim mode As String, msg As String
NL = Chr$(13)
rtn = S6k_Write("SYST:CPON " & SelectedModule)  'reset the module
rtn = S6k_Write("INST:NSEL " & SelectedModule)  'select the module
rtn = S6k_Write("CURR:RANG 6")                  'select the 6A range
rtn = S6k_Write("CURR 2")                       'set current to 2A
'NOTE: resistance and nominal voltage combine to form a
'   current limit in Constant Resistance Mode
rtn = S6k_Write("RES 2.5")                      'set resistance to 2.5 ohms
rtn = S6k_Write("VOLT:NOM 5")                   'set nominal voltage to 5V
rtn = S6k_Write("MODE CR")                      'go to Constant Resistance
Mode
rtn = S6k_Write("MODE?")                        'query the mode
If rtn = RET_OK Then
    rtn = S6k_Read()
    mode = S6k_Response
End If
' Display results of commands to operator
msg = "Load Mode: " & mode & NL & NL & "Apply power to UUT now."
MsgBox msg, MB_ICONINFORMATION, "Load (Addr " & SelectedModule & ")"
rtn = S6k_Write("MODE CC")                      'go to Constant Current
Mode
rtn = S6k_Write("MODE ?")                       'query the mode
If rtn = RET_OK Then
    rtn = S6k_Read()
    mode = S6k_Response
End If
rtn = S6k_Write("MEAS:CURR?")                   'measure the current
If rtn = RET_OK Then
    rtn = S6k_Read()
    curr = Val(S6k_Response)
```

```
End If
' Display results of commands to operator
msg = "Load Mode: " & mode & NL & "Current: " & curr
MsgBox msg, MB_ICONINFORMATION, "Load (Addr " & SelectedModule & ")"
rtn = S6k_Write("CURR 0")                         'set current to 0A
End Sub
```

Load Trigger Subroutine

```
   ' Illustrate a simple triggered turn-on sequence:
   ' 1) Setup the selected Load module (using a "soft-start" operation)
   ' 2) Initialize the trigger sequence, and set the input current to 5A.  Note
   that commands
   '    sent after INIT are not executed until the chassis has been armed and
   triggered.
   ' 3) Issue the trigger and measure the input current
   ' 4) Turn off the Load
Sub LoadTrigger ()
Dim rtn As Integer
Dim curr As Single
Dim trig As String, msg As String
NL = Chr$(13)
rtn = S6k_Write("SYST:CPON " & SelectedModule)  'reset the module
rtn = S6k_Write("INST:NSEL " & SelectedModule)  'select the module
rtn = S6k_Write("CURR:RANG 6")                  'select the 6A range
rtn = S6k_Write("CURR 2")                       'set current to 2A
rtn = S6k_Write("RES 2.5")                      'set resistance to 2.5 ohms
rtn = S6k_Write("VOLT:NOM 5")                   'set nominal voltage to 5V
rtn = S6k_Write("MODE CR")                      'go to Constant Resistance
Mode
' Prompt operator to turn on the UUT
MsgBox "Apply power to UUT now.", MB_ICONINFORMATION, "Load (Addr " &

SelectedModule & ")"
rtn = S6k_Write("MODE CC")                      'go to Constant Current
Mode
rtn = S6k_Write("INIT")                         'initialize the trigger
sequence
rtn = S6k_Write("CURR 5")                       'set current to 5A
rtn = S6k_Write("MEAS:CURR?")                   'measure the current
If rtn = RET_OK Then                            ' (S/B 0A)
    rtn = S6k_Read()
    curr = Val(S6k_Response)
```

```
End If
rtn = S6k_Write("ARM")                            'arm the trigger sequence
rtn = S6k_Write("TRIG?")                          'query the trigger state
If rtn = RET_OK Then                              ' (S/B WAIT FOR TRIGGER)
    rtn = S6k_Read()
    trig = S6k_Response
End If
' Display results of commands to operator
msg = "Trigger state: " & trig & NL & "Current: " & curr & "A" & " (0A)"
MsgBox msg, MB_ICONINFORMATION, "Load (Addr " & SelectedModule & ")"
rtn = S6k_Write("TRIG")                           'generate the trigger
rtn = S6k_Write("TRIG?")                          'query the trigger state
If rtn = RET_OK Then                              ' (S/B IDLE)
    rtn = S6k_Read()
    trig = S6k_Response
End If
rtn = S6k_Write("MEAS:CURR?")                     'measure the current
If rtn = RET_OK Then                              ' (S/B 5A)
    rtn = S6k_Read()
    curr = Val(S6k_Response)
End If
' Display results of commands to operator
msg = "Trigger state: " & trig & NL & "Current: " & curr & "A" & " (5A)"
MsgBox msg, MB_ICONINFORMATION, "Load (Addr " & SelectedModule & ")"

rtn = S6k_Write("CURR 0")                         'set current to 0A
End Sub
```

10.6 Find_device() support routine

```
' This routine calls the NI DLL to find the selected device.
' The GPIB device table should have already been setup via WIBCONF.
Sub Find_device ()
S6k = DLLibfind(DevStr, ibsta, iberr, ibcntl)
If S6k < 0 Then
    ' error detected -- call routine to display GPIB Errors
    Call GPIBErrMsg("Error opening device '" & DevStr & "'")
Else
    ' OK, enable S300 Initialization and Single Command menu items
    frmS6kExample.mnuApp(1).Enabled = True
    frmS6kExample.mnuApp(4).Enabled = True
End If
End Sub
```

10.7 GetTypeDescription() support routine

```
' Add a descriptive string to the module Type value
Sub GetTypeDescription (modtype As Integer)
Dim modescrp As String      ' module description string
Select Case modtype
    Case 1
        modescrp = "DC Source 10V, 60A, 400W"
    Case 2
        modescrp = "DC Source 60V, 16A, 400W"
    Case 3
        modescrp = "DC Source 80V, 12A, 400W"
    Case 4
        modescrp = "DC Source 400V, 3A, 400W"
    Case 11
        modescrp = "DC Source 10V, 30A, 200W"
    Case 12
        modescrp = "DC Source 60V, 8A, 200W"
    Case 13
        modescrp = "DC Source 80V, 6A, 200W"
    Case 14
        modescrp = "DC Source 400V, 1.5A, 200W"
    Case 31
        modescrp = "Load 450V, 60A, 300W"
    Case Else
        modescrp = "Unknown Type"
    End Select
    ' Configure the appropriate "Applications" menu items
    If modtype > 0 And modtype < 20 Then
        frmS6kExample.mnuApp(2).Enabled = True
        frmS6kExample.mnuApp(3).Enabled = False
    ElseIf modtype = 31 Then
        frmS6kExample.mnuApp(2).Enabled = False
        frmS6kExample.mnuApp(3).Enabled = True
    End If
    S6k_Response = S6k_Response & " (" & modescrp & ")"
End Sub
```

10.8 Initialization() support routine

```
' Standard S300 initialization sequence:
' 1) Clear internal registers, and reset the system
' 2) Establish communication requirements
' 3) Query system configuration
Sub Initialization ()
Dim rtn As Integer, x As Integer, abortflag As Integer
Dim msg As String
NL = Chr$(13)
' Prevent re-access of "Applications" menu or module selection
frmS6kExample.mnuMain(1).Enabled = False
frmS6kExample.cboAddr.Enabled = False
OPC_Enabled = False                     ' disable OPC bit checking
TimerValue = 60000                      ' Wait up to 60 seconds for init
' Clear the S300 interface, reset the S300, and read the status byte.
' Issuing the query forces the program and the S300 to "sync" with
' the I/O since the program will wait for a response...
rtn = S6k_Write("*CLS;*RST;*STB?")
rtn = S6k_Read()
' other commands should execute within 10 seconds
TimerValue = 10000
' Mask out the POWER ON bit in the Standard Event Register and
' enable the OPERATION COMPLETE bit
rtn = S6k_Write("*ESE 127;*OPC")
' Require that all subsequent commands wait for Operation Complete
OPC_Enabled = True
' Make sure the connected device is an S300 chassis
rtn = S6k_Write("*IDN?")        'SCPI Identification query
If rtn = RET_OK Then
    rtn = S6k_Read()
    If rtn = RET_ERR Then
        msg = "Cannot determine device ID"
        abortflag = True
    Else
        If InStr(S6k_Response, "NH RESEARCH,S300") = 0 Then
            msg = "Connected device is not an S300 Power Subsystem"
            msg = msg & NL & "ID Response: " & S6k_Response
            abortflag = True
        End If
    End If
Else
    msg = "Cannot determine device ID"
    abortflag = True
End If
If abortflag Then
    MsgBox msg, MB_ICONSTOP, "Initialization Error"
    frmS6kExample.mnuMain(1).Enabled = True
    Exit Sub
End If
' Read the system configuration
rtn = S6k_Write("DIAG:CONF? 0,SYTM")
If rtn = RET_OK Then rtn = S6k_Read()
' If no errors, parse the string containing the system configuration
If rtn = RET_OK Then
    Call Parse_Diag_Sytm(S6k_Response)
    If frmS6kExample.cboAddr.Text = "" Then
        For x = 0 To 9
            frmS6kExample.lblInfo(x).Caption = ""
        Next
    End If
End If
'Restore access to the "Applications" menu and module selections
frmS6kExample.cboAddr.Enabled = True
frmS6kExample.mnuMain(1).Enabled = True
End Sub
```

10.9 Parse_Diag_Sytm() support routine

```
'This routine will parse the response to the command DIAG:CONF? 0,SYTM command
'to initialize a table of modules in the system. The format of
'the response string is XX,XX,XX,..., where the XX's are the logical
'addresses of modules in the system.
Sub Parse_Diag_Sytm (SytmRsp As String)
    Dim x As Integer        ' index
    Dim addr As Integer     ' integer value of module addresses in DIAG response
    Dim addrstr As String   ' string value of module addresses in DIAG response
    addrstr = Space(10)     ' initialize string
    'Remove any existing elements before adding new
    frmS6kExample.cboAddr.Clear
    For x = 0 To (MaxModules - 1)               ' for all possible modules
        addrstr = Mid$(SytmRsp, (x * 3) + 1, 2) ' strip out module address
        addr = Val(addrstr)                     ' convert to integer
        If addr > 0 And addr < 64 Then          ' if address in range
            frmS6kExample.cboAddr.AddItem Str$(addr)  ' add element for later use
        Else
                Exit For                        ' exit routine
        End If
    Next
    addrstr = ""
End Sub
```

10.10 UpdateFields() support routine

```
' Perform various queries of the selected module and present the data to the user
Sub UpdateFields ()
    Dim rtn As Integer
    Dim pointer As Integer
    pointer = frmS6kExample.MousePointer    ' Save mouse image for later restoration
    frmS6kExample.MousePointer = HOURGLASS
' Prevent the "Applications" menu from any action until the update is complete
    frmS6kExample.mnuMain(1).Enabled = False
    frmS6kExample.cboAddr.Enabled = False
    SelectedModule = Val(frmS6kExample.cboAddr.Text)
    ' Get module type
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",TYPE")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        GetTypeDescription (Val(S6k_Response))  ' Add description to response string
        frmS6kExample.lblInfo(0).Caption = S6k_Response
    End If
    ' Get module ID
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",ID")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(1).Caption = S6k_Response
    End If
    ' Get module model number
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",MODN")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(2).Caption = S6k_Response
    End If
    ' Get options
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",OPTS")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(3).Caption = S6k_Response
    End If
    ' Get hardware revision
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",HREV")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(4).Caption = S6k_Response
    End If
    ' Get serial number
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",SER")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(5).Caption = S6k_Response
    End If
    ' Get build date
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",BLD")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(6).Caption = S6k_Response
    End If
    ' Get maximum voltage
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",MAXV")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(7).Caption = S6k_Response
    End If
    ' Get maximum current
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",MAXI")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(8).Caption = S6k_Response
    End If
    ' Get maximum wattage
    rtn = S6k_Write("DIAG:CONF? " & SelectedModule & ",MAXP")
    If rtn = RET_OK Then
        rtn = S6k_Read()
        frmS6kExample.lblInfo(9).Caption = S6k_Response
    End If
    frmS6kExample.mnuMain(1).Enabled = True ' restore the "Applications" menu
    frmS6kExample.cboAddr.Enabled = True    ' restore module selection
    frmS6kExample.MousePointer = pointer    ' restore original image
End Sub
```

10.11 S6k_Read() support routine

```
'This routine reads a message from the S300 and loads
'the response into the global buffer S6k_Response
'
'If an error or timeout is detected the function returns an error code
'
'This routine should only be call after the MAV bit has
'been detected in the serial poll response
Function S6k_Read ()
    Dim status As Integer           ' function return value
    Dim rsp As String               ' response string
    Dim pointer As Integer          ' holds current mouse image
    Dim cr As Integer               ' holds position of chr$(13) in
                                    '   response string
    pointer = frmS6kExample.MousePointer
    frmS6kExample.MousePointer = HOURGLASS
    rsp = Space(S6k_Response_len)
    S6k_Read = RET_OK               ' initialize return value
    status = Serial_Poll_MAV()      ' Wait for message to become available
    If status = RET_OK Then
        ' get message
        status = dllibrd(s6k, rsp, S6k_Response_len, ibsta, iberr, ibcntl)
        ' Remove carriage returns from response
        cr = InStr(rsp, Chr$(13))
        ' Error messages do not contain chr$(13), but are terminated with chr$(10)
        If cr = 0 Then cr = InStr(rsp, Chr$(10))
        If cr = 0 Then cr = S6k_Response_len
        S6k_Response = Mid$(rsp, 1, cr - 1)
        If ibsta And EERR Then                       ' check for GPIB error
            Call GPIBErrMsg("Error Reading Message")
            S6k_Read = RET_ERR                       ' set return error
        End If
    Else
        S6k_Read = RET_ERR                  ' set return error
    End If
    frmS6kExample.MousePointer = pointer    ' restore original image
    rsp = ""
End Function
```

10.12 S6k_Write() support routine

```
'This routine writes the message out to the device
Function S6k_Write (Cmd As String)
    Dim cnt As Integer                 ' number of bytes in command message
    Dim status As Integer              ' function return value
    S6k_Write = RET_OK                 ' initialize return value
    cnt = Len(Cmd)                     ' get message length
    If cnt = 0 Then Exit Function
    status = dllibwrt(s6k, Cmd, cnt, ibsta, iberr, ibcntl)  ' issue command
    If ibsta And EERR Then             ' check for GPIB error
        Call GPIBErrMsg("Error Writing Command '" & Cmd & "'")
        S6k_Write = RET_ERR            ' set return error
    End If
    ' If required, wait for Operation Complete before continuing
    If OPC_Enabled Then
        status = Serial_Poll_OPC(Cmd)
        S6k_Write = FlushS6kErrors()    ' set return error
    End If
End Function
```

10.13 Serial_Poll() support routine

```
'This function serial polls the S300, loading the serial
'poll data into the global variable SP_Response.
'If an error is detected a message box is displayed and an error
'code is returned
Function Serial_Poll () As Integer
Dim fun_ret As Integer      ' returned function value
Serial_Poll = RET_OK        ' initialize return value
fun_ret = dllibrsp(s6k, SP_Response, ibsta, iberr, ibcntl)   ' serial poll the S300
If ibsta And EERR Then                              ' check for GPIB error
        Call GPIBErrMsg("Error Getting Serial Poll")    ' during the serial poll
        Serial_Poll = RET_ERR                           ' set return error condition
    End If
End Function
```

10.14 Serial_Poll_MAV() support routine

```
'This function will serial poll the S300 until the MAV bit
'is set in the serial poll data byte or the communication
'times out.
'If there is a time out or a serial poll error this routine will
'return an error code.
Function Serial_Poll_MAV ()
Dim fun_ret As Integer                  ' return value from called functions
    Dim sp_ret As Integer                   ' return value from serial poll functions
Serial_Poll_MAV = RET_OK                ' initialize function return value
' Set up a Visual Basic timer
    TimerFlag = False                       ' set up GPIB timer
    frmS6kExample.tmrGPIB.Interval = TimerValue  ' Wait value
    frmS6kExample.tmrGPIB.Enabled = True    ' turn on wait timer
' wait for operation complete or timeout
    Do
        sp_ret = Serial_Poll()              ' serial poll the S300
If sp_ret = RET_ERR Then            ' if serial poll error
            Serial_Poll_MAV = RET_ERR       '   set error code and return
Exit Do
        End If
fun_ret = DoEvents()                ' check for and process WINDOWS events
    Loop Until (SP_Response And SP_MAV) <> 0 Or TimerFlag = True
frmS6kExample.tmrGPIB.Enabled = False   ' disable GPIB timer
If TimerFlag = True Then                ' if timeout; display message
        MsgBox "No Response", 1 + MB_ICONEXCLAMATION, "MAV Communication Timeout"
        Serial_Poll_MAV = RET_ERR           ' set return error condition
    End If
End Function
```

10.15 Serial_Poll_OPC() support routine

```
'This function will serial poll the S300 until the OPC bit
'is set in the serial poll data byte or the communication
'times out.
'If there is a time out or a serial poll error this routine will
'return an error code.
Function Serial_Poll_OPC (msg As String) As Integer
    ' msg - last command sent to S300
Dim fun_ret As Integer                  ' return value from called functions
    Dim sp_ret As Integer                   ' return value from serial poll functions
Serial_Poll_OPC = RET_OK                ' initialize function return value
If OPC_Enabled = False Then             ' if OPC bit has not been enabled
        Exit Function                       ' do not look for the OPC bit
    End If
' Set up a Visual Basic timer
    TimerFlag = False                       ' set up GPIB timer
    frmS6kExample.tmrGPIB.Interval = TimerValue  ' Wait value
    frmS6kExample.tmrGPIB.Enabled = True    ' turn on wait timer
' wait for operation complete or timeout
    Do
        sp_ret = Serial_Poll()              ' serial poll the S300
If sp_ret = RET_ERR Then            ' if serial poll error
            Serial_Poll_OPC = RET_ERR       '   set error code and return
            Exit Do
        End If
fun_ret = DoEvents()                ' check for and process WINDOWS events
    Loop Until (SP_Response And SP_OPC) <> 0 Or TimerFlag = True
    frmS6kExample.tmrGPIB.Enabled = False   ' disable GPIB timer
    If TimerFlag = True Then                ' if timeout; display message
        MsgBox "Command:" + msg, 1 + MB_ICONEXCLAMATION, "OPC Communication Timeout"
        Serial_Poll_OPC = RET_ERR           ' set return error condition
    End If
End Function
```

10.16 FlushS6kErrors() support routine

```
' This routine will read the errors from the S300 until there are no more errors
' This routine starts by reading the serial poll register.
' If the error bit is not set, it exits and returns a zero.
' If an error is detected, it reads out the top error from
' the system error queue with the "SYST:ERR?" command. The
' error response message is displayed to the user. If the
' return code is a generic module error it calls a routine to
' read all of the modules errors. After all of the module errors
' are read, this routine continues to read the system error
' queue until all errors are removed from the queue.
' By using the NI DLL ibwrt() command instead of S6k_Write(), we prevent
' "Stack Overflow" errors which can be caused by recursively calling S6k_Write().
' This routine will pass back a zero if there are no errors, one if any errors exist.
Function FlushS6kErrors ()
    Dim sp_ret As Integer                   ' return value from serial poll functions
    Dim fun_ret As Integer                  ' return value from functions
    Dim error_code As Integer               ' Returned S300 error code
FlushS6kErrors = 0                      ' initialize return code
    Do
        sp_ret = Serial_Poll()              ' serial poll the S300
        If (SP_Response And SP_ERR) <> 0 Then
            fun_ret = dllibwrt(s6k, "SYST:ERR?", 9, ibsta, iberr, ibcntl)  ' issue
command
            fun_ret = S6K_Read()                    ' read response
            error_code = Val(S6k_Response)          ' get error code from returned
message
            MsgBox S6k_Response, MB_ICONEXCLAMATION, "Chassis Error"
            FlushS6kErrors = 1                      ' set return code
            ' Check if error code is a generic module error.
            ' The system error queue can contain generic module errors;
            ' their codes are the module logical address plus 100
            If error_code > 100 And error_code < 199 Then
                ' pass module address to module error handler
                fun_ret = Get_Module_Error(error_code - 100)
                If fun_ret Then FlushS6kError = 1   ' set return code
            End If
        Else    ' set error code to zero if no errors in the serial poll response
            error_code = 0
        End If
    Loop Until error_code = 0       ' loop until error code of zero is returned
End Function
```

10.17 Get_Module_Error() support routine

```
' This routine will read the errors from a specific S300 module until
' there are no more errors
' This routine starts by selecting the module with the error.
' It then reads out the top error from the module's error queue
' with the "STAT:QUE?" command.  The error response message is
' displayed to the user.  This routine continues to read the module
' error queue until all errors are removed from the queue.
' By using the NI DLL ibwrt() command instead of S6k_Write(), we prevent
' "Stack Overflow" errors which can be caused by recursively calling S6k_Write().
' This routine will pass back a zero if there are no errors, one if any errors exist.
Function Get_Module_Error (address As Integer) As Integer
    Dim fun_ret As Integer      ' called function return value
    Dim error_code As Integer   ' Returned S300 error code
    Dim cnt As Integer          ' length of command string
Get_Module_Error = 0        ' initialize return code
cnt = Len("INST:NSEL " + LTrim$(Str$(address)))
    fun_ret = dllibwrt(s6k, "INST:NSEL " + LTrim$(Str$(address)), cnt, ibsta,
iberr, ibcntl)  ' issue command
Do
        fun_ret = dllibwrt(s6k, "STAT:QUE?", 9, ibsta, iberr, ibcntl)  ' issue command
        fun_ret = S6K_Read()                    ' read response
        If fun_ret = RET_OK Then
            error_code = Val(S6k_Response)      ' get error code from returned message
            If error_code Then
                Get_Module_Error = 1 ' set return code
                MsgBox S6k_Response, MB_ICONEXCLAMATION, "Module Error"
            End If
        Else
            Get_Module_Error = 1
        End If
    Loop Until error_code = 0                   ' loop until error code of zero is
returned
End Function
```

10.18 AddIbcnt() support routine

```
' Display GPIB Count variable
Function AddIbcnt () As String
    AddIbcnt = Chr$(13) + Chr$(10) + "ibcnt = 0x" + Hex$(ibcnt%)
End Function
```

10.19 AddIberr() support routine

```
' Display mnemonics for GPIB error value
Function AddIberr () As String
NL = Chr$(13) + Chr$(10)
    If (ibsta And EERR) Then
        If (iberr% = EDVR) Then AddIberr = NL + "iberr = EDVR <DOS Error>"
        ElseIf (iberr% = ECIC) Then AddIberr = NL + "iberr = ECIC <Not CIC>"
        ElseIf (iberr% = ENOL) Then AddIberr = NL + "iberr = ENOL <No Listener>"
        ElseIf (iberr% = EADR) Then AddIberr = NL + "iberr = EADR <Address Error>"
        ElseIf (iberr% = EARG) Then AddIberr = NL + "iberr = EARG <Invalid argument>"
        ElseIf (iberr% = ESAC) Then AddIberr = NL + "iberr = ESAC <Not Sys Ctrlr>"
        ElseIf (iberr% = EABO) Then AddIberr = NL + "iberr = EABO <Op. aborted>"
        ElseIf (iberr% = ENEB) Then AddIberr = NL + "iberr = ENEB <No GPIB board>"
        ElseIf (iberr% = EDMA) Then AddIberr = NL + "iberr = EDMA <DMA Error>"
        ElseIf (iberr% = EOIP) Then AddIberr = NL + "iberr = EOIP <Async I/O in prg>"
        ElseIf (iberr% = ECAP) Then AddIberr = NL + "iberr = ECAP <No capability>"
        ElseIf (iberr% = EFSO) Then AddIberr = NL + "iberr = EFSO <File sys. error>"
        ElseIf (iberr% = EBUS) Then AddIberr = NL + "iberr = EBUS <Command error>"
        ElseIf (iberr% = ESTB) Then AddIberr = NL + "iberr = ESTB <Status byte lost>"
        ElseIf (iberr% = ESRQ) Then AddIberr = NL + "iberr = ESRQ <SRQ stuck high>"
        ElseIf (iberr% = ETAB) Then AddIberr = NL + "iberr = ETAB <Table overflow>"
    Else
        AddIberr = NL + "iberr = " + Str$(iberr%)
    End If
End Function
```

10.20 AddIbsta() support routine

```
' Display mnemonics for GPIB status bits
Function AddIbsta () As String
sta$ = Chr$(13) + Chr$(10) + "ibsta = 0x" + Hex$(ibsta%) + " < "
    If (ibsta% And EERR) Then sta$ = sta$ + "ERR "
    If (ibsta% And TIMO) Then sta$ = sta$ + "TIMO "
    If (ibsta% And EEND) Then sta$ = sta$ + "END "
    If (ibsta% And SRQI) Then sta$ = sta$ + "SRQI "
    If (ibsta% And RQS) Then sta$ = sta$ + "RQS "
    If (ibsta% And CMPL) Then sta$ = sta$ + "CMPL "
    If (ibsta% And LOK) Then sta$ = sta$ + "LOK "
    If (ibsta% And RREM) Then sta$ = sta$ + "REM "
    If (ibsta% And CIC) Then sta$ = sta$ + "CIC "
    If (ibsta% And AATN) Then sta$ = sta$ + "ATN "
    If (ibsta% And TACS) Then sta$ = sta$ + "TACS "
    If (ibsta% And LACS) Then sta$ = sta$ + "LACS "
    If (ibsta% And DTAS) Then sta$ = sta$ + "DTAS "
    If (ibsta% And DCAS) Then sta$ = sta$ + "DCAS "
    sta$ = sta$ + ">"
    AddIbsta = sta$
End Function
```

10.21 GPIBErrMsg() support routine

```
' Build and display a GPIB error message string
Sub GPIBErrMsg (msg$)
    msg$ = msg$ + AddIbsta() + AddIberr() + AddIbcnt()
    MsgBox msg$, MB_ICONEXCLAMATION, "GPIB ERROR"
End Sub
```

11. AVAILABLE OPTIONS

11.1 Module Types

Type	Voltage (V)	Current (A)	Power (W)	Description
0	-	-	-	System Controller
1	10	60	400	DC Source Module
2	60	16	400	DC Source Module
3	80	12	400	DC Source Module
4	400	3	400	DC Source Module
11*	10	30	200	DC Source Module
12*	60	8	200	DC Source Module
13*	80	6	200	DC Source Module
14*	400	1.5	200	DC Source Module
31	450	60	300	Load Module
33	80	60	300	Load Module

* These module types have been discontinued.

11.2 Module Options

The following factory installed options for DC modules exist:

Bit	Name	Description
0	SCR Shutdown	Provides quick removal of voltage from module output
1	Polarity Reversal Relay	Allows for reversal of output voltage polarity
2	Isolation Relay	Isolates DC source output from externally connected UUT
3-15	Reserved	

Any or all of the DC module options defined above may be specified for a given module. For each installed option, the corresponding option bit must be set in the "MODULE OPTIONS" option of the system configuration. The remaining option bits are cleared.

There are no installable options for the Load module.

12. SCPI CONFORMANCE INFORMATION

12.1 SCPI Version

The S300 instrument complies with SCPI version 1994.0.

12.2 SCPI Confirmed Commands

The syntax of all SCPI confirmed commands implemented in the S300 is as follows:

```
:CONFigure[?]
  :VOLTage
  :CURRent
  :TEMPerature
:FETCh[?]
  :VOLTage?
   :CURRent?
   :TEMPerature?
 :READ[?]
  :VOLTage?
  :CURRent?
  :TEMPerature?
 :MEASure[?]
  :VOLTage?
  :CURRent?
  :TEMPerature?
 :CALibrate[?]
  :DATA[?] <numeric data,..numeric data>
  :STATe[?] | <boolean>
:INSTrument[?]|[<string>]
  :SELect[?]|<string>
  :NSELect[?]|<integer data>
  :STATe[?]|<boolean>
:OUTPut[?]| [<boolean>]
```

```
  [:SOURce]
  :CURRent |
  :VOLTage
    [:LEVel][?]
      [:IMMediate][?]
        [:AMPLitude][?] <float>
 {[:SOURce] - continued}
    :LIMit[?] <float>
      [:MAXimum][?] <float>
        :AMPLitude[?] <float>
        :HIGH[?] <float>
        :LOW[?] <float>
        :STAT[?] <boolean>
      :MINimum[?] <float>
        :AMPLitude[?] <float>
        :HIGH[?] <float>
        :LOW[?] <float>
        :STAT[?] <boolean>
     :PROTection[?] <float>
      [:LEVel][?] <float>
        :[MAXimum][?] <float>
        :MINimum[?] <float>
      :STATe[?]
      :TRIPped?
      :CLEar
      :TIME[?]
:STATus
            :QUEue?
:SYSTem
  :COMMunicate
    :GPIB
      :ADDRess[?]|<numeric data>
  :CPON <integer data>|ALL
  :DATE[?]|<integer data>,<integer data>,<integer data>
  :ERRor?
   :TIME[?]| <integer data>,<integer data>,<integer data>
  :VERSion?
:TEST <numeric data[,..]>|ALL
:ABORt
:INITiate
  [:IMMediate]
:TRIGger
  [:IMMediate]
    :ARM
```

12.3 SCPI Approved Commands

The syntax of all SCPI approved commands implemented in the S300 is as follows:

```
:DIAGnostic
  :INput?
  :OUTput
  :CONFigure[?]
```

12.4 Non-SCPI Command Syntax

12.4.1 Load Module

To fully implement the feature set of the Load module the following command were added to the command set.

```
[:SOURce]
  :MODE[?]|<string>
```