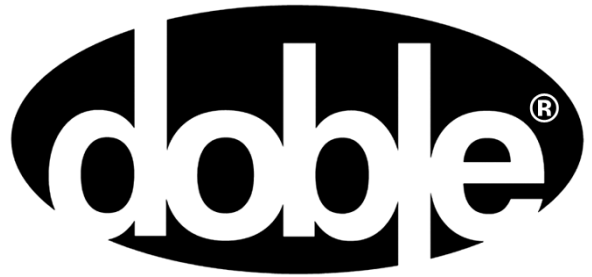


F6150 Power System Simulators User Guide



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1. Introduction

The F6150 power system simulator (Figure 1-1) enables you to test any type of protection. The current amplifier has power to test high-burden electromechanical relays. Concurrently, the F6150 provides up to 12 sources to test solid-state and multifunction numerical protection. It can test not only simple voltage, current, and frequency relays but also complex protection schemes, such as communication-assisted line protection.

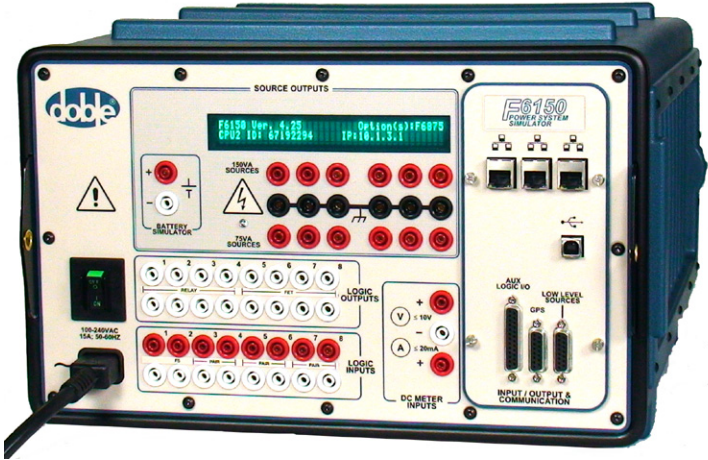


Figure 1-1 F6150 Power System Simulator

Configuration of the sources is internal and is independently controlled by a computer to meet diverse requirements for various relay tests. By combining the current sources in series or parallel, the F6150 yields higher output for testing high-burden relays or protection schemes. Eight logic input and eight logic output channels provide the means to evaluate protection scheme performance. An independent DC battery simulator is also furnished for powering digital and static relays or meters.

	The F6150 has three current amplifiers and three voltage/current convertible amplifiers.
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Hardware Architecture

Figure 1-2 shows the components of the F6150.

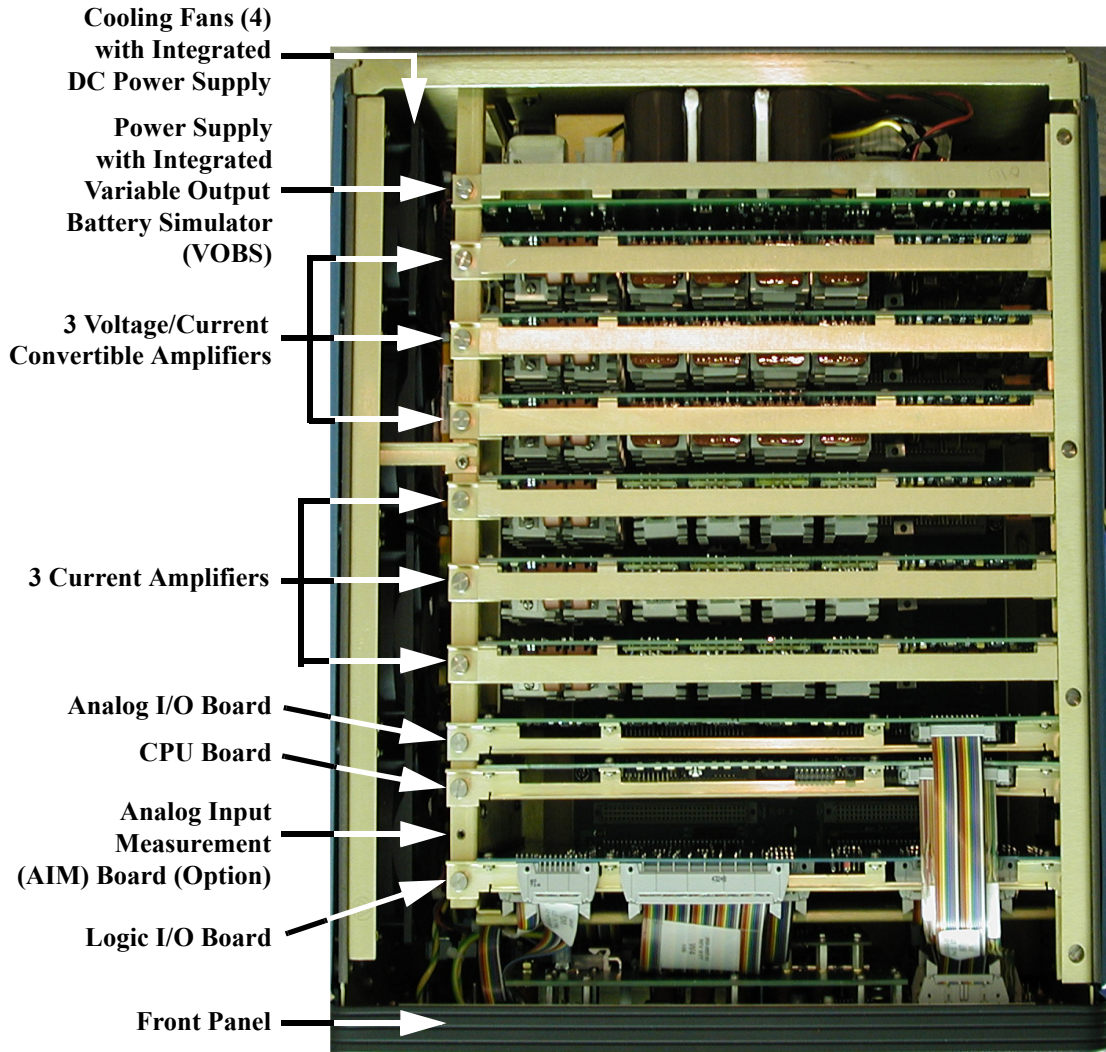


Figure 1-2 F6150 Components

F6ControlPanel

F6ControlPanel (Figure 1-3) enables you to direct the F6150 from a computer connected to the instrument's front panel. It emulates front panel controls, allowing you to configure and control the instrument's voltage sources, current sources, logic inputs, logic outputs, and timers. It also provides settings and controls that accommodate a wide range of test configurations. You can use the control panel's intuitive controls to check a relay without an elaborate test plan.

A stand-alone version of F6ControlPanel is shipped with each F6000 instrument. F6ControlPanel is also available from the Tools menu of ProTesT. For complete details on using F6ControlPanel, see the *F6ControlPanel User Guide*.

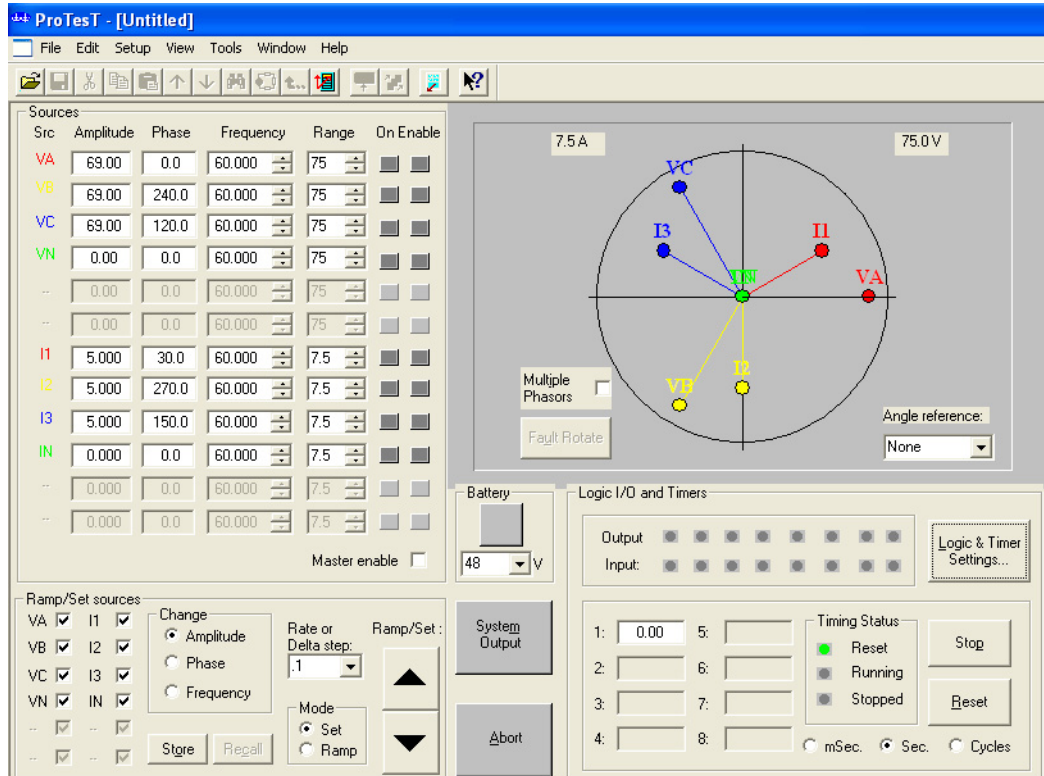


Figure 1-3 F6ControlPanel

Figure 1-4 shows a typical system configuration for the software, the instrument, and a relay under test.

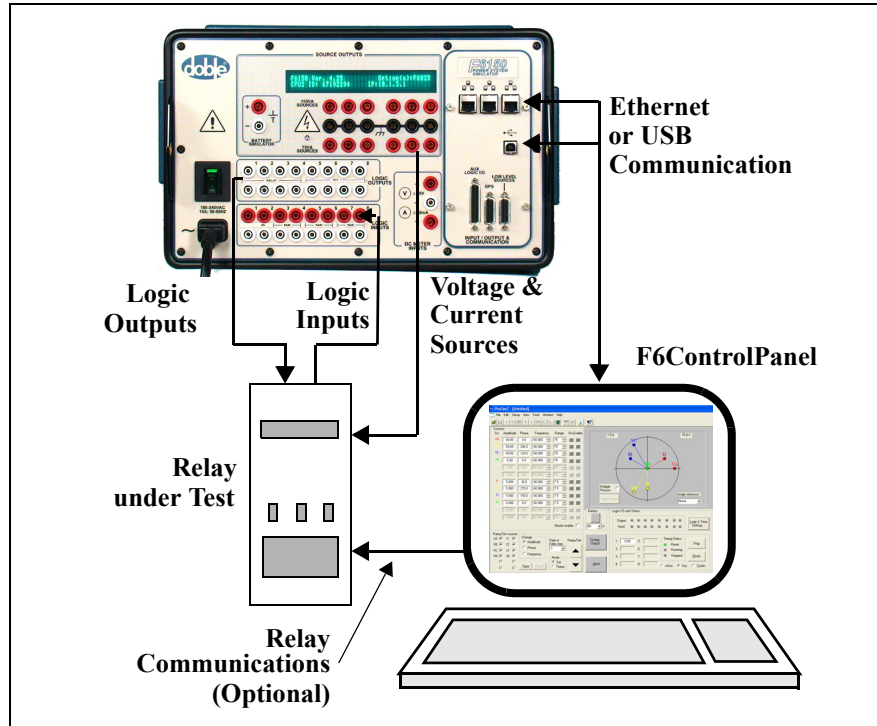


Figure 1-4 Test Setup with F6ControlPanel, F6150, and Relay under Test

USB Driver

New F6150 instruments include a USB connector on the front panel. This connector is used for serial communication between your computer and the F6150.

For your computer to be able to communicate with the F6150 using the USB serial connection, you must install the USB driver included on the CD supplied with the instrument or downloaded from the Doble website (www.doble.com/support/download.html). See the *USB Driver Installation Notice* (500-0706) for instructions on installing the driver.

F6150 Internal Options

Table 1-1 F6150 Internal Options

Option No.	Name	Description
F6800	Transducer Interface	Enables the DC meter inputs on the F6150. Includes Meter Measurement Studio software.
F6810	High-Power Convertible Voltage/Current Sources	Provides high-compliance voltage/low current ranges for overcurrent relay testing. Enables testing of older, high-burden electromechanical and all 1 amp protection.

Table 1-1 F6150 Internal Options (Continued)

F6820	Analog Input Measurement Module	Allows you to collect eight channels of analog and digital data using the logic input connectors on the front of the F6150.
F6825	High-Speed CPU2	Provides an integrated high-speed (300 MHz) communication processor, featuring memory controller with 1 MB of synchronous SRAM (SSRAM) and enhanced 32-bit communication processor module with a 10/100 Mbps RJ-45 Ethernet link.
F6841	Logic I/O Board	Type 1 (04S-0672-01) ^a
F6842	Logic I/O Board	Type 2 (04S-0742-01) ^a
F6844	Logic I/O Board	Type 4 (04S-0820-01) ^a
F6845	Logic I/O Board	Type 5 (04S-0837-01) ^a
F6860	IEC 61850 GSE Interface Module	Supports inputs from protective relays that support IEC 61850 protocol.
F6875	Variable Output Battery Simulator (VOBS)	Provides a fully adjustable variable battery supply from 6 to 300 V DC @ 90 W.
F6885	Global Positioning System (GPS) Satellite Receiver Interface	Enables the GPS receiver interface in/out on the F6150. Requires connection to the F6895 GPS Antenna (F6895).
F6895	GPS Antenna	The antenna/receiver that is connected to the F6150 and receives the GPS signal.
F6909	Control Panel Enable	Permits F6ControlPanel to communicate with the F6150.
F6910	Simulator Control and Automation Module	Permits the F6150 to communicate with automated software applications like F6ControlPanel.

^a The option number of the logic I/O board will scroll in the VFD when Firmware 2.21 or greater (CPU1 instrument) or Firmware 4.21 or greater (CPU2 instrument) is installed.



2. Front Panel

Located on the front panel (Figure 2-1) are:

- Outputs for up to six 150 VA voltage/low-current convertible sources
- Outputs for up to six current sources
- Output for the battery simulator
- Connections for eight logic outputs
- Connections for eight logic inputs
- Ports for system communications
- On/off switch and AC power connection
- Instrument display

All test functions are controlled from a computer.

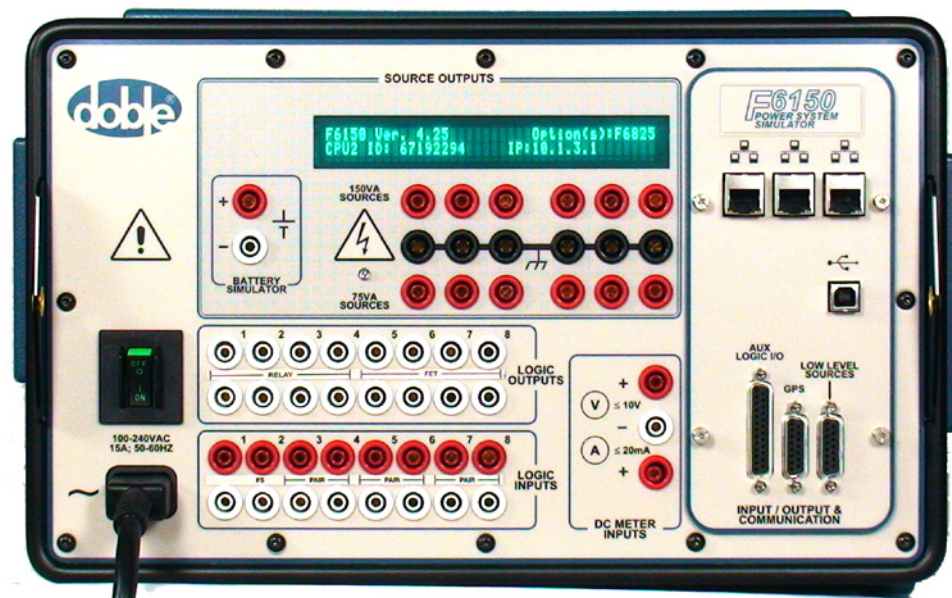


Figure 2-1 F6150 Front Panel (Present CPU2 shown)

Source Outputs

The Source Outputs section of the F6150 front panel contains outputs for AC/DC voltage and current sources and a battery simulator that supplies DC power. It also contains a VFD (vacuum fluorescent display) of key operating information (Figure 2-1).

Instrument Display

On boot-up, messages in the vacuum fluorescent display (VFD) cycle in a predictable and recognizable pattern. This pattern is disrupted if the F6150 fails its internal diagnostic test. The F6150 performs a set of internal diagnostics to check the integrity of the system's memory, data, and communication paths. It also checks the integrity of the system modules. After a successful boot-up, the VFD shows the following:

- CPU ID number
- Firmware revision currently installed
- Options enabled
- Instrument's IP address for network communications
- Status of the GPS receiver (if option 6885 is installed and receiver option 6895 is powered up and connected to the F6150)

During normal operation, the VFD shows source names and the layout of the sources. When any source is on or enabled, the VFD shows the amplitude and phase angle of the source, for up to six sources.



When a source is enabled, the source label uses a lowercase identifier (for example, va, vb, vc, i1, i2, and i3). When a source is on, the label uses an uppercase identifier (for example, VA, VB, VC, I1, I2, and I3).

Voltage and Current Sources

[Figure 2-2](#) shows the voltage (left bank) and current (right bank) sources on the instrument's front panel. The F6150 provides three 150 VA voltage sources, which optionally may be converted into current sources to provide low-range current testing. It also provides three 150 VA current sources, which can be combined to achieve more power. Two 150 VA current sources can be combined to form a 300 VA source. Three 150 VA current sources can be combined to form a 450 VA source.



Low-current convertible sources from the left bank and current sources from the right bank must not be paralleled. See [“Rules for Source Selection” on p. 3-8](#).

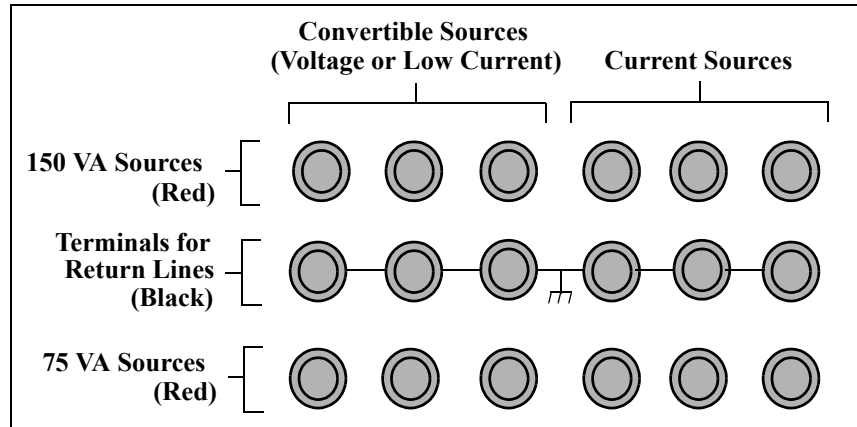


Figure 2-2 F6150 Front Panel Source Outputs

The F6150 voltage sources optionally may be converted into current sources. A convertible source, when used in current mode, provides a low-range current at a high compliance voltage. [Table 2-1](#) shows the current ranges for 150 VA sources.

Table 2-1 150 VA Convertible Sources Configured to Supply Low Current at a High Compliance Voltage

Current	Compliance Voltage
0.5 A	300 V
1.0 A	150 V
2.0 A	75 V



The high-intensity yellow LED flashes when the battery simulator or any output source is on or enabled, to indicate the potential for dangerous or fatal voltages.

The F6150 supplies three convertible voltage/current sources and three current sources. Each source is rated at 150 VA of continuous power ([Figure 2-3](#)). The F6150A supplies two convertible voltage/current sources and two current sources.

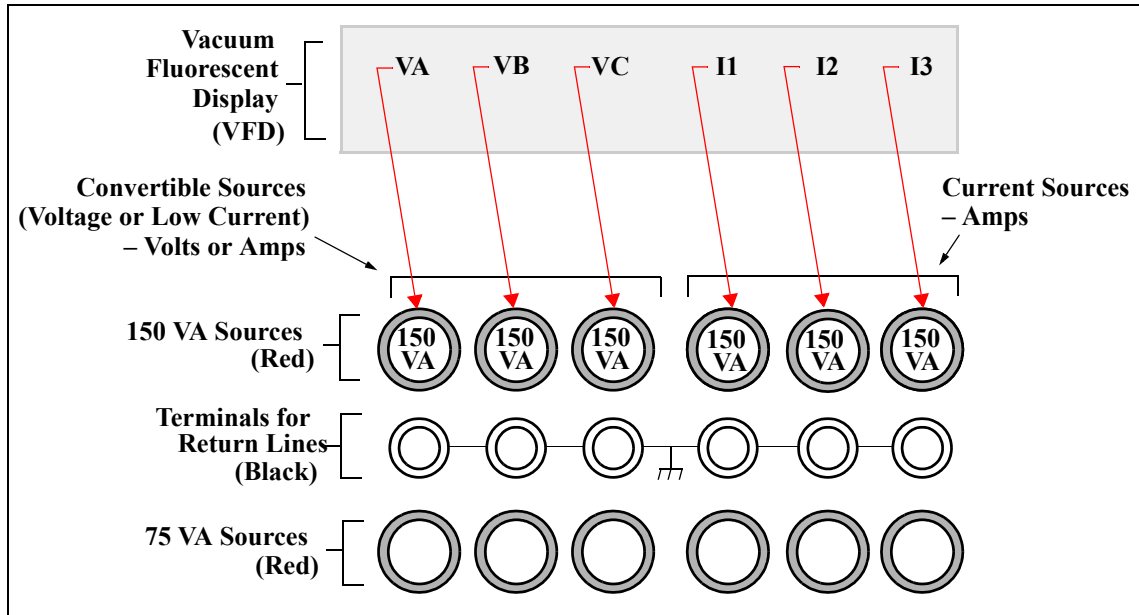


Figure 2-3 Six 150 VA Sources Mapped from VFD

These six sources can be switched to eight sources by splitting two of the 150 VA sources into four 75 VA sources (Figure 2-4).

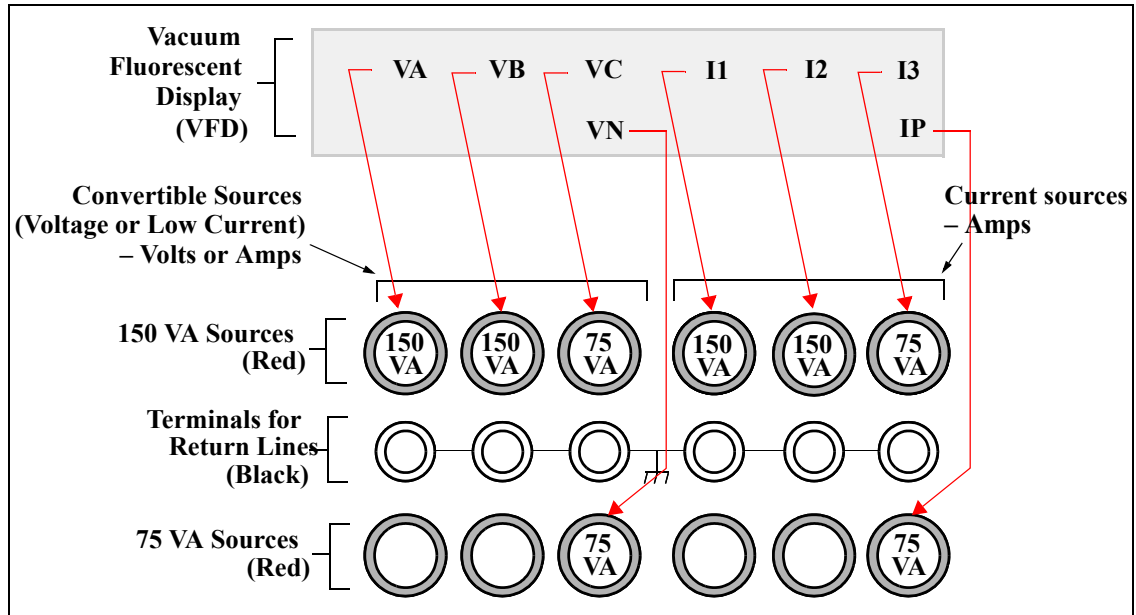


Figure 2-4 Four 150 VA Sources and Four 75 VA Sources Mapped from VFD

The source outputs on the F6150 front panel include terminals for 150 VA and 75 VA sources as well as terminals for return lines:

- The six red terminals in the first row of outputs supply up to 150 VA of power.
- The first set of three 150 VA outputs are convertible sources. Use these as voltage sources or optionally as low-current sources. The fourth, fifth, and sixth outputs are 150 VA current sources.
- The six black terminals in the second row are for return lines for all sources.
- When a 150 VA source is split into two 75 VA sources, the return line for both sources uses the common terminal in the middle row.
- The six red terminals in the third row of outputs supply 75 VA of power when a 150 VA source is split.

Figure 2-5 illustrates the front panel source configuration when six 150 VA voltage sources are split into twelve 75 VA sources.

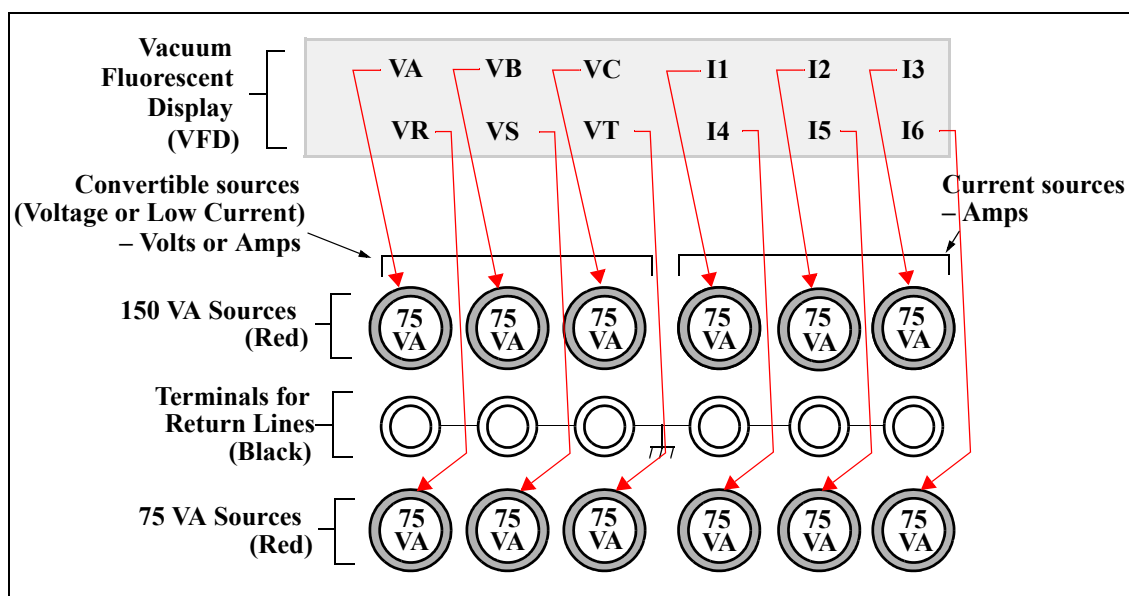


Figure 2-5 Twelve 75 VA Sources Mapped from VFD

Battery Simulator

The battery simulator can be used to power digital and static relays.

The Variable Output Battery Simulator (VOBS – Option F6875) provides up to 90 W of output power, with a voltage range that can be set between 6 and 300 VDC in 1 V increments.

The Fixed Output Battery Simulator provides up to 90 W of output power, with a choice of three discrete voltage settings: 48, 125 or 250 VDC.

The current limit for the battery simulator is 1.5 A DC.

Input/Output & Communication

The Input/Output & Communication section of the F6150 front panel (Figure 2-6) contains the following connectors:

- **Network and PC.** One of the following combinations, for connecting to a PC:
 - ♦ 3 Ethernet connectors and 1 Type-B USB connector (present CPU2 units)
 - ♦ 1 Ethernet connector and 1 RS-232 serial connector (older CPU2 units)
 - ♦ 1 BNC connector and 1 RS-232 serial connector (CPU1 units)
- **Low-Level Sources.** For use with an F6300 (see “Low-Level Sources” on p. 2-13).
- **GPS.** For use with the Global Positioning System antenna (see Appendix C, “Global Positioning System”).
- **Aux Logic I/O.** For future applications.
- **Sync.** (CPU1 and older CPU2 units.) Not used.

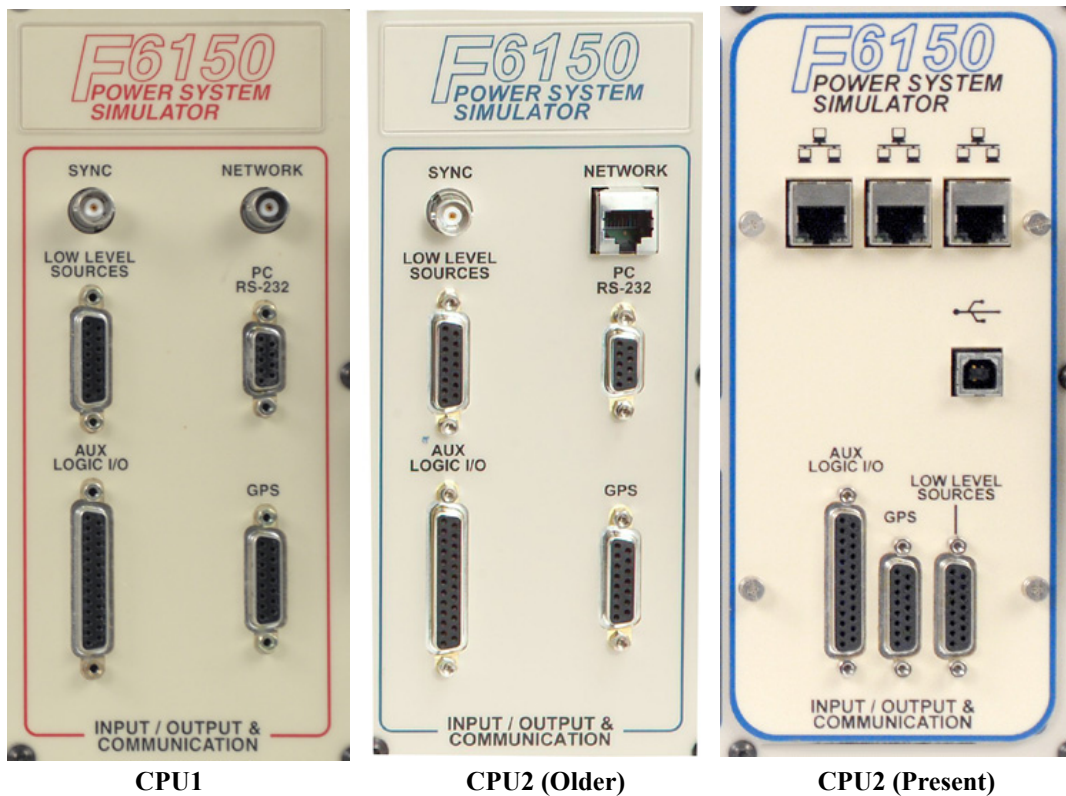


Figure 2-6 Input/Output & Communication Section



You can upgrade the Input/Output & Communication section on older models by replacing the front panel (see “Removing and Replacing the Instrument’s Front Panel” on p. 5-6).

Network and PC

Connect your PC to the F6150 using an Ethernet or USB connector on present CPU2 models or, on CPU1 and older CPU2 models, the RS-232 serial port. See [Figure 2-7](#) through [Figure 2-13](#) for connection examples.



Use the Ethernet communications link only with a discrete PC on a private network. Connecting the F6150 to a local-area or wide-area network permits unauthorized control of the test instrument.

To configure F6ControlPanel to communicate using either the serial port or an Ethernet connection, see [Chapter 3, “Setup and Configuration”](#) for an outline, or the *F6ControlPanel User Guide* for detailed information. [Table 2-2](#) summarizes the requirements for both serial and Ethernet connections for CPU1 and CPU2.

Table 2-2 Serial and Ethernet Connections for CPU 1 and CPU2

	Serial Connection	Ethernet Connection
CPU1		
Connector	9-pin female (labeled PC RS-232)	BNC (labeled NETWORK)
Computer	Serial port	Network card with BNC connector
Cable	RS-232	Cat 5 and hub: 10Base2 (BNC) to 10BaseT (RJ-45) or Cat 5 cable direct to PC (no crossover adapter)
Setup (in F6ControlPanel)	COMx (COM1 by default)	IP address (10.1.3.1 by default)
Baud Rate (in F6ControlPanel)	57,600	n/a
Older CPU2		
Connector	9-pin female (labeled PC RS-232)	RJ-45 (labeled NETWORK)
Computer	Serial port	10 or 10/100 Mbps Ethernet card
Cable	RS-232	Cat 5 to hub or Cat 5 crossover cable direct to PC
Setup (in F6ControlPanel)	COMx (COM1 by default)	IP address (10.1.3.1 by default)
Baud Rate (in F6ControlPanel)	57,600	n/a

Table 2-2 Serial and Ethernet Connections for CPU 1 and CPU2 (Continued)

	Serial Connection	Ethernet Connection
Present CPU2		
Connector	Type B USB port ^a	RJ-45
Computer	Type A USB port ^a	10 or 10/100 Mbps Ethernet card
Cable	USB	Cat 5 to hub or Cat 5 crossover cable direct to PC
Setup (in F6ControlPanel)	COMx (COM1 by default)	IP address (10.1.3.1 by default)
Baud Rate (in F6ControlPanel)	57,600	n/a

^a For your computer to be able to communicate with the F6150 using the USB serial connection, you must install the USB driver included on the CD supplied with the instrument. See “[USB Driver](#)” on p. 1-4.

Serial Connect Example

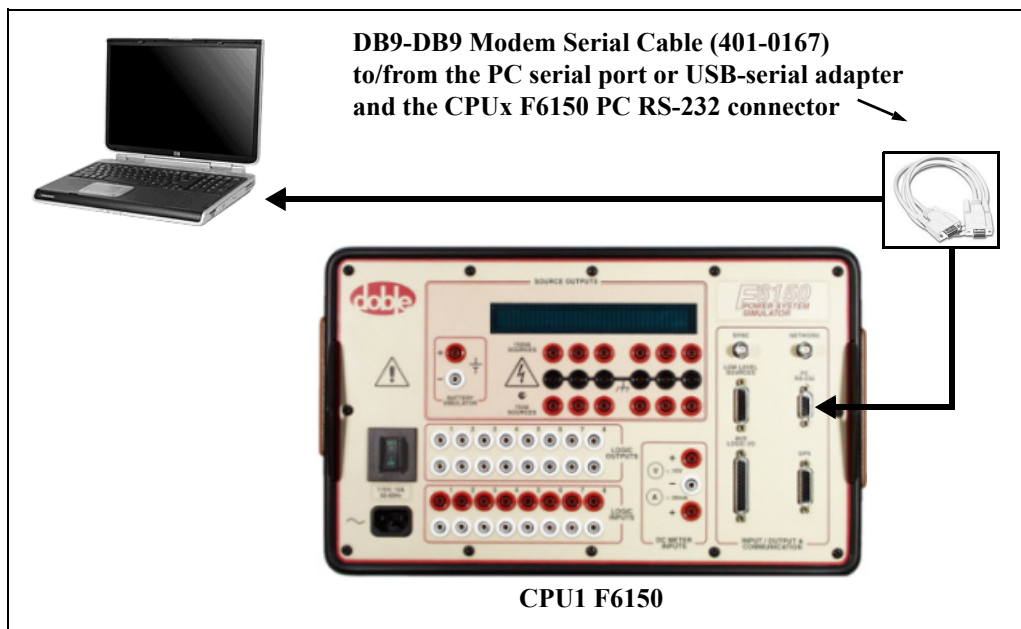


Figure 2-7 Serial Connection – Computer to CPU1 or Older CPU2 F6150

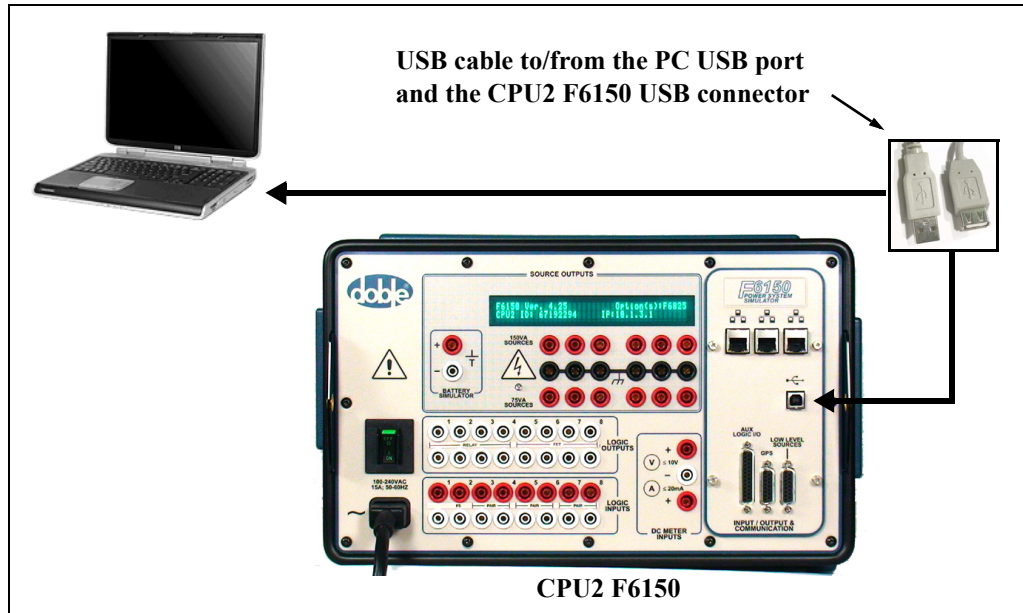


Figure 2-8 Serial Connection – Computer to Present CPU2 F6150

Ethernet Connect Examples

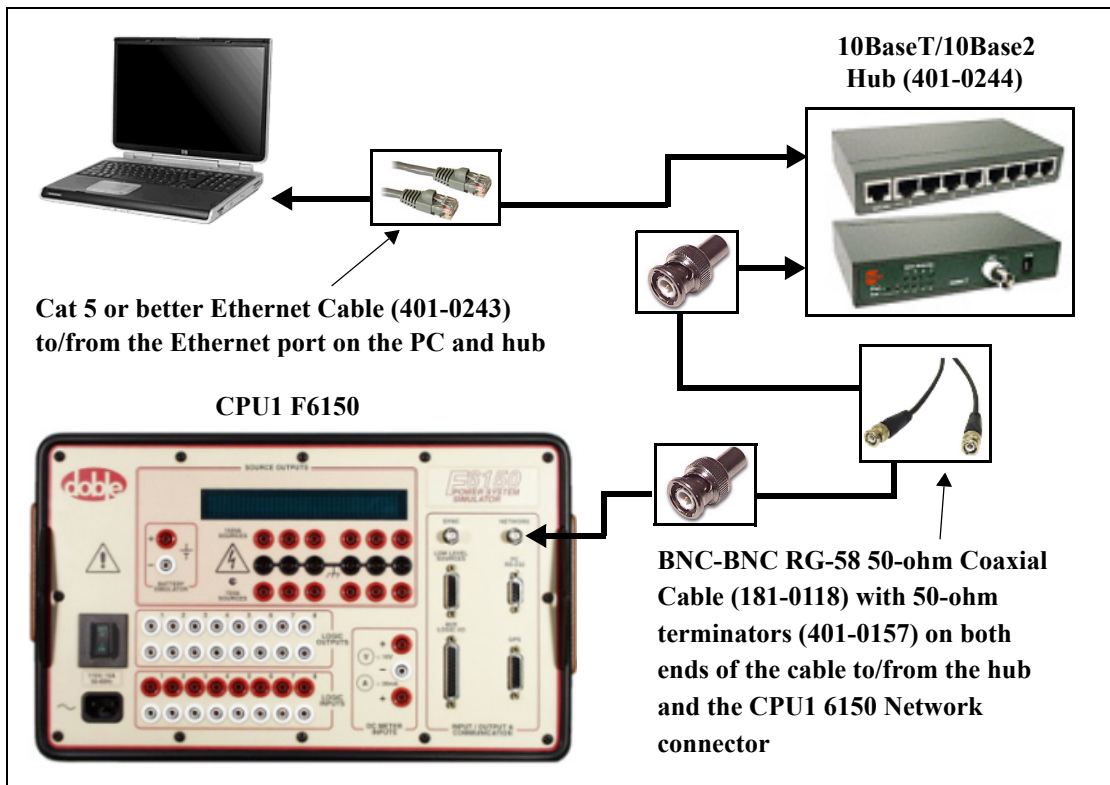


Figure 2-9 Ethernet Connection – Computer to CPU1 F6150 with Switch/Hub

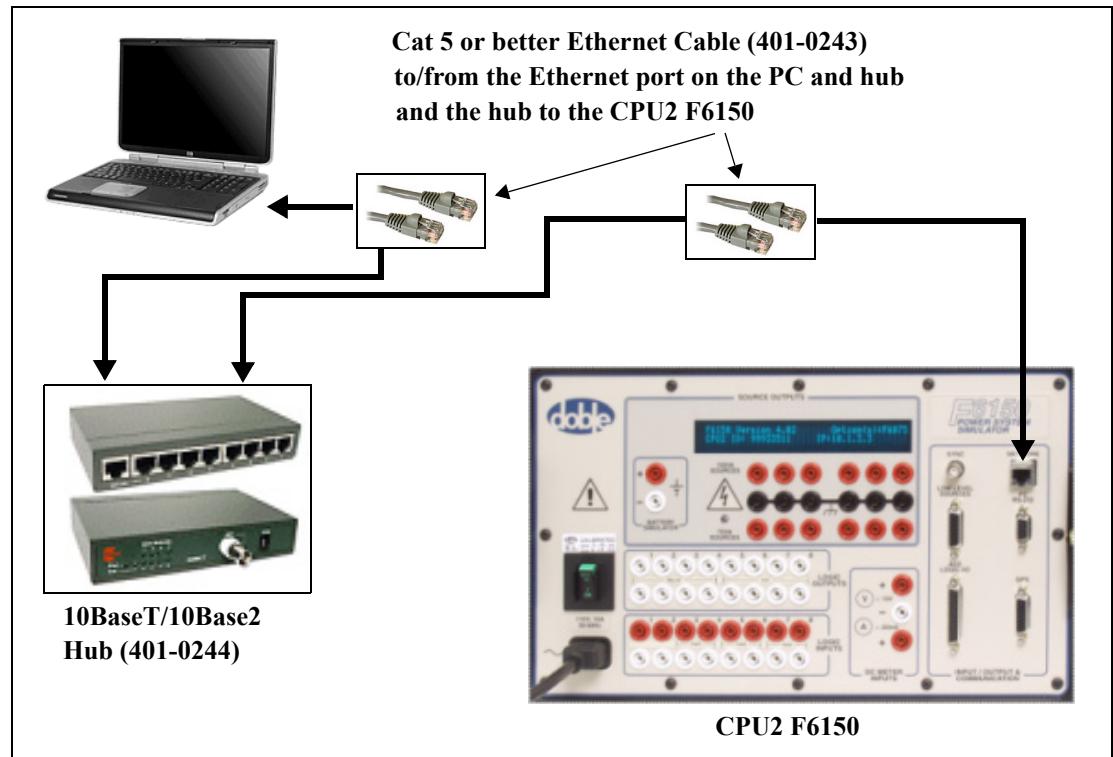


Figure 2-10 Ethernet Connection – Computer to Older CPU2 F6150 with Switch/Hub

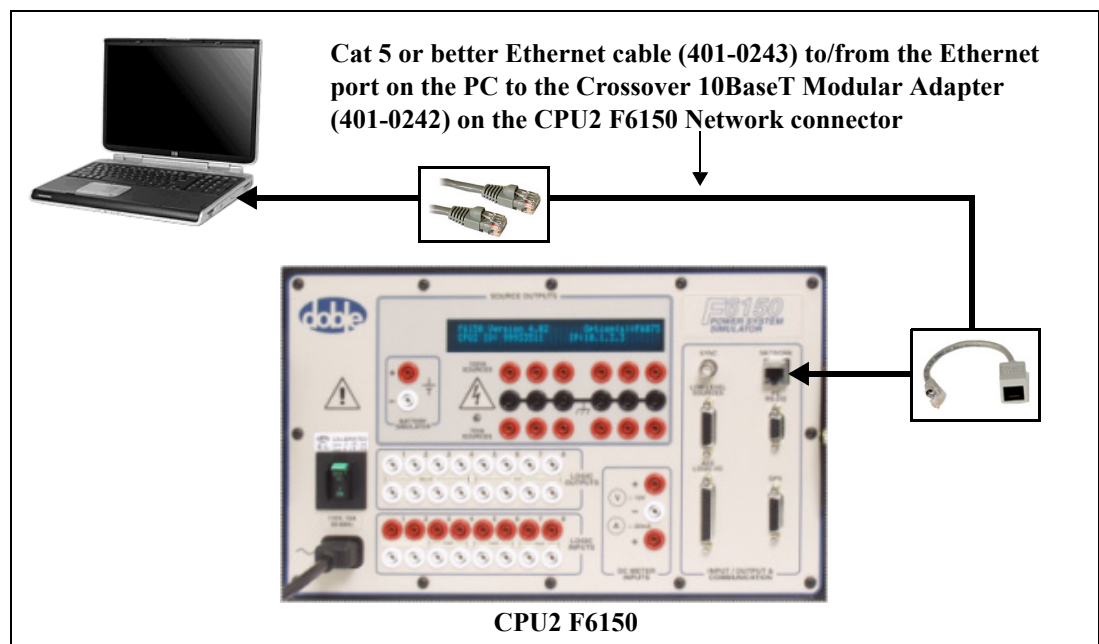


Figure 2-11 Ethernet Connection – Computer to Older CPU2 F6150 with a Cat 5 Crossover Cable

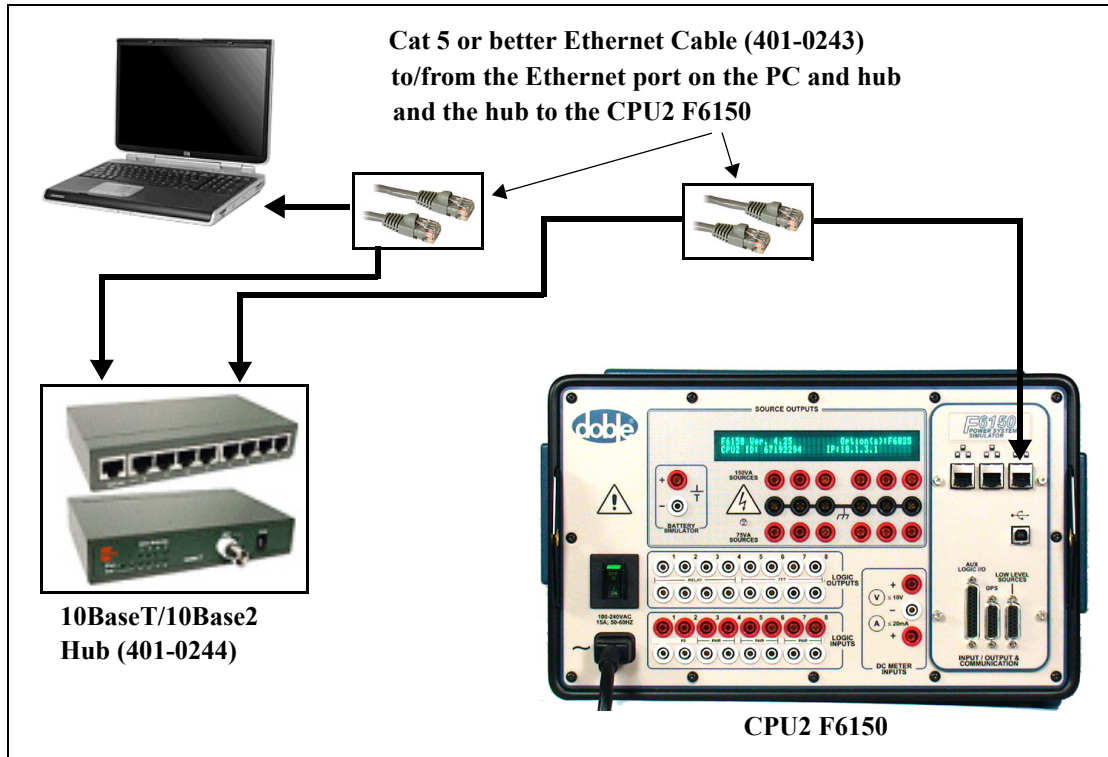


Figure 2-12 Ethernet Connection — Computer to Present CPU2 F6150 with Switch/Hub

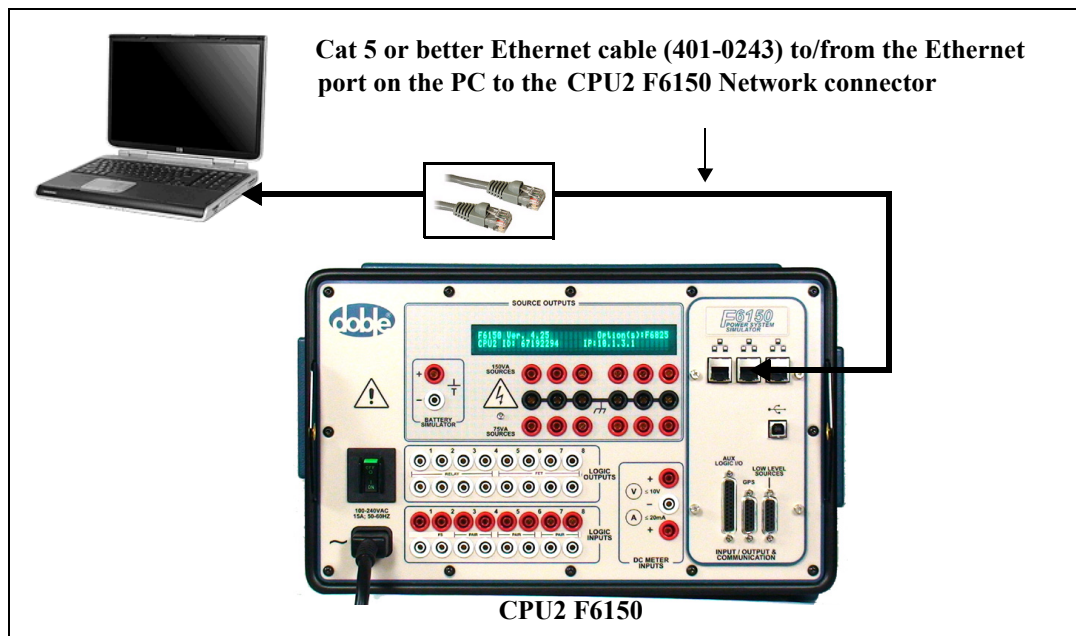


Figure 2-13 Ethernet Connection — Computer to Present CPU2 F6150 with a Cat 5 Crossover Cable

Low-Level Sources

The Low-Level Sources connector is used when connecting an F6300 to the F6150.

Figure 2-14 shows the most common configuration, a connection between a PC and a CPU2 F6150 and CPU2 F6300. For diagrams of other configurations, see the *F6300 Power System Simulator User Guide* (72A-2337-01).

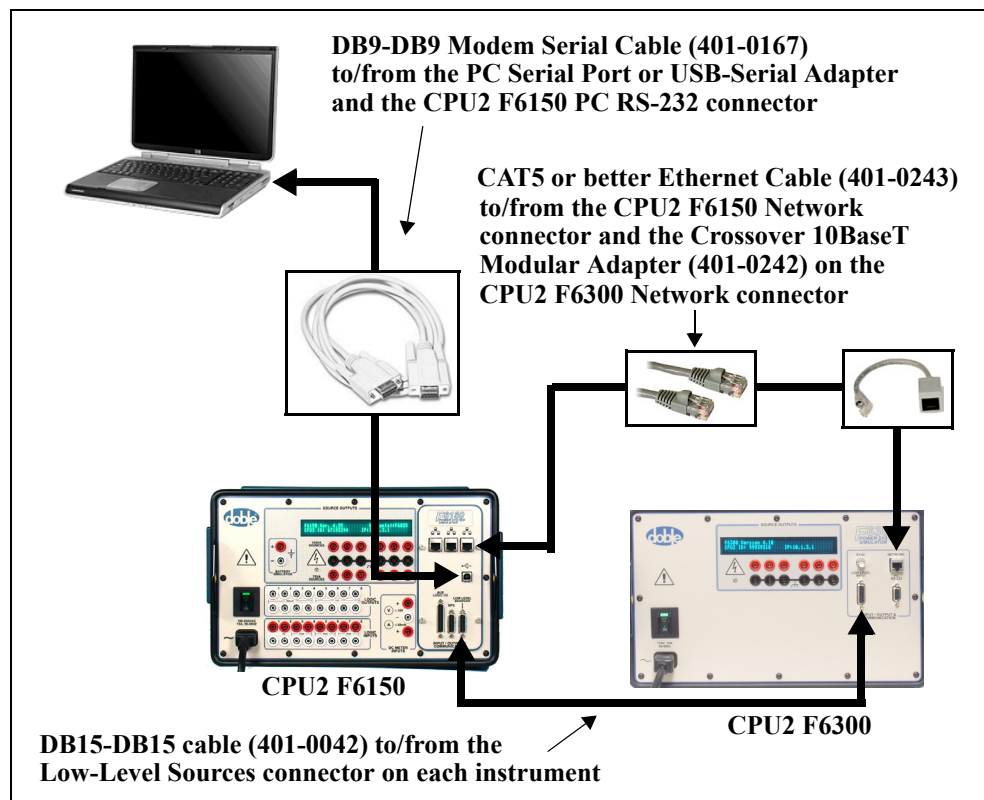


Figure 2-14 Computer to CPU2 F6150/CPU2 F6300



The male-male DB-15 cable supplied with the F6300 must be connected between the Low-Level-Sources (or Input) connectors of both instruments for proper operation of the F6300.

To connect the F6150 and F6300 for Ethernet serial communication for 3 voltages and 9 currents (Figure 2-15) or 3 voltages and 3 currents (Figure 2-16):

1. If you are connecting the F6150 directly to the F6300, connect a crossover cable adapter (401-0303) to the Network connector of either instrument.
If you are connecting the two instruments through a hub, no crossover cable is necessary.
2. Connect an RG-58 coaxial cable with 50-ohm terminators at each end (CPU1) or Cat 5 or better cable (CPU2) to the Ethernet connector of each instrument (or to the Ethernet connector of one instrument and the crossover cable connected to the other, if used in Step 1).

3. Connect a male-male DB-15 cable to the Low-Level Sources (or Input) connector of each instrument.
4. Connect an RS-232 cable with male and female ends (CPU1 and older CPU2) or a USB cable (present CPU2) from the F6150 to the COM port of your PC.

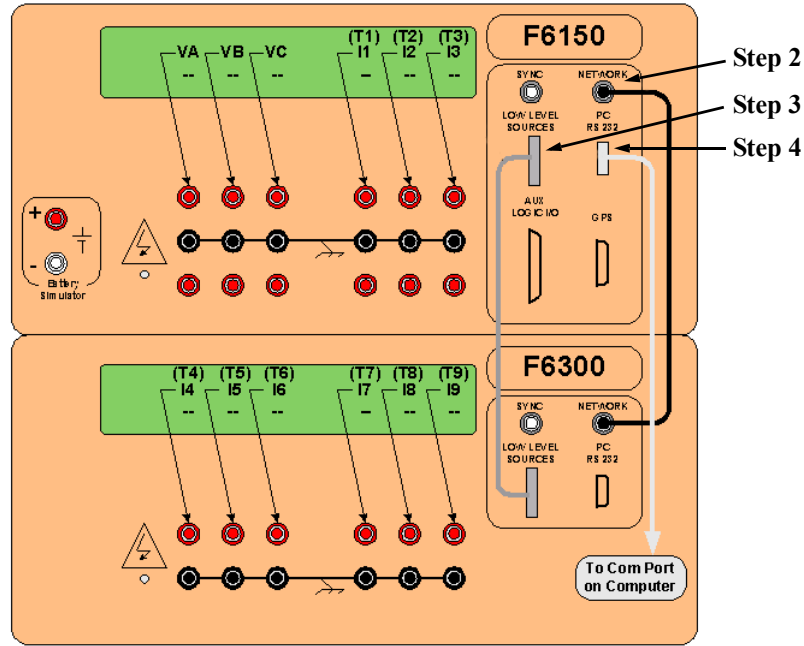


Figure 2-15 Low-Level Source Connections – 3 Voltages and 9 Currents

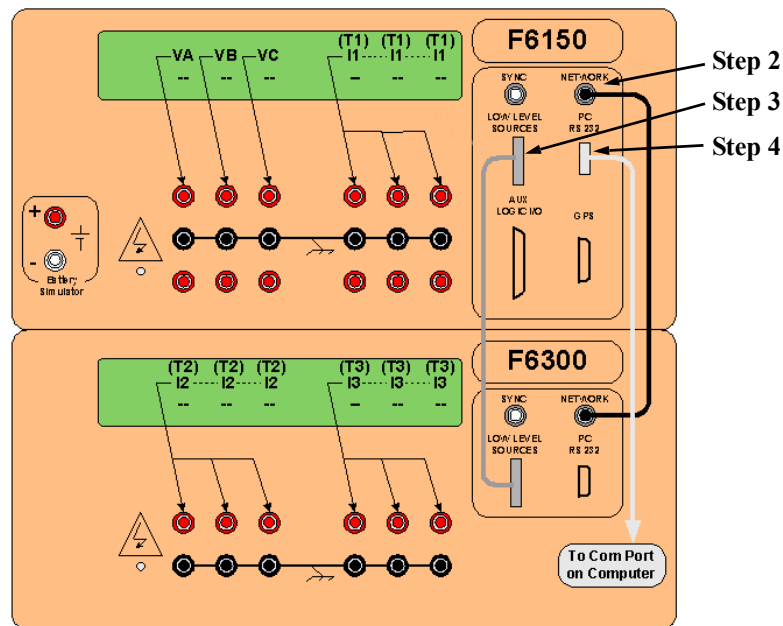


Figure 2-16 Low-Level Source Connections – 3 Voltages and 3 Currents

Logic I/O

The F6150 is delivered with one of four modes for the front panel Logic I/O section. Each mode is defined by its I/O board selection. Figure 2-17 through Figure 2-20 show the four logic I/O section variations. See Table 2-3 and Table 2-4 for logic details.

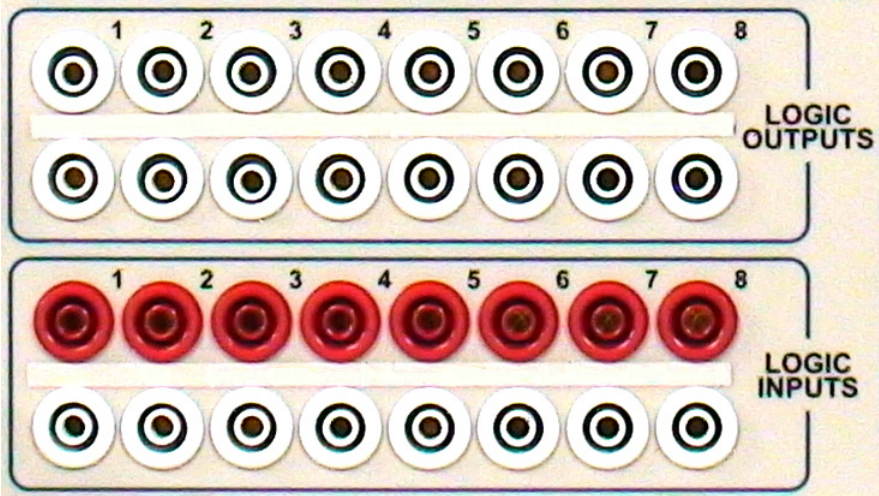


Figure 2-17 Logic I/O Section, Instrument with I/O 1 Board (Option 6841)

	For Option 6841, all the Logic Outputs are FETs and all the Logic Inputs are Isolated.
--	--

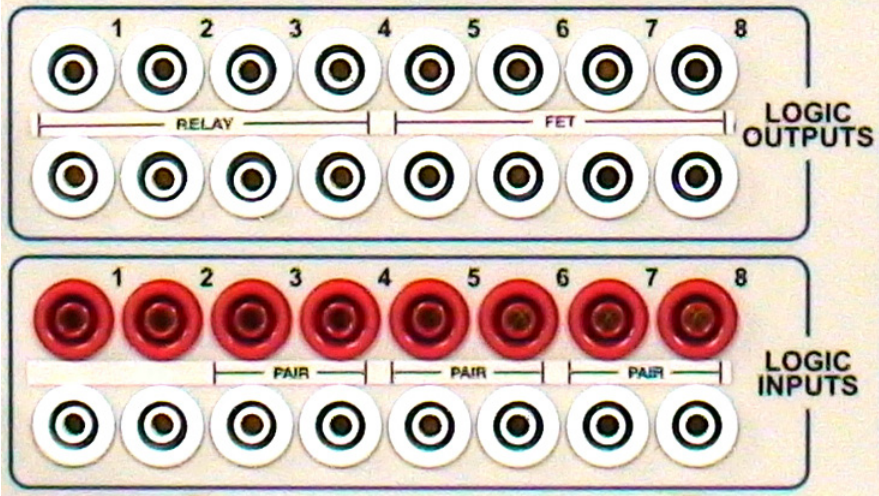


Figure 2-18 Logic I/O Section, Instrument with I/O 2 Board (Option 6842)

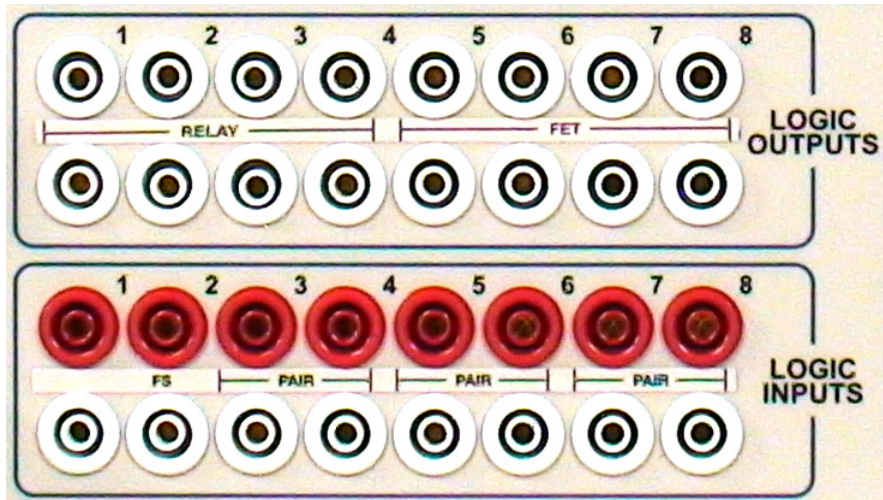


Figure 2-19 Logic I/O Section, Instrument with I/O 4 Board (Option 6844)

	For Option 6844, Input No. 2 provides the First Strike capability.
--	--

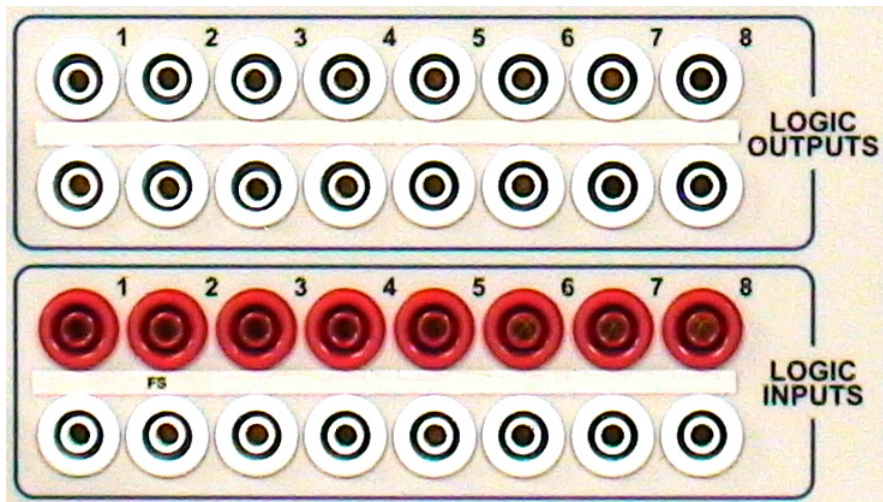


Figure 2-20 Logic I/O Section, Instrument with I/O 5 Board (Option 6845)

	For Option 6845, all the Logic Outputs are FETs, and all the Logic Inputs are Isolated. Input No. 2 provides the First Strike capability.
--	---

Logic Outputs

Logic outputs send logic signals from the F6150 to external devices. They act as logical relays located in the test equipment. The F6150 front panel includes four high-speed (FET) outputs and four relay outputs. Optionally, all eight outputs can be factory specified as high-speed (FET) outputs. The front panel Logic Outputs section will reflect this option.

Each output can be configured as normally open or normally closed. Use F6ControlPanel to configure and control the logic outputs (see [Table 2-3](#) for details).

Table 2-3 Logic Output Details

Number of Logic Outputs	8, configurable as Normally Open (NO) or Normally Closed (NC) switches	
FET Outputs	Number of switches:	4 (I/O types 2 & 4); 8 (I/O types 1 & 5)
	Input voltage:	250 V DC or AC
	Switching current:	0.5 A make or break, maximum
	Response time:	0.1 ms max pickup and dropout
	Isolation:	±500 V peak
Relay Outputs	Number of relays:	4 (I/O types 2 & 4); 0 (I/O types 1 & 5)
	Breaking cap AC:	2000 W with Vmax 250 V, Imax 8 A
	Breaking cap DC:	50 W with Vmax 300V, Imax 8A
	Response time:	10 ms max pickup and dropout
	Isolation between pairs:	±500 V peak

Logic Inputs

Logic inputs have two isolated inputs and six paired inputs isolated in three groups of two logic inputs. The logic inputs are specified in [Table 2-4](#).

Table 2-4 Logic Input Details

Number of Logic Inputs	8, configurable as voltage sense or contact sense	
Isolated Inputs	Number of isolated inputs:	2 (I/O types 2 & 4); 8 (I/O types 1 & 5)
	Voltage sense:	Up to 250 V DC or AC
	Open circuit test voltage:	12 VDC nominal
	Short circuit test current:	20 mA DC nominal
	Response time:	0.1 ms max pickup and dropout
	Isolation:	±500 V peak
	First strike capability:	I/O types 4 & 5
Paired Logic Inputs	Number of paired logic inputs:	3 pairs (6 total) (I/O types 2 & 4); 0 (I/O types 1 & 5)
	Voltage sense:	Up to 250 V DC or AC
	Open circuit test voltage:	4 VDC nominal
	Short circuit test current:	>50 µA DC nominal
	Response time:	0.1 ms max pickup and dropout
	Isolation:	±500 V peak

Optionally, the F6150 can be supplied with all the logic inputs isolated. If this alternative is ordered, the front panel Logic Inputs section will have no PAIR labels.

First Strike

Options F6844 and F6845 provide First Strike capability on Input No. 2. This feature enables the F6150 to see an input pulse width down to 10 microseconds. Without First Strike, the input pulse width must be greater than 180 microseconds to be recognized.

Input Indicators

Each power source maps to one logic output and one logic input. The mapping of sources to inputs and outputs depends on the source configuration in effect. The mapping rule assigns the inputs and outputs to voltage and current sources in ascending order first from left to right, then from top to bottom. [Figure 2-5](#), [Figure 2-6](#), and [Figure 2-7](#) illustrate how the rule works for three common source configurations.

Sources	V1	V2	V3	I1	I2	I3
Indicators	1	2	3	4	5	6
Sources			VN			IN
Indicators			7			8

Figure 2-5 Input and Output Indicators for Four Voltage Sources and Four Current Sources

Sources	V1	V2	V3	I1	I2	I3
Indicators	1	2	3	4	5	6
Sources						
Indicators						

Figure 2-6 Input and Output Indicators for Three Voltage Sources and Three Current Sources

Sources				I1	I2	I3
Indicators				1	2	3
Sources				I4	I5	I6
Indicators				4	5	6


Figure 2-7 Input and Output Indicators for Six Current Sources



If a ProTesT macro specifies source MA, the macro uses Input 1 and Output 1.

A logic output enables the F6000 to send out its own signal. It is a logical relay that opens or closes its contacts when its associated source goes on. The output is in its normal state when

the source is off. A normally open output contact closes when the source is turned on and its corresponding status indicator illuminates.

	The logic outputs can also be controlled in SSIMUL macro on a state to state basis. In this macro, the logic outputs are associated with the appropriate output sources (for example, VA11). See the ProTesT Macro Reference in the <i>ProTesT User Guide</i> (72A-1585-01).
---	--

A logic input is a signal that originates with the relay under test and is sent to the instrument. Any trigger necessary to run a test can be programmed as a logic input. See [Appendix E, “Defining Triggers”](#), for examples of using logic inputs in actual tests.

Power

AC

Present instruments have a universal power supply (Type 2) that can accept line inputs from 105 to 264 VAC at 47 to 63 Hz. Older units were factory-configured to use either 115 or 230 V 50/60 Hz power, as specified by the user when ordering (Type 1). The selected power option on older units is labeled at the power entry receptacle on the front panel.

Low-Level Sources

The Low-Level Sources connector in [“Input/Output & Communication”](#) on p. 2-6 ([Figure 2-6](#)) provides low-level power to an F6300, if connected.

[Table 2-8](#) describes the pinout and parameter ranges of the Low-Level Sources connector. The parameter values are approximate.

Table 2-8 Low-Level Source Connector Pinout and Parameter Ranges

Pin	Description	Parameter Range		
		Voltage Mode	Current Mode	Transient Mode
1	Chassis Ground	—	—	—
2	Convertible Source 4	6.7 Vrms	4.5 Vrms	6.7 Vrms
3	Convertible Source 5	6.7 Vrms	4.5 Vrms	6.7 Vrms
4	Convertible Source 6	6.7 Vrms	4.5 Vrms	6.7 Vrms
5	Current Source 4	—	3.38 Vrms	6.7 Vrms
6	Current Source 5	—	3.38 Vrms	6.7 Vrms
7	Current Source 6	—	3.38 Vrms	6.7 Vrms
8	Source Signal Return	—	—	—

Table 2-8 Low-Level Source Connector Pinout and Parameter Ranges (Continued)

Pin	Description	Parameter Range		
		Voltage Mode	Current Mode	Transient Mode
9	Current Source 1	—	3.38 Vrms	6.7 Vrms
10	Current Source 2	—	3.38 Vrms	6.7 Vrms
11	Current Source 3	—	3.38 Vrms	6.7 Vrms
12	Convertible Source 1	6.7 Vrms	4.5 Vrms	6.7 Vrms
13	Convertible Source 2	6.7 Vrms	4.5 Vrms	6.7 Vrms
14	Convertible Source 3	6.7 Vrms	4.5 Vrms	6.7 Vrms
15	Source Signal Return	—	—	—



3. Setup and Configuration

This chapter describes how to set up the F6150 and summarizes how to establish communications between the instrument and the software used to control it. It also explains how to configure the voltage and current sources on the front panel.

The F6150 is controlled via F6ControlPanel software, which requires the following:

- Personal computer with a Pentium-class processor
- Windows 98/2000/XP/NT 4.0 SP6 operating system
- F6ControlPanel installed on the PC's hard drive (for complete installation instructions, see the *F6ControlPanel User Guide*)
- Serial/Ethernet communication capability:
 - ♦ **CPU1.** RS-232 serial cable or Ethernet BNC cable with a 10 MB network card
 - ♦ **Older CPU2.** RS-232 serial cable or Ethernet Cat 5 cable
 - ♦ **Newer CPU2.** USB serial cable or Ethernet Cat 5 cable
- At least the minimum RAM required by your operating system
- A color monitor with 800 x 600 VGA resolution minimum

Getting Started

To set up the F6150:

1. Unpack the instrument and inspect it to ensure that all items are present and that no damage has occurred in transportation.
2. Verify that all system components are present.
See [Table 5-3](#) and [Table 5-4](#) for a list of cables and components shipped with the unit.
3. Connect the power cord to the power connection socket in the lower left corner of the instrument's front panel and plug it into a standard wall outlet.
4. Power the instrument on with the on/off switch located above the power connection socket.

On bootup, the messages in the Instrument Display cycle in a predictable and recognizable pattern. This pattern is disrupted if the F6150 fails its internal diagnostic test. The F6150 performs a set of internal diagnostics to check the integrity of the system's memory, data, and communication paths. It also checks the integrity of all the system modules.



When the instrument is on, there is a possibility of hazardous voltages or currents at the sources. Proceed with caution.

The following series of messages appears in the VFD as the F6150 firmware boots up. These messages track the sequence of steps in a successful bootup:

```
Starting Power On Test
Run the Doble Bootloader (Version Number)
Loading Compressed Image . . . Done
```

At the end of this series of messages, the VFD appears as in [Figure 3-1](#).

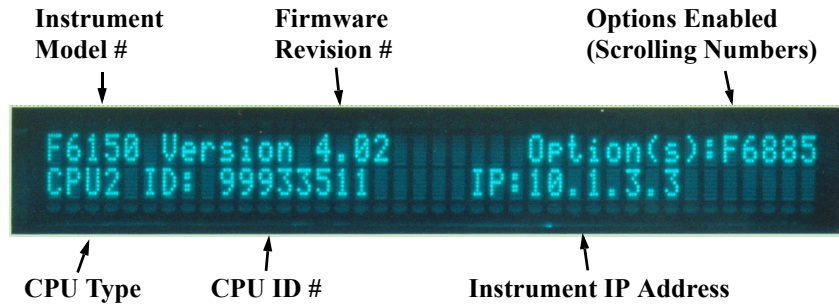


Figure 3-1 Instrument Display after Successful Bootup



If an error message appears in the VFD at the end of the bootup sequence, refer to [Chapter 4, “Troubleshooting”](#).

5. Power off the F6150.
6. If using an Ethernet connection, connect an Ethernet cable to the network card on the computer and the network connector on the instrument’s front panel.
If using a serial connection, connect an RS-232 or USB cable to the serial port on the computer and the RS-232 connector on the instrument’s front panel.
7. Power on the F6150 and the PC.

Launching F6ControlPanel

F6ControlPanel is included on a CD with the F6150. A summary of the launch procedure is given below. For complete details, see the *F6ControlPanel User Guide* (72A-2714-01).

1. Install F6ControlPanel on the PC.
2. Open the software by clicking the desktop icon.
3. Select **Setup** in the menu bar ([Figure 3-2](#)).

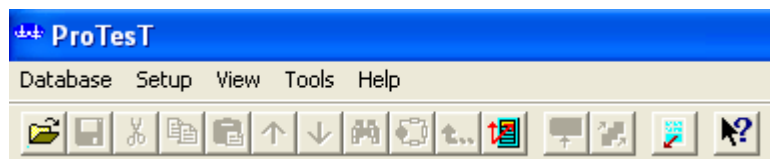


Figure 3-2 ProTest Menu Bar

The Setup dialog box appears.

4. Enter the setup parameters, including the F6 Instrument section (Figure 3-3). Required only on first use.

Check the **Control Panel Simulation** box if the computer is not connected to an instrument or if the instrument is switched off. Simulator mode is useful for training and for configuring tests that will be conducted later.

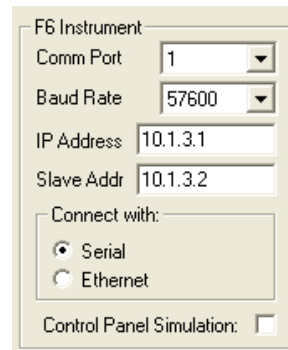


Figure 3-3 F6 Instrument Section of Setup Dialog Box

5. Click OK.
6. Select **Tools** → **F6000 Control Panel**. You are returned to the default screen of F6ControlPanel (Figure 3-4).

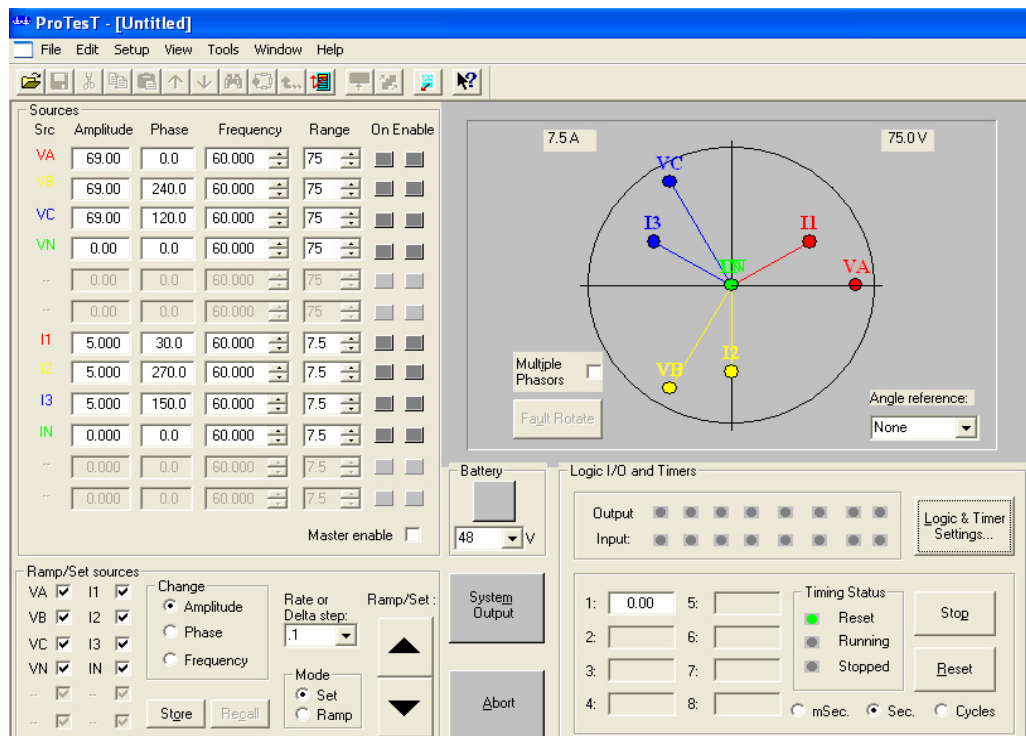



Figure 3-4 F6ControlPanel

F6ControlPanel contains the functions and controls needed to conduct tests with the F6150.

	<p>If the computer is not connected to an instrument or if the instrument is switched off when F6ControlPanel is opened, an error message appears. Acknowledge the error message, then check the box for Control Panel Simulation in Setup or switch the instrument on.</p>
---	---

Using F6000 Configuration

The F6000 Configuration dialog box (Figure 3-5) has a graphic window that represents the voltage and current source output terminals on the instrument's front panel. You can select a number of configurations for F6150 sources, to suit your test requirements. You can configure sources manually (User-Defined) or by choosing from 21 Predefined selections.

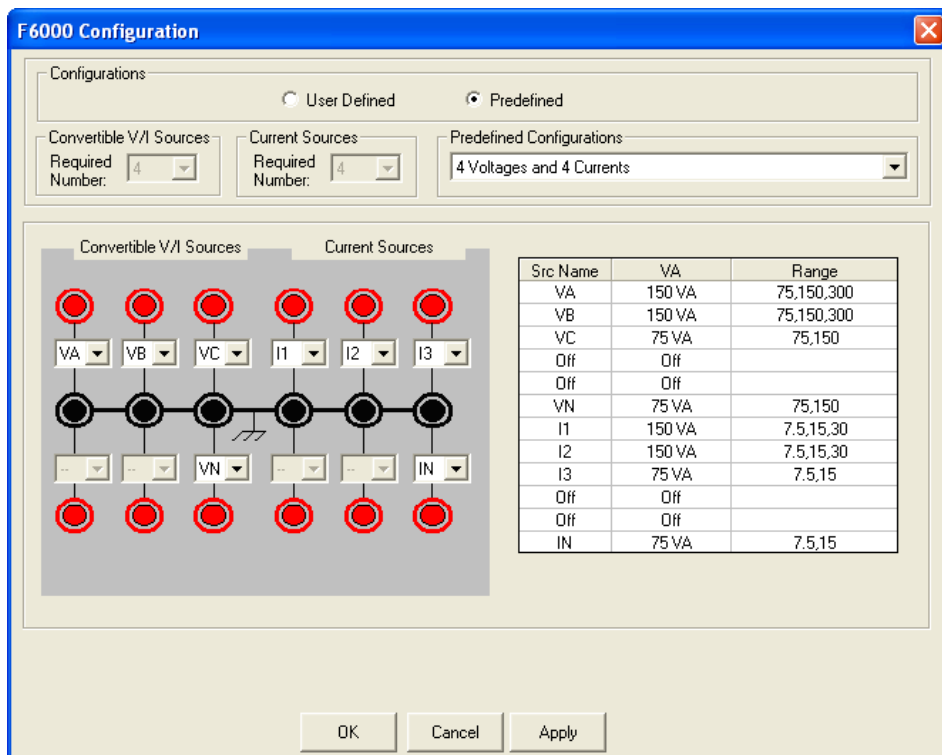


Figure 3-5 F6000 Configuration Dialog Box

Convertible V/I Sources

The F6150 has three convertible V/I sources, each rated at 150 VA. These sources are referred to as convertible V/I sources because the F6810 option enables them to be used as low-range current sources. The number of convertible sources available depends on the number selected in the Convertible V/I Sources dropdown menu. Each convertible V/I source can be split into two 75 VA sources to yield as many as six 75 VA sources.

- In voltage mode, the ranges for the 150 VA sources are 75, 150, and 300 V. The voltage ranges for the 75 VA sources are 75 and 150 V.
- In current mode, the ranges for the 150 VA sources are 0.5, 1.0, and 2.0 A. The current ranges for the 75 VA sources are 0.5 and 1.0 A.

The convertible sources can be placed in transient current mode to increase the output power by 30% and the current range by 50% for 1.5 seconds. In transient current mode, the 150 VA sources supply 195 VA for 1.5 seconds; the 75 VA sources supply 97.5 VA. The current ranges for the 195 VA sources are 0.75, 1.5, and 3.0 A. The current ranges for the 97.5 VA sources are 0.75 and 1.5 A.

Current Sources

The F6150 has three current sources, each rated at 150 VA. Each 150 VA current source can be split in two, to yield six 75 VA sources. The number of current sources available depends on the number selected in the Current Sources dropdown menu.

The current ranges for the 150 VA sources are 7.5, 15, and 30 A. The current ranges for the 75 VA sources are 7.5 and 15 A.

The current sources can be placed in transient current mode to increase the output power by 50% and the current range by 100% for 1.5 seconds. In transient current mode, the 150 VA sources supply 225 VA for 1.5 seconds; the 75 VA sources supply 112.5 VA. The current ranges for the 225 VA sources are 15, 30, and 60 A. The current ranges for the 112.5 VA sources are 15 and 30 A.

Predefined Configurations

To use the Predefined configurations:

1. Select **Tools** → **F6000 Configuration**.

The F6000 Configuration dialog box appears.

2. Click the **Predefined** option button (Figure 3-6).

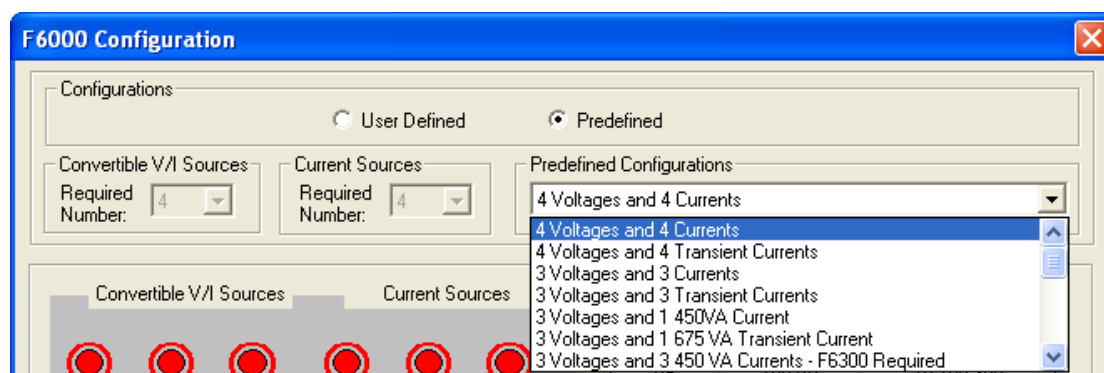


Figure 3-6 Predefined Configurations

3. Choose from one of 21 predefined options:
 - 4 Voltages and 4 Currents

- 4 Voltages and 4 Transient Currents
 - 3 Voltages and 3 Currents
 - 3 Voltages and 3 Transient Currents
 - 3 Voltages and 1 450 VA Current
 - 3 Voltages and 1 675 VA Transient Current
 - 3 Voltages and 3 450 VA Currents – F6300 Required
 - 3 Voltages and 3 675 VA Transient Currents – F6300 Required
 - 3 Voltages and 9 150 VA Currents – F6300 Required
 - 3 Voltages and 9 225 VA Transient Currents – F6300 Required
 - 6 Voltages and 6 Currents
 - 6 Voltages and 6 Transient Currents
 - 6 Voltages and 1 450 VA Current
 - 6 Voltages and 1 675 VA Transient Current
 - 6 Currents (Right Bank)
 - 6 Transients (Right Bank)
 - 6 Voltages (Left Bank)
 - 6 Low Range Currents (Left Bank)
 - 6 Low Range Transient Currents (Left Bank)
 - 1 Voltage and 2 Low Range Currents (Left Bank)
 - 1 Voltage and 2 Low Range Transient Currents (Left Bank)
4. Assign a name to each source from the drop-down menus in the graphic window or accept the defaults.
 - Voltage sources start with the letter V: for example, VA, VB, and VC
 - Current sources start with the letter I: for example, I1, I2, and I3
 - Transient current sources start with the letter T: for example, T1, T2, and T3
 5. Click **OK** to configure the sources and close the dialog box or **Apply** to configure the sources without closing the dialog box.

F6300 Source Configurations

Predefined source configurations suitable for use with the F6150/F6300 end with “F6300 Required.” When you select an F6150/F6300 source configuration, the graphic window changes appropriately ([Figure 3-7](#)).

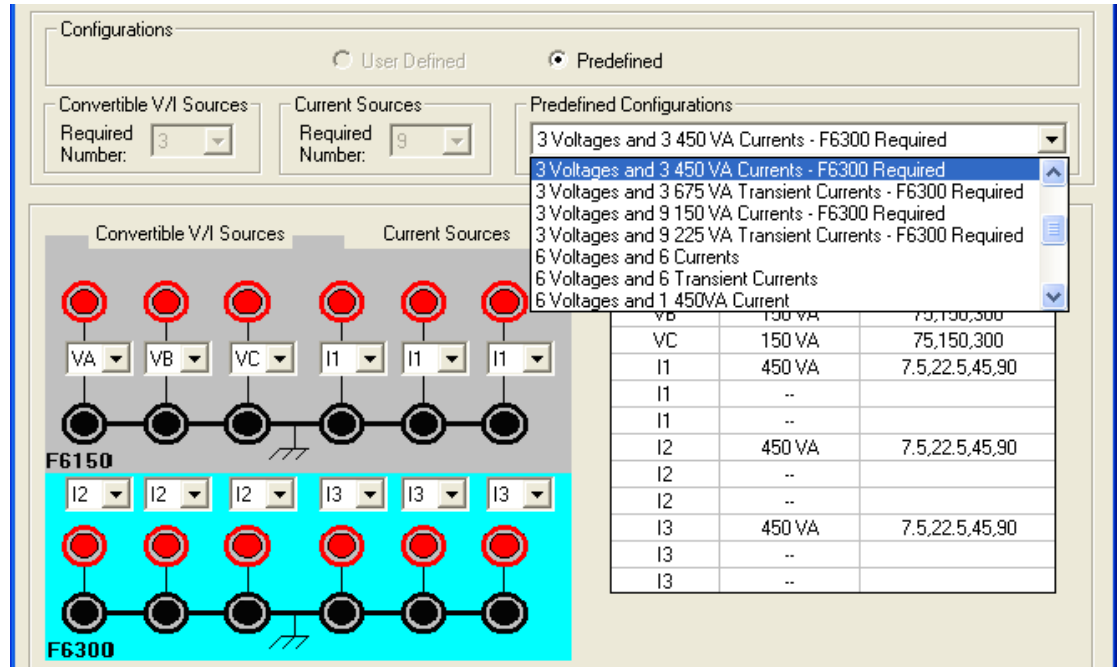


Figure 3-7 F6000 Configuration Dialog Box with F6150/F6300 Configuration Selected

User-Defined Configurations

To configure the sources manually:

1. Select **Tools** → **F6000 Configuration**. The F6000 Configuration dialog box appears.
2. Click the **User-Defined** option button (Figure 3-8).
3. Select the required number of convertible V/I sources and current sources from the two drop-down menus.

If the F6150 does not have the F6810 convertible source option installed, the sources on the left side of the F6000 Configuration dialog box can output only voltages.

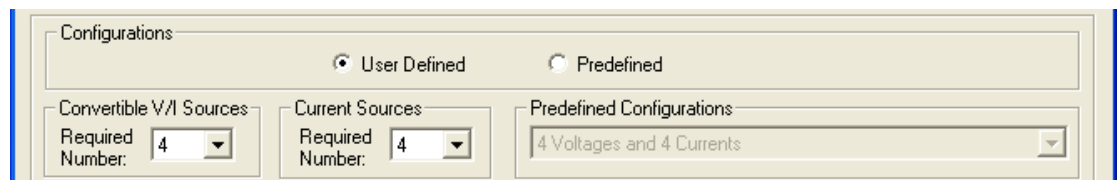


Figure 3-8 User-Defined Configurations

4. Assign a name to each source from the dropdown menus in the graphic window, or accept the defaults.
 - Voltage sources start with the letter V: for example, VA, VB, and VC
 - Current sources start with the letter I: for example, I1, I2, and I3

- Transient current sources start with the letter T: for example, T1, T2, and T3
5. Click **OK** to configure the sources and close the dialog box or **Apply** to configure the sources without closing the dialog box.

Rules for Source Selection

F6ControlPanel supports a maximum of 12 sources at a time. Apply the following rules for source selection and arrangement:

- A source is usable only if a source name is assigned.
- Voltage sources cannot be paralleled; therefore, no duplication of voltage source names is allowed. The maximum power for voltage sources is 150 VA.
- To combine 150 VA convertible sources in current mode, assign the same source name to the sources.

For example, if all three F6150 convertible sources in low-current mode are named IA, the three sources in parallel yield 450 VA of power. If the current range for the paralleled low-current source is 3.0 A, the compliance voltage is 150 V. See [Table 3-1](#).

- To combine 150 VA current sources, assign the same source name to the sources.
For example, if all three current sources are named I1, the three sources together yield a single current source rated at 450 VA.
- Only adjacent 150 VA sources can be connected left or right. A maximum of three current sources can be combined to create one 450 VA source.



Low-current convertible sources and current sources must not be paralleled.

- Only two sources can be connected in series: VA @ 0° and VB @ 180° or I1 @ 0° and I2 @ 180°.
- When one 300 VA source and one 150 VA source are needed, the first two adjacent 150 VA sources supply 300 VA, and the third source supplies 150 VA.
- Split sources cannot be combined (see [Table 3-1](#)).
- Convertible sources and current sources cannot use the same source designations.



When using paralleled current sources, it is advisable to parallel the wiring, to reduce cable heating and voltage drop.

Compliance Voltage and Current Range

The compliance voltage of a current source is the highest voltage into which the current source can inject current. The formula for calculating compliance voltage of a current source is:

$$V = \frac{P}{I}$$

where P is the VA rating of the current source and I is the current range.

For example, if a source is rated at 150 VA and the current range is set at 7.5 A, the compliance voltage for the source is 20 V.



For maximum compliance voltage, use the lowest current range that can produce the desired test current. For example, if the test requires 5 A, set the range at 7.5 A, not 15 A.

Table 3-1 through Table 3-4 show range settings and compliance voltages for all common source configurations.

Table 3-1 Maximum Compliance Voltage for Low-Current Source Combinations

Current Range	75 VA Source	150 VA Source	300 VA Source	450 VA Source
0.5 A	150 V	300 V	—	—
1.0 A	75 V	150 V	300 V	—
1.5 A	—	—	—	300 V
2.0 A	—	75 V	150 V	—
3.0A	—	—	—	150 V
4.0 A	—	—	75 V	—
6.0 A	—	—	—	75 V

Table 3-2 Maximum Compliance Voltage for Low Transient Current Source Combinations

Current Range	97.5 VA Source	195 VA Source	390 VA Source	585 VA Source
0.75 A	130 V	260 V	—	—
1.5 A	65 V	130 V	260 V	—
2.25 A	—	—	—	260 V
3.0 A	—	65 V	130 V	—
4.5 A	—	—	—	130 V
6.0 A	—	—	65 V	—
9.0 A	—	—	—	65 V

Table 3-3 Maximum Compliance Voltage for Current Source Combinations

Current Range	75 VA Source	150 VA Source	300 VA Source	450 VA Source
7.5 A	10 V	20 V	40 V	60 V
15 A	5 V	10 V	20 V	30 V
22.5 A	—	—	—	20 V
30 A	—	5 V	10 V	—
45 A	—	—	—	10 V
60 A	—	—	5 V	—
90 A	—	—	—	5 V

Table 3-4 Maximum Compliance Voltage for Transient Current Source Combinations

Current Range	112.5 VA Source	225 VA Source	450 VA Source	675 VA Source
15 A	7.5 V	15 V	30 V	45 V
30 A	3.75 V	7.5 V	15 V	22.5 V
45 A	—	—	—	15 V
60 A	—	3.75 V	7.5 V	—
90 A	—	—	—	7.5 V
120 A	—	—	3.75 V	—
180 A	—	—	—	3.75 V

Timing between State Changes

The F6150 builds waveforms based on a 10 kHz sample rate. Its waveforms are assembled with data every 100 microseconds, or 0.1 milliseconds. When the instrument generates a waveform, it rounds the total time for the required number of cycles to the nearest 0.1 millisecond.

In a 60 Hz waveform, for example, 1 cycle is completed over 16.66666... milliseconds. Under the rounding function, the cycle actually completes at 16.7 milliseconds. For two cycles at 60 Hz, the time is 33.33333... milliseconds, rounded to 33.3 milliseconds.

The rounding function may cause a discrepancy between expected and actual times for state simulations where a timer is started in one state and stopped after one or several states with a long duration time. A workaround for this discrepancy is to have state durations in factors of time that negate the rounding factor.

For example, 60 Hz durations in factors of 3 cycles per state (3, 6, 9..., 63...) equate to an even 50 milliseconds per 3-cycle duration. In this case no discrepancy appears, because no rounding is used to generate the waveform.



50 Hz systems do not use the rounding function, as their base time unit per cycle is 20 milliseconds.



4. Troubleshooting

This chapter contains diagnostic information and troubleshooting tools for the F6150 that are designed to pinpoint problems based on symptoms. If these solutions do not resolve the problem, obtain further assistance by contacting Doble Customer Service:

Website: (www.doble.com/support/)

Email: customerservice@doble.com

Telephone: 617-926-4900

General Troubleshooting Techniques

If the F6150 experiences difficulties, perform the following external checks to isolate the problem before removing the cover.

F6150

- Check for boot-up errors. Power up the F6150 and watch the boot sequence scrolling information in the VFD.
- Check for short circuits (voltage sources). Remove all connections to the F6150 and check the source outputs with a voltmeter. If no voltmeter is available, turn the source on and check for error messages.
- Check for open circuits (current sources). Remove all connections and check the source outputs with an ammeter after shorting the output terminals.

F6ControlPanel

- Check for source errors in the F6ControlPanel source table.
- Verify the configuration of voltage and current sources.
- Turn the battery simulator on from the control panel and measure its output with a voltmeter.

Communication

- If the F6150 is connected via Ethernet, verify that the Ethernet connection is functioning properly.
- Ping the F6150 from a DOS window (see [Appendix B, “Ethernet Communications”](#)).

If preliminary external checks do not identify the problem, remove the cover (see [Chapter 5, “Field Replacement Procedures”](#)) and check the LED status of internal components for proper operation (see [“LED Status Indicators”](#) on p. 4-4).



Many of the major problems encountered in the F6150 can be corrected by replacing a board in the unit. [Chapter 5, “Field Replacement Procedures”](#), explains how to remove a defective board and replace it.

Troubleshooting Flowcharts

Figure 4-1 and Figure 4-2 are diagnostic flowcharts to help identify and isolate problems in F6150 operation.

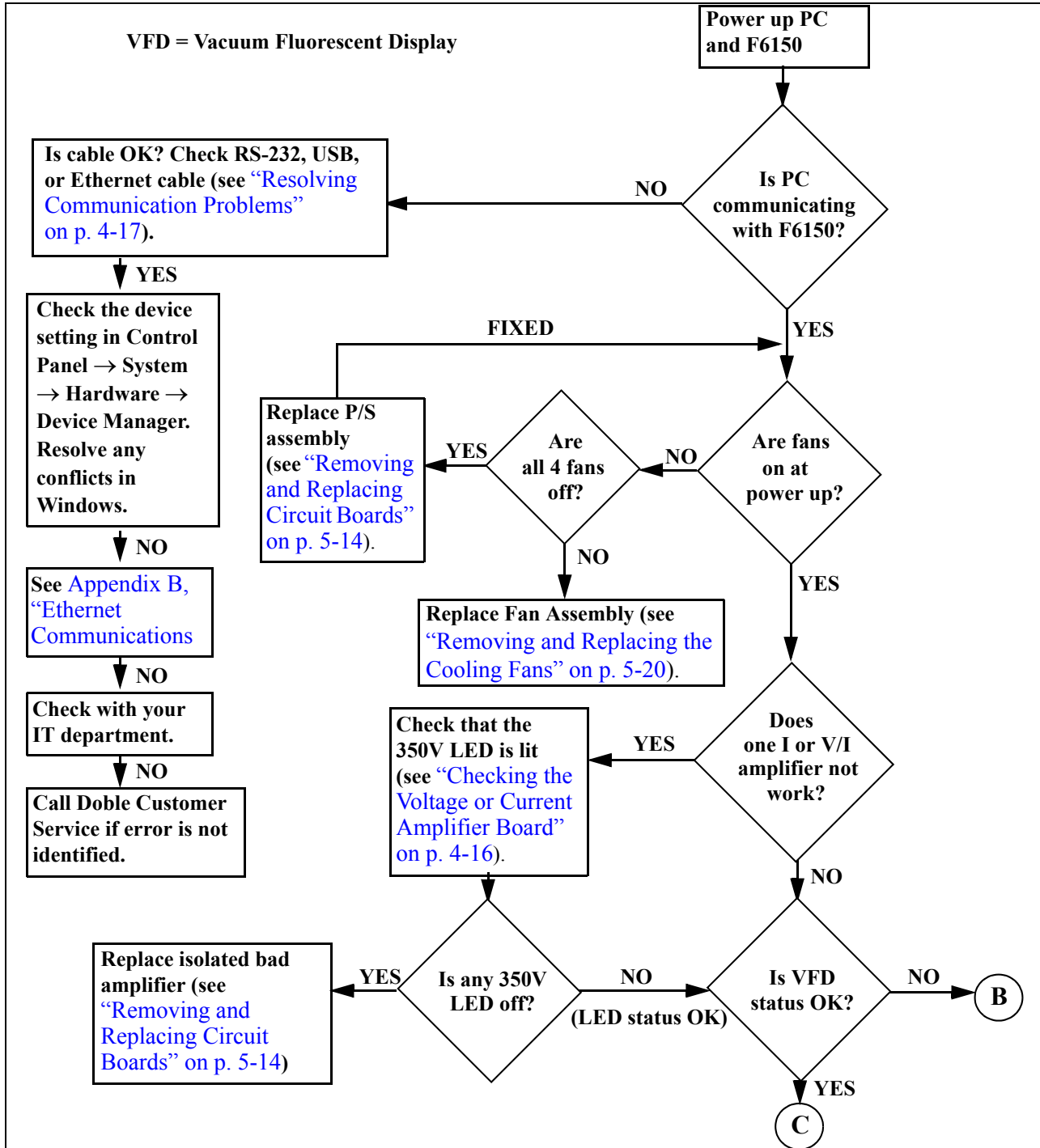


Figure 4-1 Troubleshooting Flowchart – Part 1

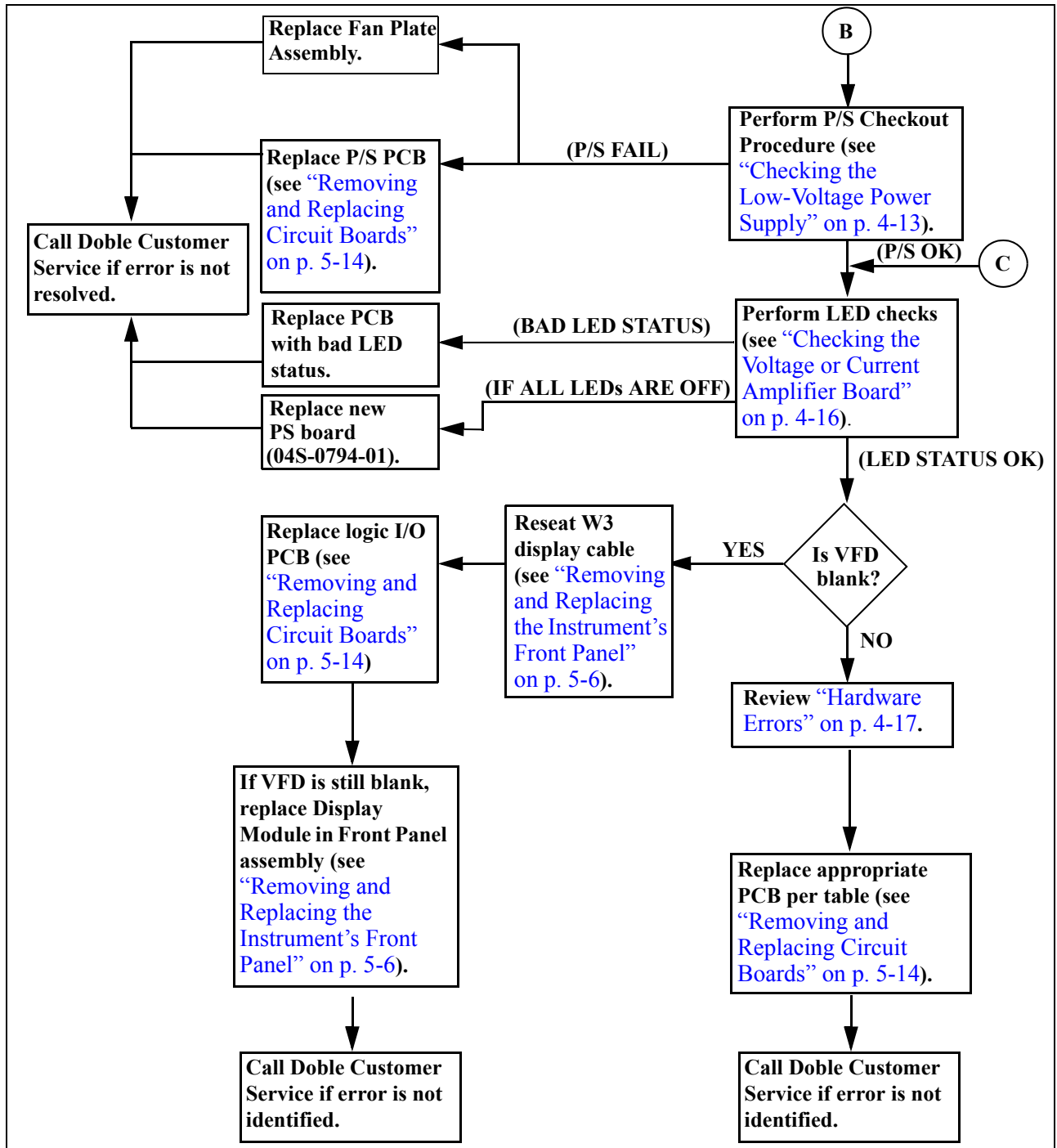


Figure 4-2 Troubleshooting Flowchart – Part 2

LED Status Indicators

The following circuit boards have status LEDs:

- CPU
- Analog I/O
- Voltage and Current Amplifiers
- Power Supply



Lethal voltages are exposed with the cover removed. Follow safe procedures designed to protect against electrical shock. Always turn the unit off before making contact with any of the internal components.

CPU Circuit Boards

The CPU1 or CPU2 circuit board is installed in slot 3. The LEDs indicate communication status (either RS-232 or Ethernet). Pressing Reset activates a new power diagnostic cycle.

CPU1

The CPU1 circuit board (Figure 4-3) has twelve LEDs and one pushbutton (Table 4-1), located at the top of the board.

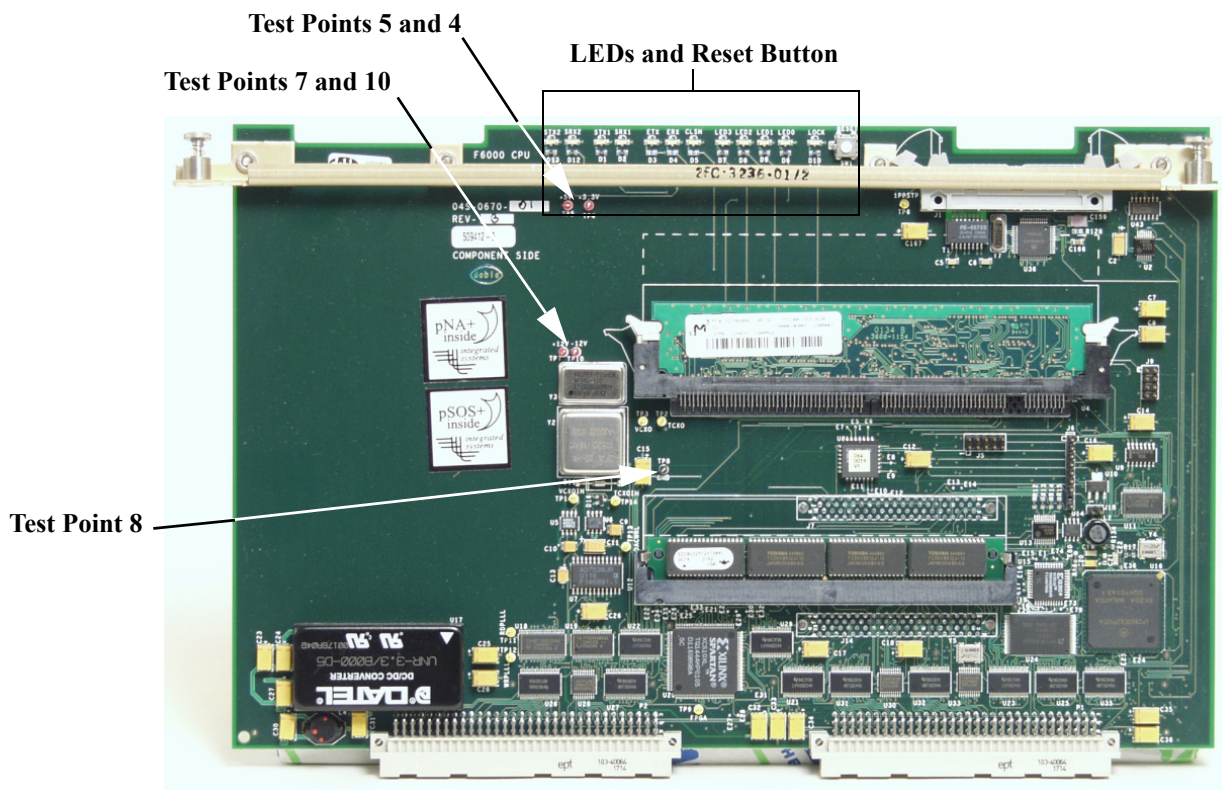


Figure 4-3 Slot 3 – CPU1 Board

Table 4-1 CPU1 Board LEDs

Code	LED No.	Indication
STX2	D13	RS-422 GPS transmit active. Illuminates green during power-up only; otherwise, it is off.
SRX2	D12	RS-422 GPS receive active.
STX1	D1	RS-232 serial port transmit active. Blinks red during RS-232 communication with the controlling computer.
SRX1	D2	RS-232 serial port receive active. Blinks red during RS-232 communication with the controlling computer.
ETX	D3	Ethernet transmit active. Blinks during Ethernet communication. This LED is always off if no Ethernet cable is attached.
ERX	D4	Ethernet receive active. Blinks during Ethernet communication. This LED is always off if no Ethernet cable is attached.
CLSN	D5	Ethernet collision. Blinks red during power-up and when no Ethernet cable is attached.
LED3	D7	General-purpose LEDs for CPU/RAM status and power-on self-test.
LED2	D8	
LED1	D9	
LED0	D6	
LOCK	D10	

CPU2

The CPU2 circuit board (Figure 4-4) has nineteen LEDs (Table 4-2) in two rows at the top of the board.

Table 4-2 CPU2 Board LEDs

Code	LED No.	Indication
STX2	D13	RS-422 GPS transmit active. Illuminates green during power-up only; otherwise, it is off.
SRX2	D14	RS-422 GPS receive active.
STX1	D2	RS-232 serial port transmit active. Blinks red during RS-232 communication with the controlling computer.
SRX1	D3	RS-232 serial port receive active. Blinks red during RS-232 communication with the controlling computer.
ETX	D4	Ethernet transmit active. Blinks during Ethernet communication. This LED is always off if no Ethernet cable is attached.
ERX	D5	Ethernet receive active. Blinks during Ethernet communication. This LED is always off if no Ethernet cable is attached.
CLSN	D6	Ethernet collision. Blinks red during power-up and when no Ethernet cable is attached.
LED0–LED7		General-purpose LEDs for CPU/RAM status and power-on self-test.
LOCK	D15	General purpose LED for CPU/RAM status and power-on self-test.
10/100	D7	Indicates the speed of the Ethernet connection. Illuminates if the connection is 100 Mbps.
+2V	D1	Illuminates if the +2 V supply on the CPU is OK.
+3V	D12	Illuminates if the +3 V supply on the CPU is OK.

Analog I/O Circuit Board

The Analog I/O circuit board (Figure 4-5) is installed in slot 4 and has four LEDs. When the F6150 is powered but idle, all LEDs should be off. Table 4-3 identifies the Analog I/O board LEDs.

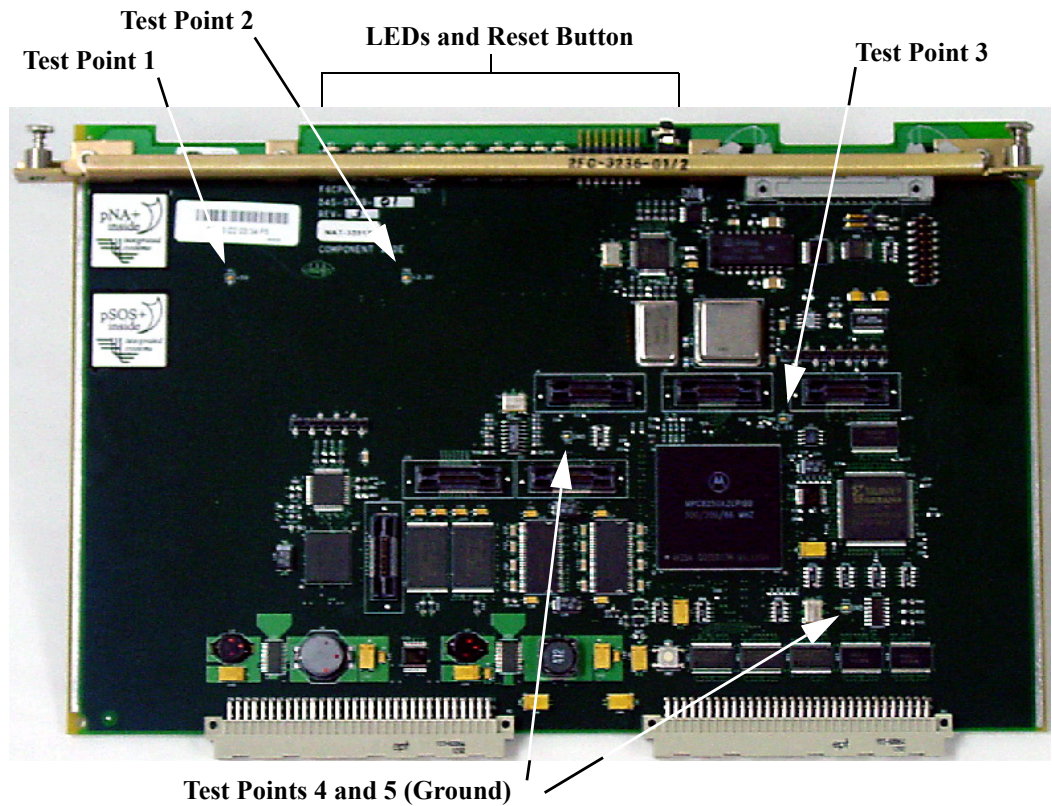


Figure 4-4 Slot 3 – CPU2 Board

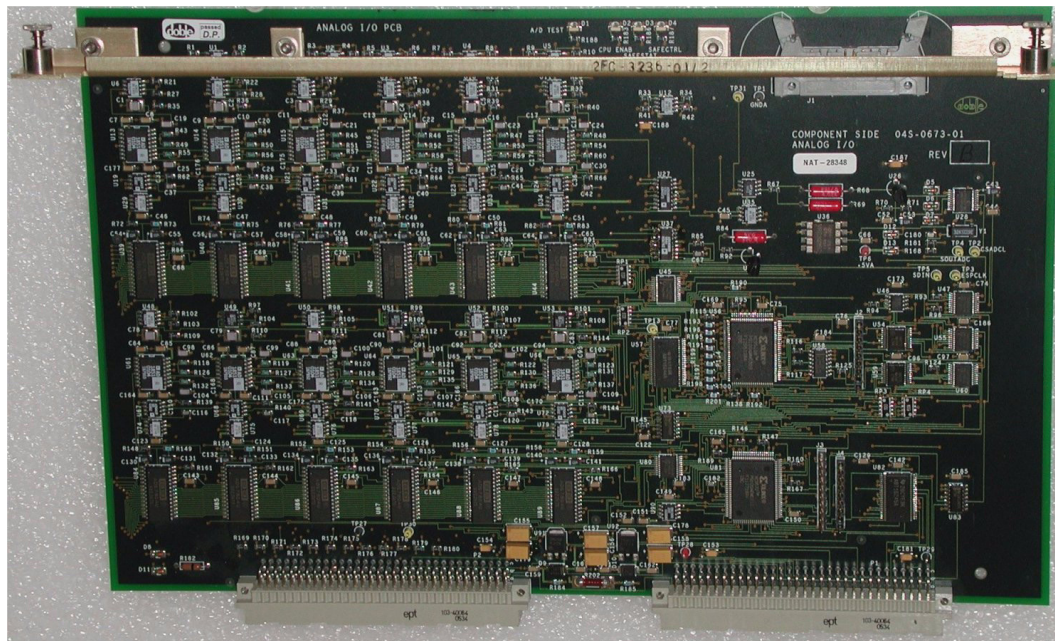


Figure 4-5 Slot 4 – Analog I/O Board

Table 4-3 Analog I/O Board LEDs

Code	LED No.	Indication
A/D Test	D1	Illuminates red during power-up only, then off. This LED is for Doble use only. If the LED illuminates steady red, the PCB may be installed in an incorrect slot.
CPU ENAB	D2	Illuminates green during power-up only, then off.
SAFESTAT	D3	Should never illuminate green during power-up.
SAFECTRL	D4	Illuminates green when any source is turned on. Does not illuminate during power-up or when idle.

Voltage and Current Amplifier Circuit Boards

The F6150 has three Current Amplifier boards (Figure 4-6) in slots 5–7 and three voltage/current Convertible Amplifier boards (Figure 4-7) in slots 8–10.

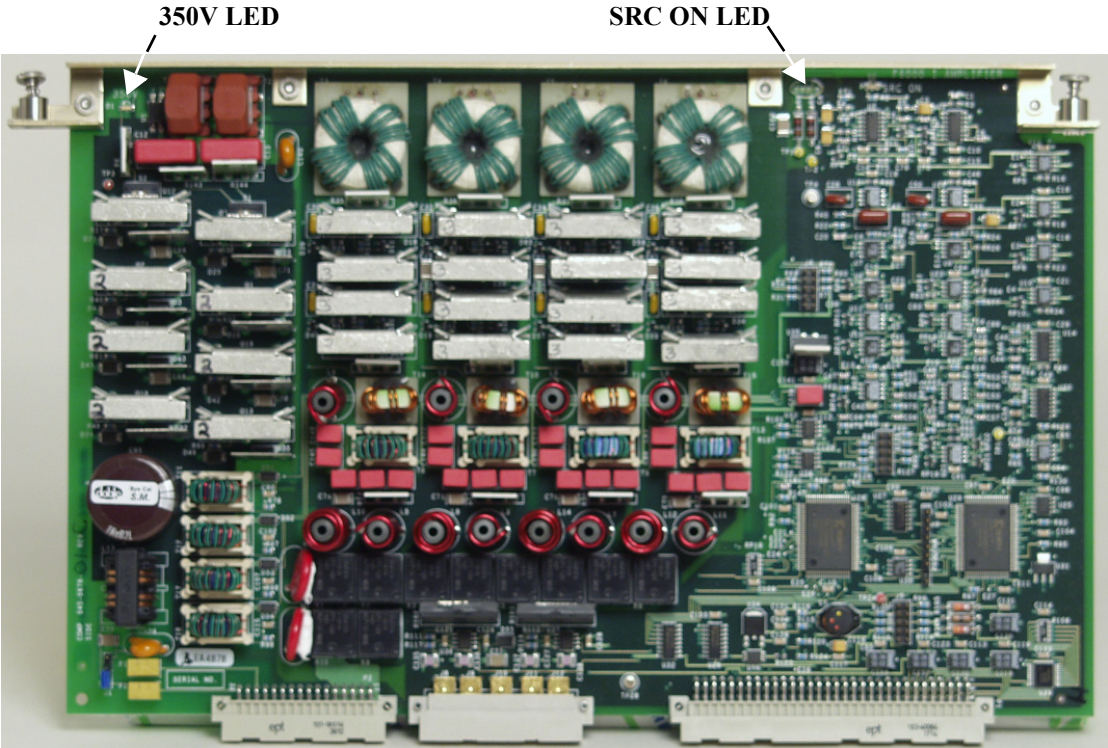


Figure 4-6 Slots 5, 6, 7 – Current Amplifier Boards

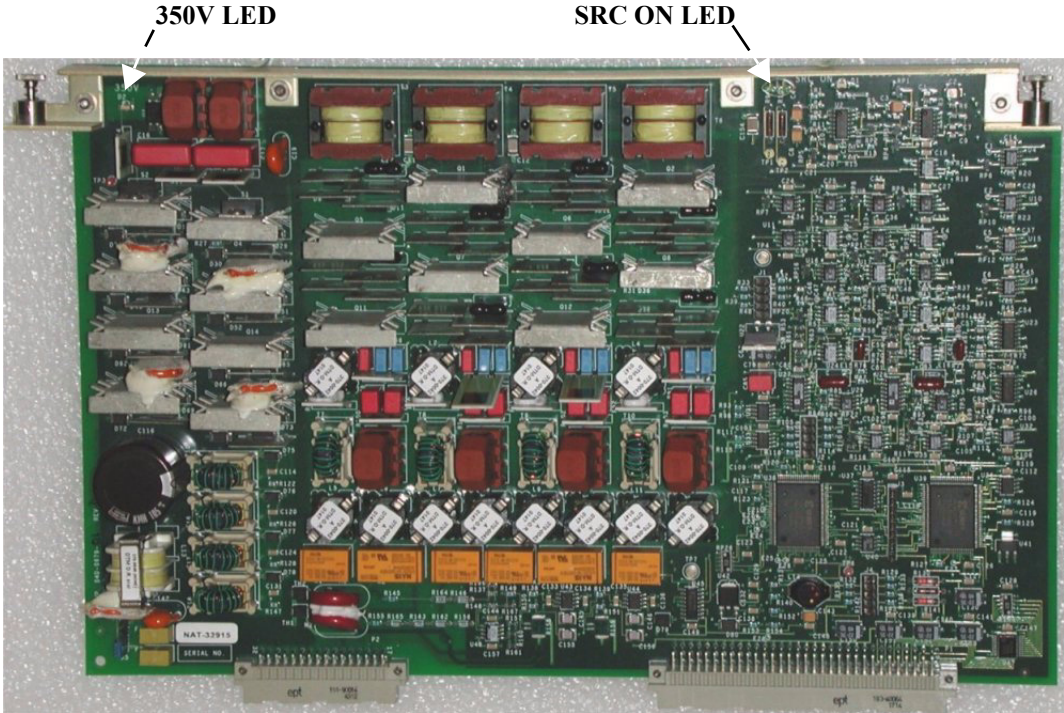


Figure 4-7 Slots 8, 9, 10 – Voltage/Current Convertible Amplifier Boards

Each Current and voltage/current Convertible Amplifier circuit board has two LEDs that are visible when looking at the front of the board:

- **350V.** Illuminates steady green after the power-up diagnostics pass, indicating a healthy status. This LED is located on the left side of the board, close to the top edge, as viewed from the front. If all six 350V LEDs are off, check the power supply (see [“Checking the Low-Voltage Power Supply”](#) on p. 4-13).
- **SRC ON (right side).** Illuminates steady green when the amplifier is enabled or turned on by F6ControlPanel software, indicating an active source. This LED is located on the right side of the board, close to the top edge, as viewed from the front. If the 350V LED is not illuminating green, replace the amplifier circuit board (see [“Removing and Replacing Circuit Boards”](#) on p. 5-14).

Power Supply Circuit Board

F6150 instruments contain two power supplies: a high-voltage supply in slot 11, to power the voltage and current amplifiers, and a low-voltage supply, to power the rest of the unit. On CPU1 instruments, the low-voltage supply is on the high-voltage supply circuit board. On CPU2 instruments, the low-voltage supply is at the bottom of the Fan Plate Assembly ([Figure 5-24](#)).

Type 1

Type 1 (earlier) power supplies ([Figure 4-8](#)) were configured for either 115 or 230 V 50/60 Hz. These models [04S-0676-01 (120V) or 04S-0676-02 (220V)] have three LEDs (D1, D2, and D3) visible from the rear of the chassis ([Table 4-4](#)). This board supports the high/low voltage requirements and the Fixed Output Battery Simulator functions ([Table 4-6](#)).

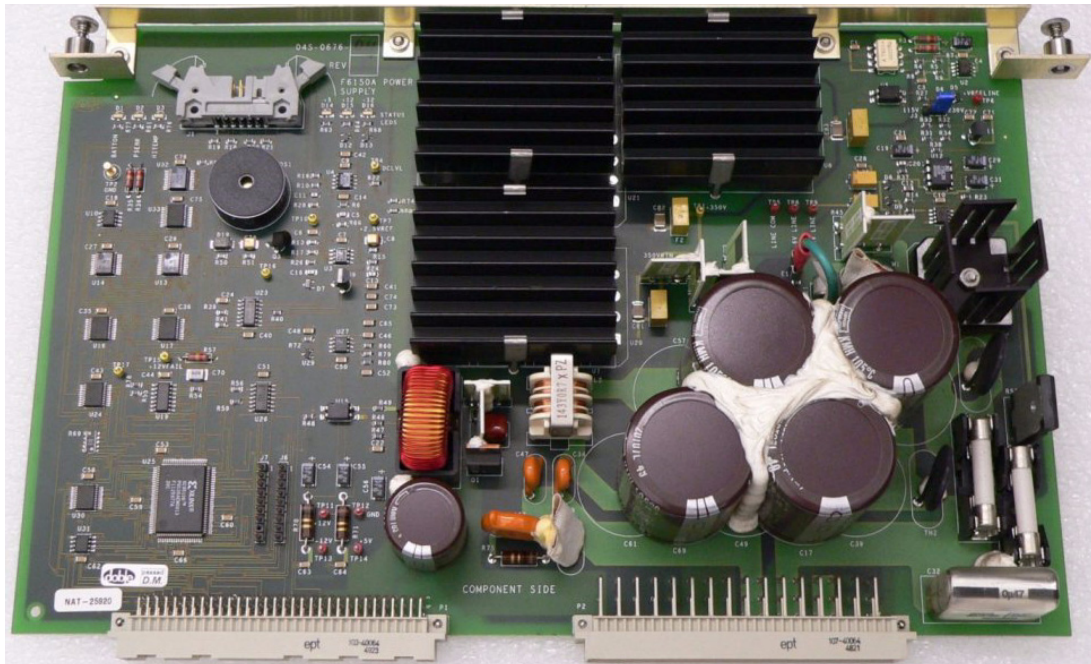


Figure 4-8 Slot 11 – Power Supply (Type 1)

Fuses. Type 1 power supply boards contain two fuses for AC mains input (F3 and F4):

- For a 115 V power supply, the fuse value is 20 A.
- For a 230 V power supply, the fuse value is 10 A.

Type 1 power supply boards also have a 3 A (384-0167) fuse for the board itself at F1, with other fuses at F2 and F5. These fuses are soldered to the board, however, and should be replaced only after consulting with Doble Customer Service.

Table 4-4 Type 1 Power Supply Board LEDs

Code	LED No.	Indication
PSERR	D1	Illuminates green for the first 30 seconds after power-up, then is off after completing the power supply power-up sequence. The PSERR LED performs this sequence even if the CPU board is not installed.
LOFLOW	D2	This LED is normally off. If illuminating green, check power supply voltages on the CPU PCB and proper fan operation.
BATTON	D3	Illuminates green when the Fixed Output Battery Simulator is instructed to turn on; otherwise, it is off. Illuminating green indicates only that the FOBS is instructed to turn on and is not an indication of proper operation.

Type 2

Type 2 (present) universal power supplies ([Figure 4-9](#)) accept line inputs from 105 to 264 VAC at 47 to 63 Hz. The power supply board on these models 04S-0794-01 has six LEDs (D20, D21, D22, D23, D4, and D25) visible from the rear of the chassis ([Table 4-5](#)). This board supports the high-voltage requirements and the Variable Output Battery Simulator functions ([Table 4-6](#)).

Fuses. Type 2 power supply boards do not contain fuses for AC mains input. They have a 3 A fuse (384-0167) for the board itself at F1. This fuse is soldered to the board, however, and should be replaced only after consulting with Doble Customer Service.

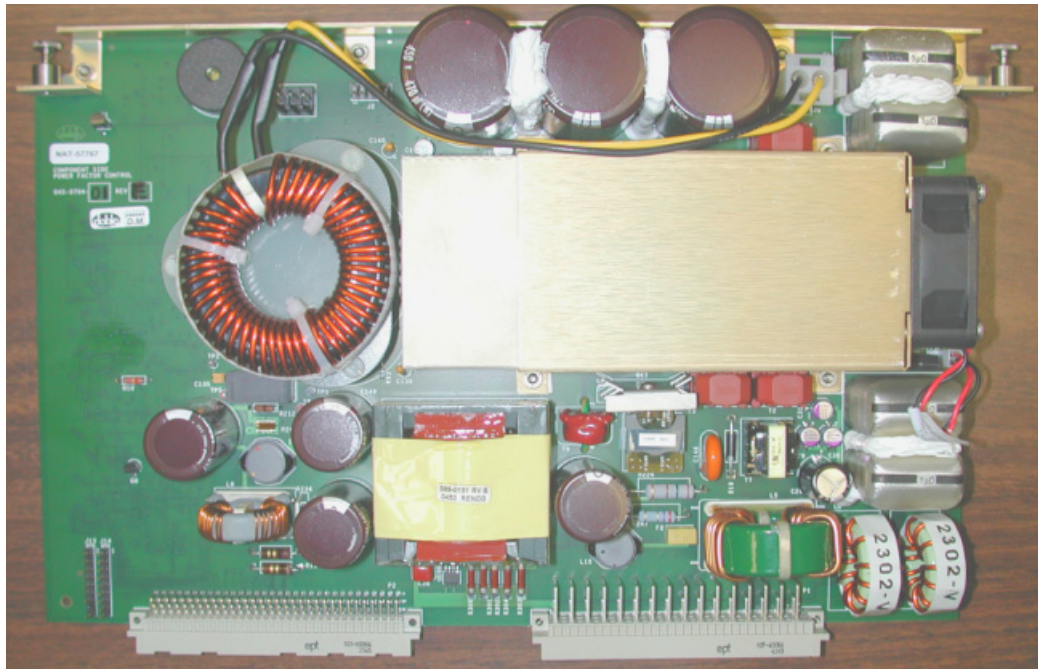


Figure 4-9 Slot 11 – Power Supply with Variable Output Battery Simulator (Type 2)

Table 4-5 Type 2 Power Supply Board LEDs

Code	LED No.	Indication
VDD	D20	Illuminates green to indicate presence of +5 VDC.
+12	D21	Illuminates green to indicate presence of +12 VDC.
-12	D22	Illuminates green to indicate presence of -12 VDC.
BATTON	D23	Illuminates green when the Variable Output Battery Simulator is instructed to turn on; otherwise, it is off. Illuminating green indicates only that the FOBS is instructed to turn on and is not an indication of proper operation.
PSERR	D24	Illuminates green for the first 30 seconds after power-up, then is off after completing the power supply power-up sequence. The PSERR LED performs this sequence even if the CPU board is not installed.
HITEMP	D25	This LED is normally off. If illuminating green, check power supply voltages on the CPU PCB and proper fan operation.

Battery Simulator

Table 4-6 shows the battery simulator alternatives.

Table 4-6 Battery Simulator Alternatives

Board Part Number	Location	Option No. on VFDdisplay	Power Supply
Fixed Output Battery Simulator 04D-0598-01	On rear chassis wall	None	04S-0670-01 (CPU1-115V) 04S-0670-02 (CPU1-230V) 04S-0670-03 (CPU2-115V) 04S-0670-04 (CPU2-230V)
Variable Output Battery Simulator 04S-0598-02	On rear chassis wall	F6875	04S-0676-01 (CPU1-115V) 04S-0676-02 (CPU1-230V) 04S-0676-03 (CPU2-115V) 04S-0676-04 (CPU2-230V)
Variable Output Battery Simulator 04S-0794-01 (Universal)	Slot 11	F6875	04S-0794-01 (Universal)

Component Checkout Procedures

Checking the Low-Voltage Power Supply

CPU1

1. Remove the Logic I/O board in slot 1 and the AIM board (if present) in slot 2 to access test points on the CPU board.
2. Connect a multimeter to a ground point, either on the chassis or test point 8 on the CPU1 board.
3. Measure the test points in Table 4-7 on the CPU1 circuit board in slot 3 (Figure 4-3).

Table 4-7 CPU1 Power Supply Test Points

Test Point	Value
4	+3.3 VDC \pm 0.25 V
5	+5 VDC \pm 0.25 V
7	+12 VDC \pm 0.25 V
10	-12 VDC \pm 0.25 V

4. If any voltages are not present, replace the Power Supply circuit board in slot 11 (see Chapter 5, "Field Replacement Procedures").

CPU2

1. Remove the logic I/O board in slot 1 and the AIM board (if present) in slot 2 to access test points on the CPU board.
2. Remove the high-voltage power supply board in slot 11 and the V/I convertible amplifier boards in slots 9 and 10 to access the J20 backplane connector behind slot 11.
3. Connect a multimeter to a ground point, either on the chassis or test point 4 or 5 on the CPU2 board.
4. Measure the test points in [Table 4-8](#) on the CPU2 circuit board in slot 3 ([Figure 4-4](#)).

Table 4-8 CPU2 Power Supply Test Points

Test Point	Value
1	+5 VDC \pm 0.25 V
2	+3.3 VDC \pm 0.25 V
3	+2 VDC \pm 0.25 V

5. Measure the voltages in [Table 4-9](#) on pins 3 and 4 and on pins 5 and 6 of connector J20, a 6-pin Molex connector at the rear of the backplane ([Figure 4-10](#)).
Pin 1 is at the left of the connector, looking down from the front.
6. If any voltages are not present, replace the Fan Plate Assembly (see [Chapter 5, “Field Replacement Procedures”](#)).

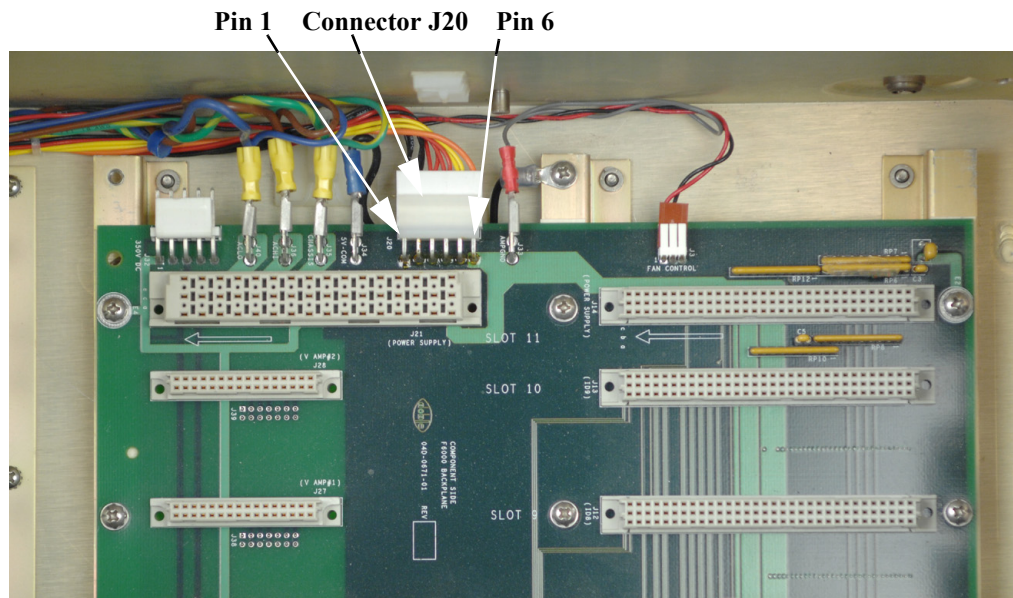


Figure 4-10 Connector J20 Test Points at Rear of Backplane (Top View)

Table 4-9 Connector J20 Test Points

Pin	Wire Color	Value
1	Black	Ground
2	Black	Ground
3	Red	+5 VDC \pm 0.25 V
4	Red	+5 VDC \pm 0.25 V
5	Yellow	+12 VDC \pm 0.25 V
6	Blue	-12 VDC \pm 0.25 V

Checking the Battery Simulator

There are two styles of battery simulators: fixed output and variable output.

Fixed Output Battery Simulator (FOBS)

Older equipment can have a fixed output battery simulator mounted on the rear of the chassis. It is equipped with one non-standard fuse soldered on the circuit board. There are no LED indicators.

To check the FOBS:

1. Remove the cover and inspect the battery simulator's fuse. The fuse is designated F1 and is located near J4.
2. If the fuse is blown, replace the battery simulator circuit board (04D-0598-01). See [Chapter 5, "Field Replacement Procedures"](#).

Variable Output Battery Simulator (VOBS) – Standalone

Instruments with a standalone VOBS (04S-0598-02) have this equipment mounted on the rear of the chassis.

To check the standalone VOBS:

1. Remove the cover and VOBS board (see [Chapter 5, "Field Replacement Procedures"](#)).
2. Inspect the VOBS fuse. The fuse is designated F1 and is located near J10.
3. If the fuse is blown:
 - a. Replace the power supply board (see [Chapter 5, "Field Replacement Procedures"](#)).
 - b. Replace the fuse.

The fuse must be rated 500V DC, 2A. Use Bussman type KLM2.0 A or equivalent.

4. Reinstall the VOBS board and cover.

Variable Output Battery Simulator (VOBS) – Integrated

Instruments with an integrated VOBS have this equipment mounted on the power supply circuit board (04S-0794-01) in slot 11.

To check the integrated VOBS:

1. Remove the cover and inspect the VOBS fuse. The fuse is designated F2 and is located near P1.
2. If the fuse is blown, replace the Power Supply board (see [Chapter 5, “Field Replacement Procedures”](#)).

Checking the Logic I/O Printed Circuit Board

If the VFD shows a Logic Input or Logic Output error:

1. Verify proper operation of the power supply (see [“Checking the Low-Voltage Power Supply”](#) on p. 4-13).
2. If the power supply is operating correctly, replace the Logic I/O circuit board installed in slot 1 (see [“Removing and Replacing Circuit Boards”](#) on p. 5-14).

Checking the Voltage or Current Amplifier Board

To verify proper operation of the amplifier circuit boards:

1. In F6ControlPanel, select three Is and three Vs.
2. Verify that the 350V and SRC ON LEDs illuminate when enabled.
3. If any LED fails to illuminate when enabled, replace the circuit board for that amplifier (see [“Removing and Replacing Circuit Boards”](#) on p. 5-14).

Checking the Cooling Fan

To verify cooling fan operation, power up the F6150 and listen for the sound of the fans spinning. This sound is the only indication that the fans are functioning. No LEDs or error messages appear to indicate a problem until an overtemperature condition occurs.



It is important to verify fan operation at power-up. Equipment damage can result during operation with one or more broken fans.

If one or more of the cooling fans is not operating:

1. Immediately power down the F6150.
2. Remove the cover (see [“Removing the Instrument’s Cover”](#) on p. 5-4).
3. Check that the large inductor (L1) in the middle of the power supply circuit board has not broken loose.
 - If the L1 inductor has broken loose, replace the power supply board (04S-0676-01 or 04S-0676-02).

- If the L1 inductor has not broken loose, replace the fan (see [“Removing and Replacing the Cooling Fans”](#) on p. 5-20).

There are two styles of cooling fan assemblies. Some instruments have a fan assembly with an integrated power supply (03D-1587-01). See [Chapter 5, “Field Replacement Procedures”](#), for removal instructions.

Equipment with the older style fan assembly (without an integrated power supply) uses a different removal procedure (see [“Removing and Replacing the Cooling Fans”](#) on p. 5-20).

Resolving Communication Problems

If communication fails or cannot be established between the Control Panel and the F6150:

1. Check the RS-232 cable or Ethernet cable.
2. Verify that the CPU circuit board LEDs (D1 and D2) are blinking.
3. Check for conflicts in the COM port of the PC running Control Panel. To do this:
 - a. In Windows, select **Start** → **Control Panel** → **System**. The System Properties dialog box appears.
 - b. On the Hardware tab, click **Device Manager**. The Device Manager dialog box appears.
 - c. Double-click **PORTS (COM & LPT)**.
 - d. Verify that no other device, such as a Palm Pilot, or software is using the same COM port as Control Panel.
 - e. If a device conflict is found, contact your system administrator.
4. If the communication cable is functioning and no conflicts are found, replace either the CPU board, Analog I/O board, or Communications board. Refer to [Chapter 5, “Field Replacement Procedures”](#), when replacing these boards.

Error Types

Hardware Errors

Hardware error messages are displayed in the VFD. They are often the first sign that something is not functioning properly.



Hardware errors must be resolved before further testing can proceed. Also ensure that the IP address is set correctly on the F6150 (and F6300, if used).

[Table 4-10](#) describes hardware errors and possible solutions.

Table 4-10 Hardware Errors

Error Message	Description	Action (Refer to Chapter 5, “Field Replacement Procedures”, when replacing boards.)
Cal A/D hardware failure	The analog- to-digital converter calibration hardware failed.	Replace the Analog I/O board.
DAC Calibration hardware failure	The digital-to-analog converter calibration hardware failed.	Replace the Analog I/O board.
DAC calibration out of limits	The digital-to-analog converter calibration is out of limits.	Replace the Analog I/O board.
Analog GND sense failed	The analog GND sense failed.	Check the power supply with a voltmeter (see “Checking the Low-Voltage Power Supply” on p. 4-13). <ul style="list-style-type: none"> • If the voltages are not correct, replace the Power Supply board. • If the voltages are correct, replace the Analog I/O board.
Analog I/O –5V out of range	The instrument reads out of range.	Check the power supply with a voltmeter (see “Checking the Low-Voltage Power Supply” on p. 4-13). <ul style="list-style-type: none"> • If the voltages are not correct, replace the Power Supply board. • If the voltages are correct, replace the Analog I/O board.
Analog I/O +5V out of range	The instrument reads out of range.	Check the power supply with a voltmeter (see “Checking the Low-Voltage Power Supply” on p. 4-13). <ul style="list-style-type: none"> • If the voltages are not correct, replace the Power Supply board. • If the voltages are correct, replace the Analog I/O board.
Positive DAC readback failure	Positive digital-to-analog converter readback failure.	Replace the Analog I/O board or CPU board.
Negative DAC readback failure	Negative digital-to-analog converter readback failure.	Replace the Analog I/O board or CPU board.
Missing/bad Logic I/O board	The Logic I/O board is either missing or bad.	Replace the Logic I/O board.
Missing/bad Analog I/O board	The Analog I/O board is either missing or bad.	Replace the Analog I/O board.
Missing/bad (I AMP#0) SLOT 5	The current amplifier in slot 5 is either missing or bad.	Replace the Current Amplifier board in slot 5.

Table 4-10 Hardware Errors (Continued)

Error Message	Description	Action (Refer to Chapter 5, “Field Replacement Procedures”, when replacing boards.)
Missing/bad (I AMP#1) SLOT 6	The current amplifier in slot 6 is either missing or bad.	Replace the Current Amplifier board in slot 6.
Missing/bad (I AMP#2) SLOT 7	The current amplifier in slot 7 is either missing or bad.	Replace the Current Amplifier Board in slot 7.
Missing/bad (V AMP#0) SLOT 8	The voltage amplifier in slot 8 is either missing or bad.	Replace the Voltage Amplifier board in slot 8.
Missing/bad (V AMP#1) SLOT 9	The voltage amplifier in slot 9 is either missing or bad.	Replace the Voltage Amplifier board in slot 9.
Missing/bad (V AMP#2) SLOT 10	The voltage amplifier in slot 10 is either missing or bad.	Replace the Voltage Amplifier board in slot 10.
Missing/bad HVPS	The high-voltage power supply is either missing or bad.	Check the power supply with a voltmeter (see “Checking the Low-Voltage Power Supply” on p. 4-13). Replace the board if necessary.
Bad/Blank CPU EEPROM	The CPU board is bad or the EEPROM has no data.	Replace the CPU board.

Source Errors

Source errors display in the F6ControlPanel source table. A source error is typically due to problems with the load. For example:

- Current is driven into an open circuit or high impedance.
- Voltage is applied across a short circuit or low impedance.
- Power requirements of the relay under test exceed the capacity of the source.

If a source error occurs:

- The name of the affected source displays as ER and blinks in the source table.
- The Amplitude and Phase fields for the affected source blink in the source table.
- An audible alarm sounds from the speakers of the control PC.

Table 4-11 defines common source errors.

Table 4-11 Common Source Errors

Error	Description	Action
Transient over 1.5 seconds	Hardware disables the source.	Turn off the source.

Table 4-11 Common Source Errors (Continued)

Error	Description	Action
Peak current	Hardware disables the source. Normally, this error does not occur for a current source. It typically means a voltage source is overloaded (as, for example, when a short circuit occurs at high amplitude).	Reduce the voltage or current, depending on which source caused the error.
Clip Fast	A current source cannot drive a load.	
Clip Slow	A current source cannot drive a load.	
Distortion	Software processing of error feedback ADCs. A current source cannot drive a load.	
Battery Power Limit	Battery simulator load has exceeded maximum power output of 60 W.	Reduce the battery simulator load.
Battery Current Limit	Battery simulator load has exceeded maximum current limit of 1.5 A.	Reduce the battery simulator load.

System Errors

System errors display in F6ControlPanel. A system error occurs when an instrument component controlled by F6ControlPanel functions improperly. For example, if a current amplifier overheats, F6ControlPanel shows a system error message.

System errors display in a dialog box. [Figure 4-11](#) shows the first message that appears.

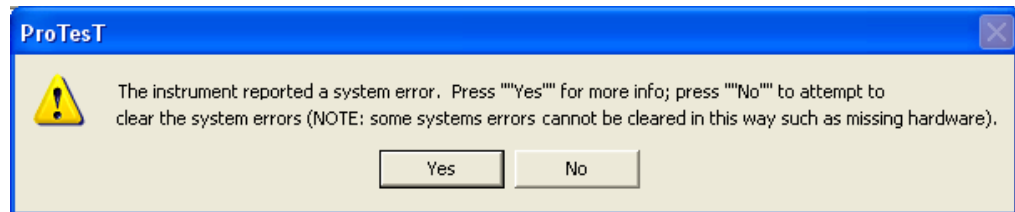


Figure 4-11 System Error Message

Click **Yes** for more information about the system error.

[Figure 4-12](#) illustrates the kind of error that can occur.

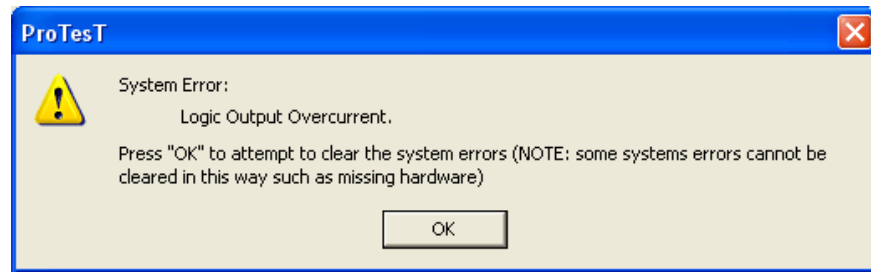


Figure 4-12 System Error Diagnostic Information

Click **OK** to close the dialog box and clear the system error. As the note in the dialog box indicates, the system error does not clear if the problem is related to missing hardware (or a bad amplifier).

When replacing any boards, use [Table 4-12](#) to diagnose and correct the error. See [Chapter 5](#), "Field Replacement Procedures".



Some system errors cannot be cleared. For example, if the instrument has no Analog I/O board, the error condition remains until the board is supplied. If any of the fuses on the amplifier boards are blown, the F6150 will not operate. Visually inspect the fuses to ensure that they are intact.

Table 4-12 System Errors

Error	Description	Action
Current monitor (Power supply high amps)	Input line current is too large. Hardware detects that the instrument is drawing too much current from the wall. The total of all amplifier outputs exceeds system specifications.	Reduce the source amplitude or the load.
Voltage monitor (Power supply high volts)	Either the AC input line voltage is too high or power is being fed back into the F6150 through the amplifier outputs.	Reduce the input line voltage or replace the power supply (old type).
Open ground detector (Power supply)	Hardware detects an open ground detector.	This hardware problem must be addressed before it is safe to operate the F6150. When the F6150 clears the error, it will occur again if the hardware problem has not been fixed.
Logic Output (Logic I/O)	Hardware detects an overcurrent condition on a logic output. The F6150 software shuts down all amplifiers. The F6150 hardware latches all logic outputs open.	Reboot the system. If the error persists, replace the Logic I/O circuit board (see Chapter 5, “Field Replacement Procedures”).
+12 Volt fail monitor (DC power supply)	Hardware disables amplifiers to prevent damage to relays on the amplifier assemblies if system +12 V falls below a threshold of approximately +5 V.	Check the DC power supply.
High voltage heart beat	<p>Five-second software timeout on lack of communication while hazardous voltages may be present on the front panel terminals. The F6150 software shuts down the amplifiers. This fault can occur if a communication cable is removed.</p> <p>The PC gets a communication timeout and displays it in F6ControlPanel. The system error is displayed only when communication is re-established.</p>	Replace the communication cable.
Fan flow monitor error	Fans are blocked or inoperative.	Verify fan operation. Replace the fan assembly if required. If the fans are functioning, replace the power supply circuit board (see Chapter 5, “Field Replacement Procedures” when replacing this board).

Table 4-12 System Errors (Continued)

Error	Description	Action
Lost pulse per second	Software shuts down the amplifiers because it detects lost external synchronization. This occurs only in an external synchronization mode.	Verify that the Global Positioning System (GPS) components are correctly connected and that the instrument is synchronized to the GPS clock (see Appendix C, “Global Positioning System”).
Waveform Underrun	System error in waveform generation and I/O.	Verify operation of the Logic I/O board.
Source Disabled	The hardware disabled one or more sources.	Verify the status of the amplifier circuit boards.
Over Temperature or fuse blown (I AMP#0) SLOT 5	Current amplifier in slot 5 is overheated or has a blown fuse.	Replace the current amplifier board in slot 5.
Over Temperature or fuse blown (I AMP#1) SLOT 6	Current amplifier in slot 6 is overheated or has a blown fuse.	Replace the current amplifier board in slot 6.
Over Temperature or fuse blown (I AMP#2) SLOT 7	Current amplifier in slot 7 is overheated or has a blown fuse.	Replace the current amplifier board in slot 7.
Over Temperature or fuse blown (V AMP#0) SLOT 8	Voltage amplifier in slot 8 is overheated or has a blown fuse.	Replace the voltage amplifier board in slot 8.
Over Temperature or fuse blown (V AMP#1) SLOT 9	Voltage amplifier in slot 9 is overheated or has a blown fuse.	Replace the voltage amplifier board in slot 9.
Over Temperature or fuse blown (V AMP#2) SLOT 10	Voltage amplifier in slot 10 is overheated or has a blown fuse.	Replace the voltage amplifier board in slot 10.
Missing analog I/O board	Hardware is missing or not communicating properly with the CPU.	Check the communication cable. If OK, replace the analog I/O board in slot 4.
Missing digital I/O board	Hardware is missing or not communicating properly with the CPU.	Check the communication cable. If OK, replace the Battery Simulator board (04D-0598-01).
Control Panel Mode	Option F6909 required.	Call Doble Customer Service.
Macro Mode	Option F6910 required.	Call Doble Customer Service.
No convertible sources	Option F6810 required.	Call Doble Customer Service.



5. Field Replacement Procedures

This chapter explains how to replace a major component in the field. The procedures apply to the replacement of a failed component or the installation of a new upgrade.

To replace a component in the field:

1. Power the instrument off.
2. Remove the instrument's cover.
3. Power the instrument on and perform a visual check to identify the faulty component.
4. Power the instrument off and remove the power cord.
5. Replace the component.
6. Replace the cover, plug in the power cord, and power the instrument on.
7. Verify that the replacement solves the problem.

Replaceable components in the F6150 are:

- Front panel
- Communications board
- Circuit boards in slots 1 through 11
- Cooling fans

Safety Precautions

To avoid electrical shocks, burns, or equipment damage, be sure to follow all safety precautions. When handling components in an F6150, read and follow these warnings:



Before proceeding, ensure that the instrument is disconnected from the power source by disconnecting the power cable from the front panel connection. Also ensure that all inputs and outputs are disconnected from the unit.



Failure to disconnect the power cable is a shock hazard and may result in damage to the instrument or personal injury.



The F6150 contains electrostatic-sensitive components. Practice safe handling methods to protect components against electrostatic discharge.



Hazardous voltage exists within the instrument. Only trained service personnel should install, remove, or replace front panel modules or cards. When the instrument is powered on, do not:

- Insert metal objects such as a screwdriver or a finger with jewelry into open module slots.
- Touch any connections within the chassis with your hands or fingers.
- Insert metal objects into the backplane or power supply.

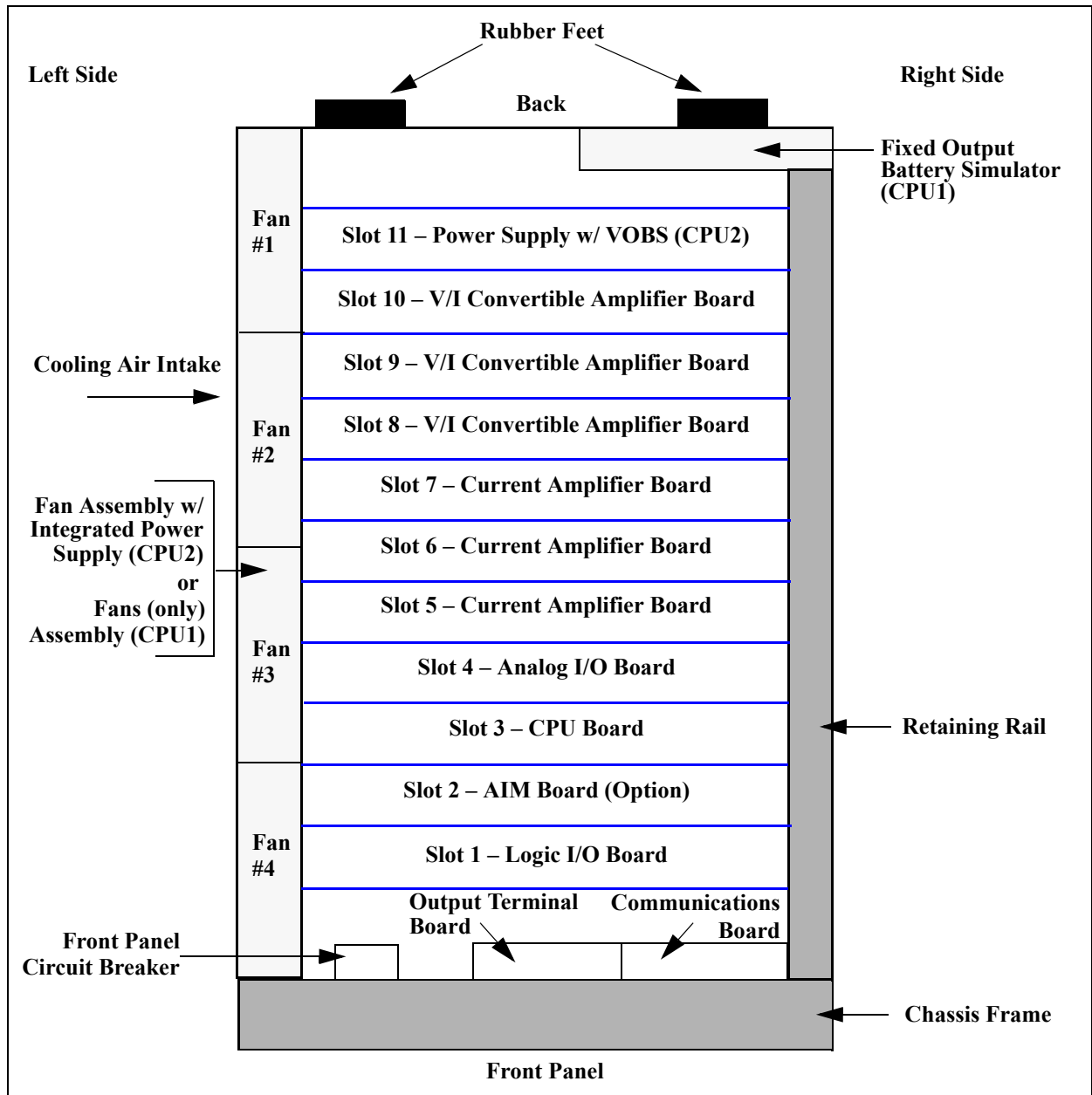


Figure 5-1 Top View of F6150 Component Orientation – CPU1 and CPU2

Except for W16, all cables in the F6150 (Table 5-1) connect to the communications board or the output terminal board on the front panel.

Table 5-1 Cable Connections

Cable	Connects from	Connects to
W2	Communications Board	Logic I/O Board
W3	Output Terminal Board	Logic I/O Board
W4	Output Terminal Board	Logic I/O Board
W5	Output Terminal Board	Logic I/O Board
W6	Communications Board	CPU Board
W7	Communications Board	Analog I/O Board
W8	Output Terminal Board	Motherboard
W16	Power Supply	Battery Simulator
W18	Power Supply	Output Terminal Board

Preparatory Steps

Replacing any component in the F6150 requires removing the cover. If the cause of a problem is undetermined at the time the cover is removed, turn the instrument on and check the components visually. When the faulty component is identified, follow the replacement procedures in this chapter.

Removing the Instrument's Cover

Remove the cover to access the replaceable components. [Figure 5-1](#) illustrates the location of these components.

To remove the instrument's cover:

1. Power the instrument off.
2. Remove the power cord
3. Use a flat-head screwdriver to remove the top two rubber feet from the back of the instrument ([Figure 5-2](#)).
4. Remove the cover to expose the circuit boards and other components inside the instrument ([Figure 5-3](#)).
5. On the side of the capture rail, remove the screw at the right end with a Phillips-head screwdriver.
6. On top of the capture rail, remove the four screws holding the capture rail to the chassis by inserting a flat-head screwdriver into each hole.
7. Remove the capture rail.
8. Reseat the circuit boards and ribbon cables, to make sure all connections are firm.

Remove the two
top rubber feet,
then remove
the enclosure
cover

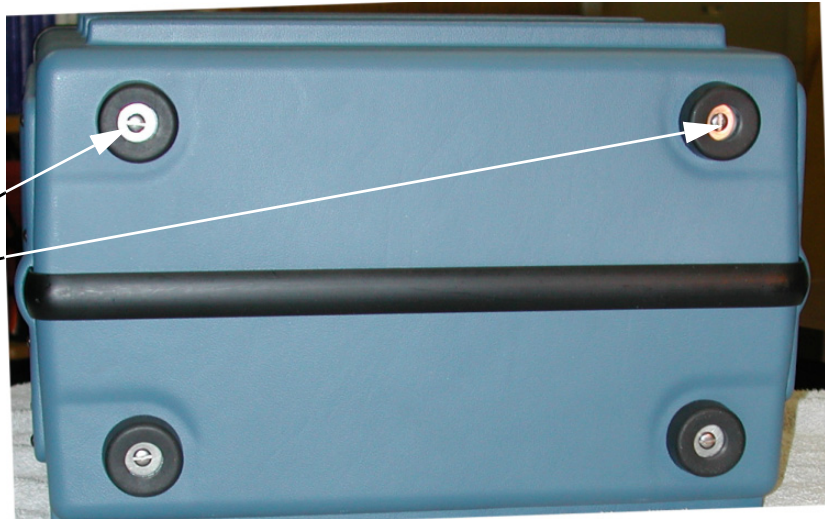


Figure 5-2 Rubber Feet at the Back of the Instrument

Capture Rail

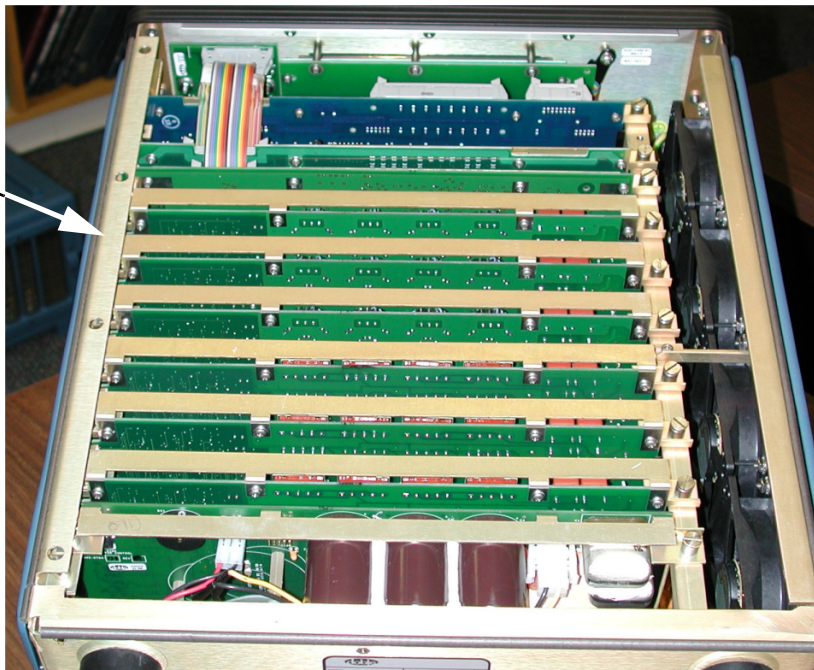


Figure 5-3 Internal Components and Capture Rail

Power Up and Perform a Visual Check

For the initial power-up and visual check:

1. Attach the power cord to the instrument and turn it on.
2. Observe the LEDs on the left side of each amplifier board.

- A green light indicates a good board. When the sources are active and that amplifier is supplying power, the green LED on the right side of an amplifier board illuminates.
 - No LED indicates a faulty amplifier board.
3. Verify, by the sound, that the four cooling fans are operating.

Removing and Replacing the Instrument's Front Panel

Removal

1. Remove the two rubber feet at the top rear of the instrument housing by unscrewing the screw in the center of each foot (Figure 5-2).
2. Remove the instrument's top cover by sliding it upward and toward the rear.
3. Disconnect ribbon cables W2, W3, W4, W5, W6, and W7 (Figure 5-4).
If your instrument is equipped with a W19 ribbon cable, disconnect that as well.

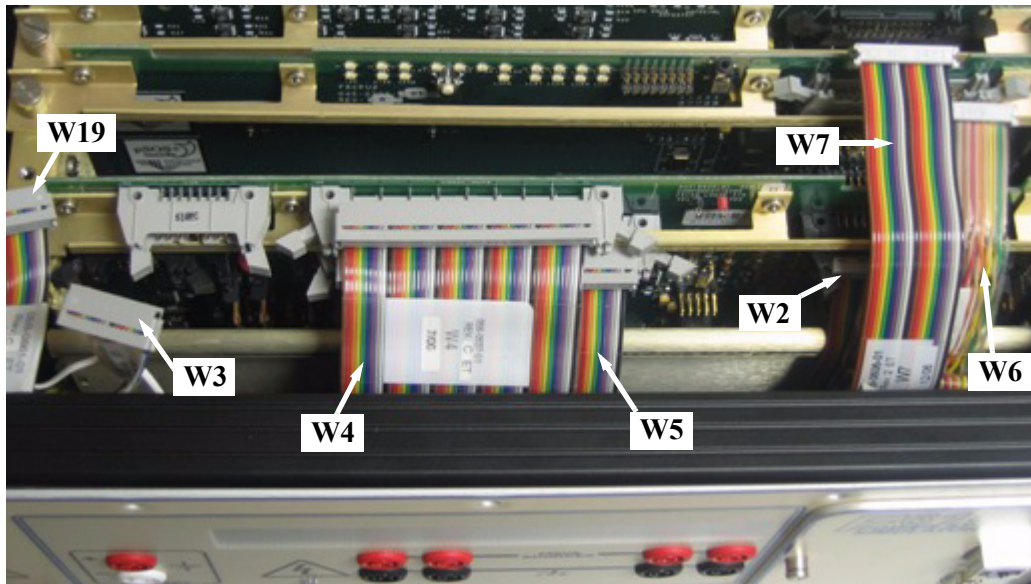


Figure 5-4 F6150 Ribbon Cables

If your instrument is equipped with an AIM board, the W5 connector plugs into an extender cable that splits into two parts (Figure 5-5). In these units, disconnect the W5 connector from the AIM board extender.



Each connector is a different size, so it will reinstall only to the correct location.

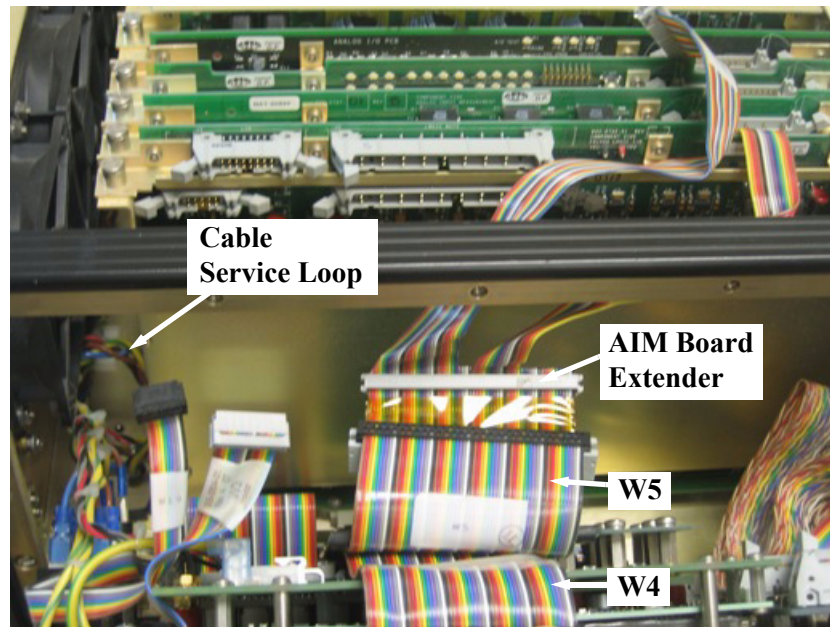


Figure 5-5 W5 Connector Plugged into AIM Board Extender

4. Remove the 12 hex-head retaining screws from around the edge of the front panel.
5. Gently pry the front panel away from the unit, starting at the top and working down the left and right hand sides until the connector at the bottom disengages.



Applying excessive pressure when removing the front panel will damage or destroy this connector.

6. After the connector has disengaged, gently pull the top of the front panel forward to an angle of about 30 degrees. This will allow access to the wiring connecting the front panel to the main chassis.
7. Disconnect the W8 connector from the back of the printed circuit board ([Figure 5-6](#)).

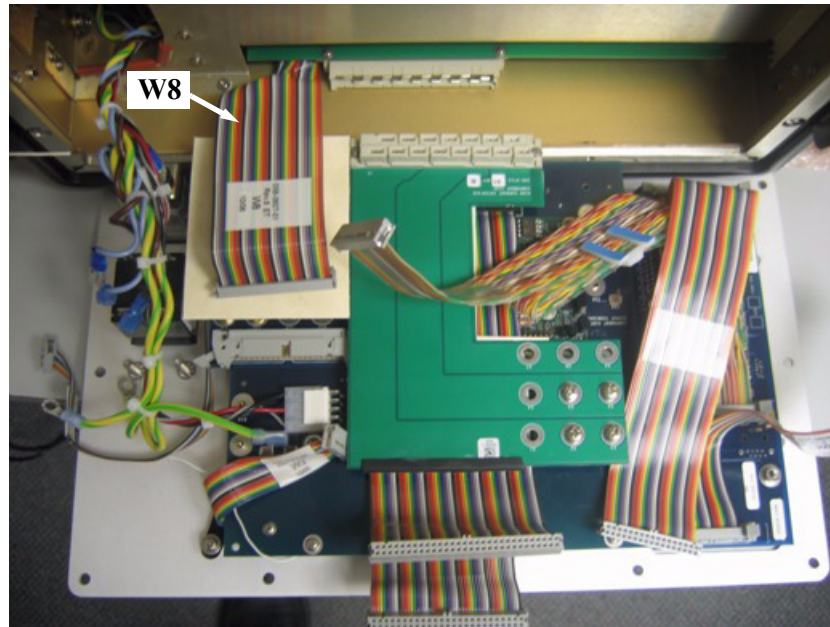


Figure 5-6 W8 Connector and Front Panel Components (Rear View)

8. Pull the cable service loop carefully forward from the opening at the left side of the chassis (Figure 5-5).
9. Place the front panel flat face down on a protective surface in front of the instrument.
10. With a 5/16" open-end wrench or nutdriver, remove the nuts from the two studs that retain the green/yellow ground wires on the left above the AC power switch (Figure 5-7). Remove the wires from the studs.

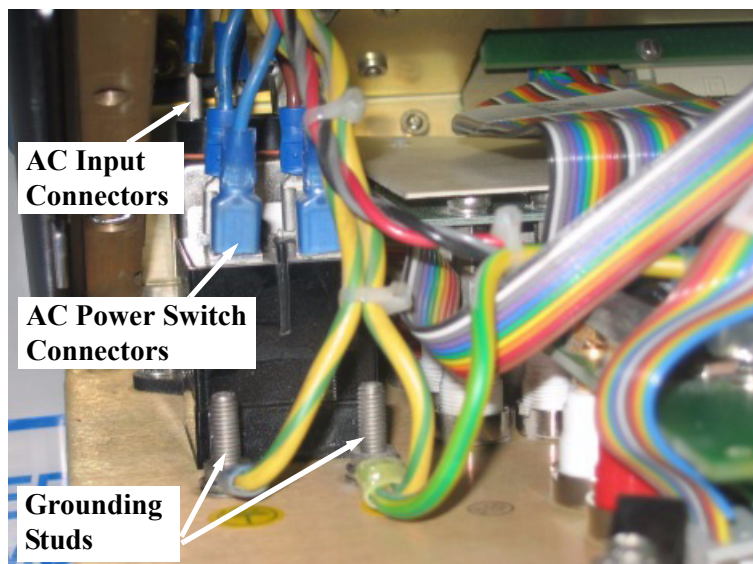


Figure 5-7 Rear of Front Panel – Yellow/Green Ground Wires and AC Connectors

11. Remove the two brown and two blue wires with push-on connectors from the AC power switch (Figure 5-7).
12. Remove one brown, one blue, and one green/yellow wire with push-on connectors from the AC input connector below the AC power switch (Figure 5-7).
13. Remove the green/yellow wire with a right-angle push-on connector from the left side of the printed circuit board (Figure 5-8).

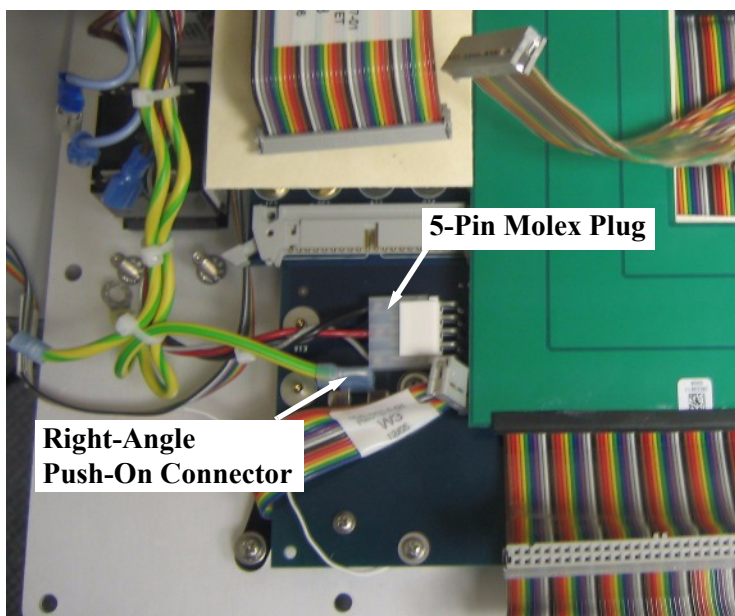


Figure 5-8 Rear of Front Panel – Green/Yellow Ground Wire and 5-Pin Molex Plug

14. Remove the five-pin Molex plug from the left side of the printed circuit board (Figure 5-8).

This completes the front panel removal. Carefully set aside the unit.

Installation

1. The new front panel should have been shipped with all ribbon cables attached. If any cables are missing or defective, detach them from the old panel and install them on the new panel.
If you are installing a new communications board, the only ribbon cable that cannot be reused is the W7, because the old cable is too short to fit the updated installation.
2. Attach the following wires to the front panel in the order given. The panel should be face down and the top should be nearest to you. Refer to Figure 5-4 through Figure 5-9.
 - a. Attach the shortest green/yellow wire with a push-on connector to the center terminal of the AC input connector.
 - b. Attach the short blue wire with a push-on connector to the left terminal of the AC input connector.

- c. Attach the short brown wire with a push-on connector to the right terminal on the AC input connector.
 - d. Attach the medium-length blue wire with a push-on connector to the left bottom terminal of the AC power switch.
 - e. Attach the medium-length brown wire with a push-on connector to the right bottom terminal of the AC power switch.
 - f. Attach the long blue wire with a push-on connector to the top left terminal of the AC power switch.
 - g. Attach the long brown wire with a push-on connector to the top right terminal of the AC power switch.
 - h. Attach the long green/yellow wire with a blue connector sleeve to the left stud of the front panel.
 - i. Attach the long green/yellow wire with a yellow connector sleeve to the right stud of the front panel.
 - j. Assemble the previously removed nuts and lockwashers to the front panel grounding studs and tighten securely.
 - k. Attach the long green/yellow wire with a right-angle push-on connector to the blade terminal on the printed circuit board.
 - l. Snap the five-pin Molex plug into the five-pin connector on the printed circuit board.
3. Place the bottom of the front panel into the bottom rail of the instrument chassis and tilt the top of the panel toward the instrument.
4. Reconnect ribbon cable W8.
5. Thread the other ribbon cables between the card cage and the top rail.
6. Fold ribbon cables W4 and W5 (the large cables in the center of the front panel) back over the top rail.

Looking straight down between the front panel and the backplane, you should be able to see the female connector on the bottom center of the front panel and the matching male connector on the bottom front of the backplane.
7. Carefully align the two connectors. Make sure the bottom of the front panel is inside the bottom rail.
8. Press lightly on the bottom center of the front panel to mate the two connectors.
9. Reconnect the ribbon cables to their respective cards. When routing ribbon cables W7 and W6:
 - a. Route ribbon cable W7 straight up to the right.
 - b. Route ribbon cable W6 to the left above its connector on the printed circuit board and back to the right, with two 90-degree bends ([Figure 5-9](#)).



Figure 5-9 Routing of W6 and W7 Ribbon Cables



Before proceeding, ensure that all preceding steps have been performed and confirmed.



Failure to adhere to the directions may result in damage to the instrument and an electrical hazard.

10. Turn the instrument on and verify that it powers up correctly.
If it does, proceed to the next step. If the instrument is not functioning properly, review the preceding steps and attempt to remedy the problem.
11. Reinstall the front panel retaining screws.



Be certain the backplane connector is properly aligned before tightening the screws. Damaging the connector will require returning the unit to Doble for repair.

12. Install the cover.
13. Reinstall the two rubber feet at the top rear of the instrument housing.
The front panel replacement procedure is complete ([Figure 5-10](#)).

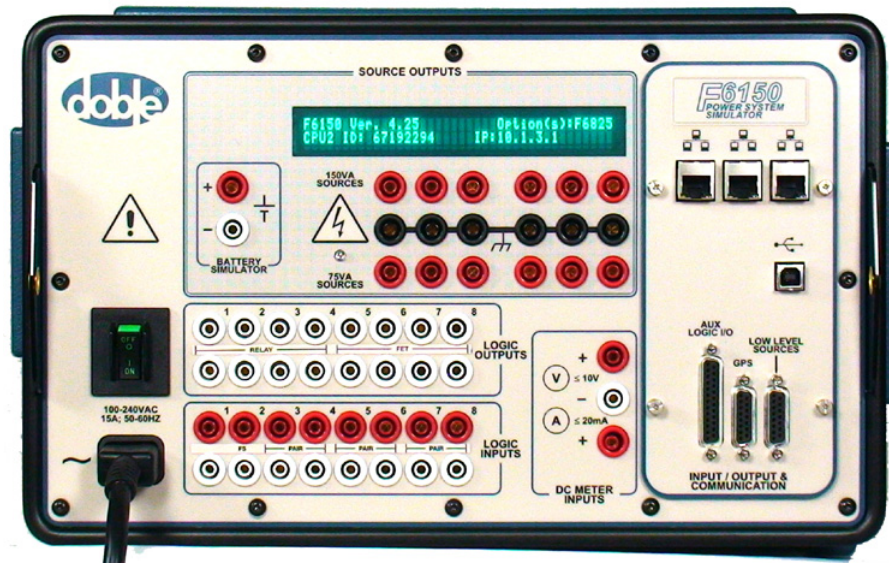


Figure 5-10 Completed Installation

Removing and Replacing the Communications Board

The communications board (Figure 5-11) supports the input and output terminals on the right side of the front panel.

CPU1 and Older CPU2 Instruments



Upgrading the communications board on a CPU1 instrument also requires upgrading the CPU1 board to a CPU2 board.

Removal

1. Follow Steps 1–8 in “[Removing and Replacing the Instrument’s Front Panel](#)” on p. 5-6.
2. With the front panel removed (except for the leads from the circuit breaker), remove the two Phillips-head screws that secure the Communications board to the rear of the front panel (Figure 5-11).
3. Tilt the front panel up until it leans against the instrument.
4. Use an open-ended wrench or pliers to remove the eight nuts on the right of the front panel (two for each of the four D-sub connectors) (Figure 2-6).
5. Tilt the front panel back down until it lies face down on the table.
6. Lift the communications board off the front panel.

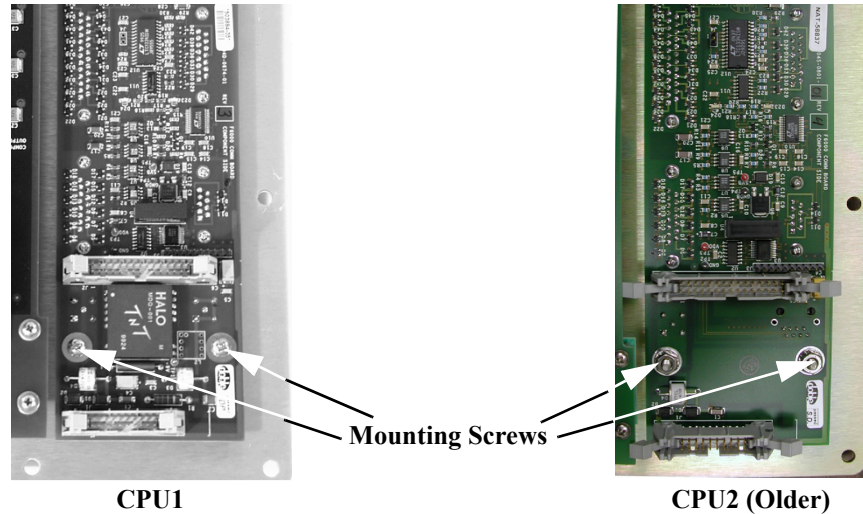


Figure 5-11 Communications Board(s) Ready for Removal (CPU1 and Older CPU2)

Installation

1. Place the new communications board in position on the right of the front panel.
2. Secure the communications board to the rear of the front panel with the two Phillips-head screws (Figure 5-11).
3. Use an open-ended wrench or pliers to tighten the eight nuts on the front of the front panel.
4. Tilt the front panel back into place.
Be sure the connector at the bottom of the front panel mates properly with the connector on the motherboard.
5. Secure the front panel to the instrument chassis with the 12 hex-head screws.
6. Reconnect the W2, W3, W4, W5, W6, and W7 ribbon cables.
7. Replace the instrument cover.

Present CPU2 Instruments

On present CPU2 instruments, the Communications board is a separate component that can be removed without removing the front panel.

Removal

1. Loosen the four Phillips-head screws retaining the communications board to the front of the front panel.
2. Angle the board to the left to allow the right side of the printed circuit card to clear the edge of the opening (Figure 5-12).
3. Withdraw the board from the opening far enough to disconnect the three ribbon cable connectors.
4. Remove the board.



Figure 5-12 Removing the Communications Board (Present CPU2)

Installation

1. Connect the three ribbon cable connectors to the communications board.
2. Insert the board into the opening.
3. Angle the board to the left to allow the right side of the printed circuit card to clear the edge of the opening (Figure 5-12).
4. Insert the board the rest of the way.
5. Tighten the four Phillips-head screws retaining the communications board to the front of the front panel.

Removing and Replacing Circuit Boards

Doble customer service may recommend that a circuit board be replaced to remedy an operating problem. None of the solid-state circuit boards requires user calibration or adjustment. Figure 5-1 shows a list of slot numbers and circuit boards in the F6150.



Remove or insert printed circuit assemblies carefully, to avoid damage to their mating connectors. To ensure that new boards go into their correct locations, remove and replace each one before proceeding to the next one.

Contact Doble for a replacement circuit board or obtain one from your company inventory of replacement parts, if available.

Removal

1. Power the instrument off.
2. Remove the power cord.
3. Disconnect all external cables from the instrument.
4. Remove the instrument's cover.

5. Remove the capture rail.
6. Disconnect any circuit board ribbon cables required to perform the replacement.
7. Unscrew the captive fasteners on the circuit board.
8. Firmly grasp the defective board and pull it straight up.

Installation

1. Place the new board firmly in the slot and make sure it is squarely seated.
2. Reattach ribbon cables if necessary.
Use [Table 5-1](#) to verify the placement of all cables.
3. Replace the capture rail.
4. Attach the power cord and power the instrument on.
5. If the new board is a current or a voltage amplifier, verify that the healthy status indicator light on the left side of the board is on.

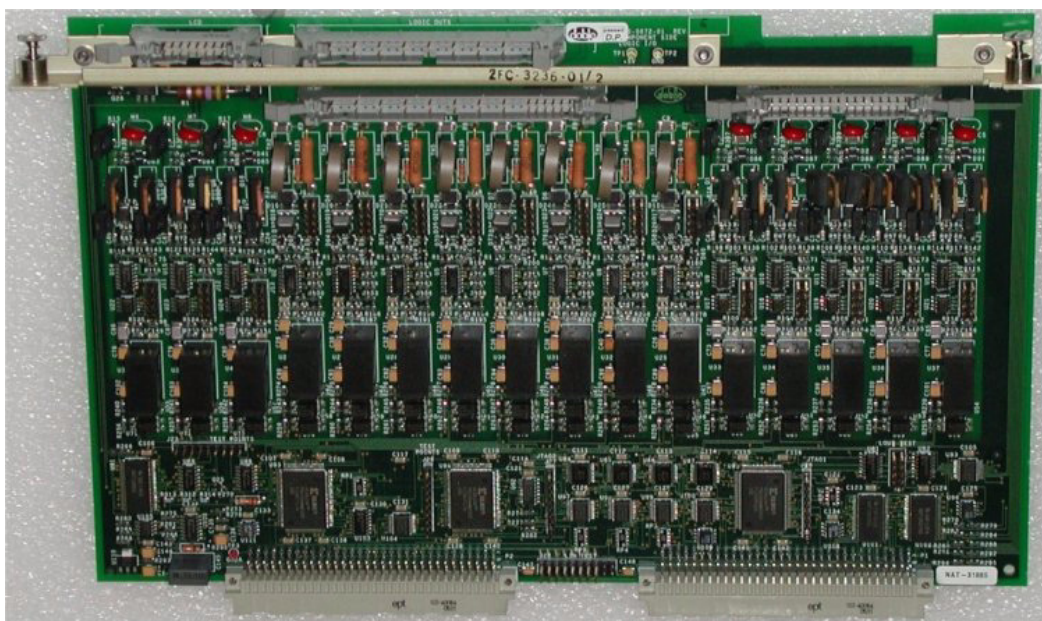


Figure 5-13 Slot 1 – Logic I/O Board Type 1

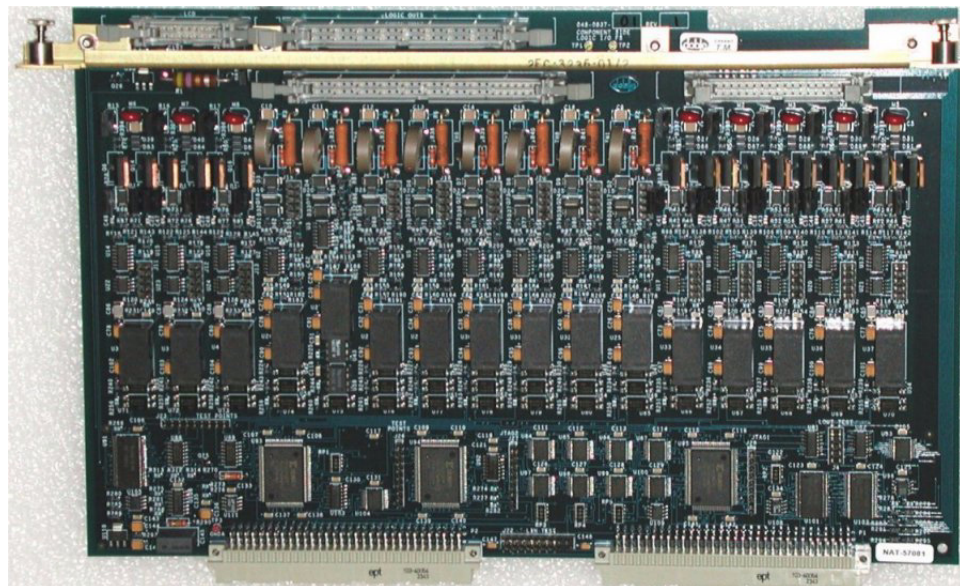


Figure 5-16 Slot 1 – Logic I/O Board Type 5

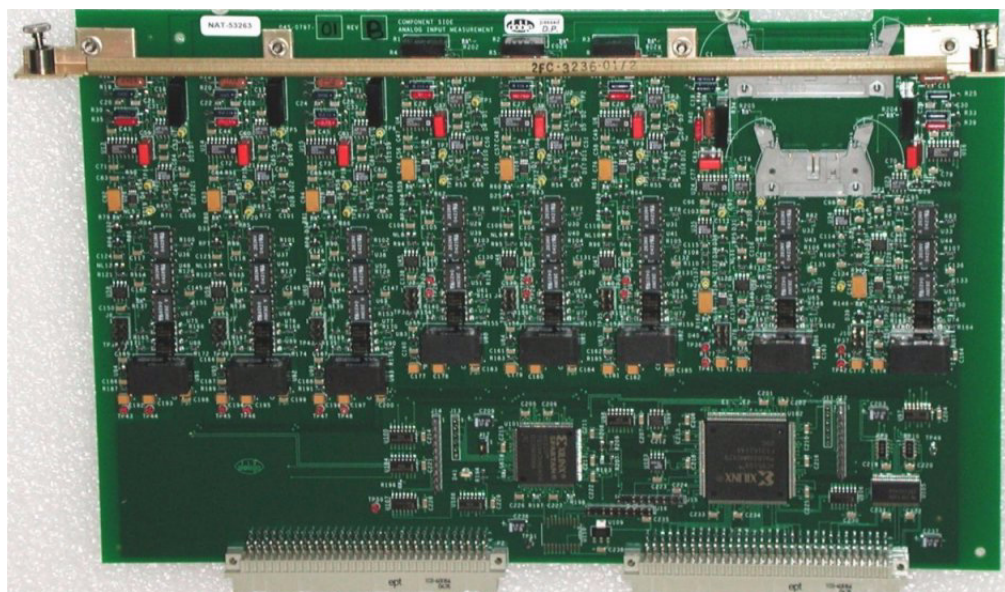


Figure 5-17 Slot 2 – Analog Input Measurement (AIM) Board



The AIM board is an option for CPU2-based instruments. Slot 2 is a spare (vacant) for CPU1-based instruments.

For photos of the remaining circuit boards, see [Chapter 4, “Troubleshooting”](#).

Removing and Replacing the Battery Simulator

F6150 with Variable Output Battery Simulator

F6150 instruments can use a power supply board (04S-0794-01) that has an integrated VOBS. This board is located in slot 11 (Figure 4-9). If the board is diagnosed as defective, remove it in the same manner as the other circuit boards.



This unit supplies the +350 VDC to amplifiers and the Variable Output Battery Simulator.

F6150 with Fixed Output Battery Simulator

F6150 (CPU1) instruments have a FOBS, located at the rear of the enclosure (Figure 5-18).



Figure 5-18 Fixed Output Battery Simulator Mounted at the Back of the Instrument

Removal

1. Power the instrument off.
2. Remove the power cord.
3. Remove the instrument cover.
4. Remove the capture rail.
5. Remove the power supply circuit board from slot 11.
6. Disconnect wire W16 from the power supply.
7. Remove the voltage amplifiers from slots 8, 9, and 10 (Figure 5-19).



Figure 5-19 Remove Power Supply and Voltage Amplifiers to Access Battery Simulator



The power supply is easily identifiable, but all voltage amplifiers look the same. Label each voltage amplifier with its slot number when it is removed from the instrument, and return it to the same slot when the instrument is reassembled. The instrument will not be properly calibrated if an amplifier is not returned to its original slot.

8. Use a Phillips-head screwdriver to remove the screws in the upper and lower left corners of the board, as viewed from the front (Figure 5-20).

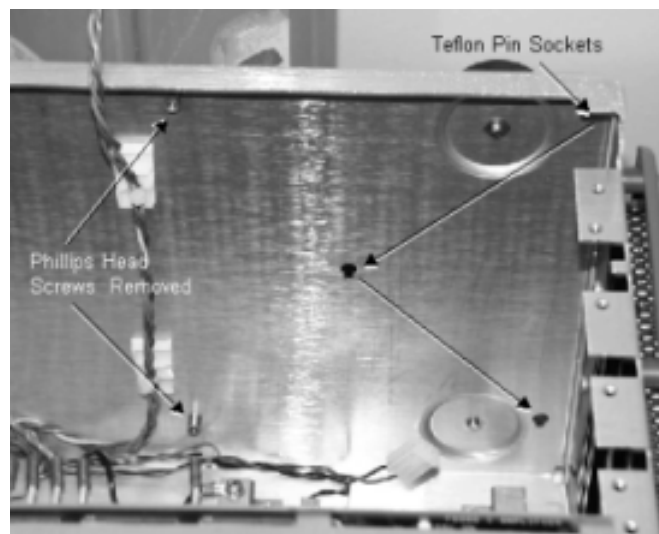


Figure 5-20 Back Panel after Removal of Battery Simulator

9. Disconnect the wire from connector J4 in the upper right corner of the board.
10. Lift the circuit board up, then pull it out from the back panel.

Three Teflon pins hold the battery simulator to the rear panel of the instrument (Figure 5-20). These pins are located in the upper right corner, the center, and the lower right corner of the circuit board.

11. Work all three pins loose from their sockets in the rear panel. Figure 5-20 shows the location of the pin sockets on the instrument chassis.
12. Disconnect the wire from connector J3 at the bottom of the board.
13. Lift the board out of the instrument.

Installation

To replace the battery simulator, reverse the removal procedure.



When replacing the battery simulator, reconnect ribbon cable W16 to the power supply board before seating the board in its slot, as it is difficult to reach the connector after the board is seated.

Removing and Replacing the Cooling Fans

Four cooling fans are located on the left side of the instrument. There are two types of cooling fan assemblies:

- Initial style, which contains housing fans only
- New style, which contains fans plus an integrated power supply

Changing the Initial-Style Fan Assembly

Older units (usually CPU1 models) have the initial-style fan assembly.

Removal

1. Power the instrument off.
2. Remove the power cord.
3. Remove the instrument's cover.
4. Remove the 11 hex-head screws from the left side of the instrument.
5. Remove the side frame and protective screen from the side of the instrument (Figure 5-21).
6. Remove the three Phillips-head screws above the fans from the instrument chassis.



Figure 5-21 Side View of Instrument before Removal of Cooling Fans

7. Remove the two Phillips-head screws that hold the top retaining bracket in place ([Figure 5-22](#)).



The two screws that secure the retaining bracket are different lengths ([Figure 5-22](#)). The outer screw is 1/4"; the inner screw is 3/8". When replacing the bracket during reassembly, replace each screw in its original position.

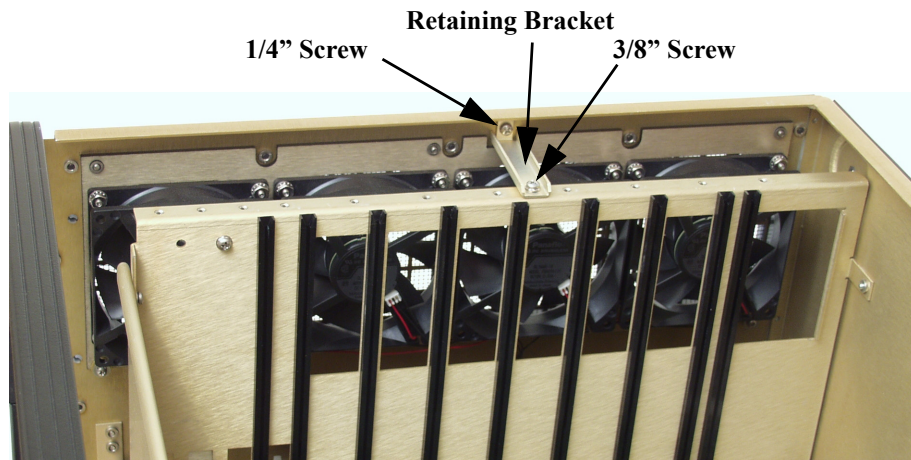


Figure 5-22 Retaining Bracket for Cooling Fans

8. Pull the fan assembly up out of the instrument until all four wire connectors are exposed ([Figure 5-23](#)).

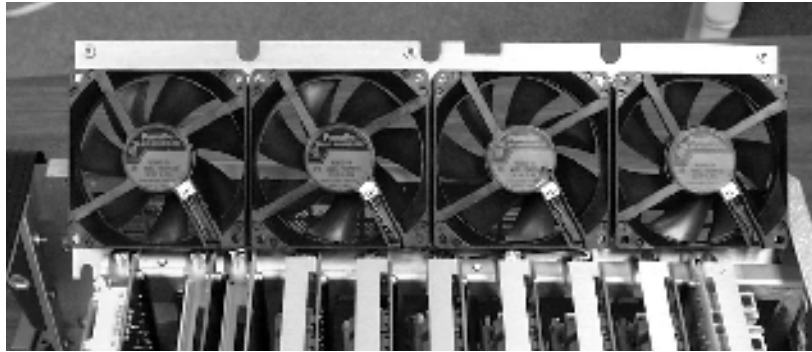


Figure 5-23 Cooling Fans with Wires Connected

9. Disconnect the wire from each of the four fans.
10. Pull the fan assembly the rest of the way out of the instrument.
11. Use an open-ended wrench to remove the four hex nuts that secure the fan to be replaced.
12. Pull the defective fan off its supporting plate.

Installation

1. Install the replacement fan.
2. Secure the fan with the four hex nuts.
3. Reconnect the four wires, one to each fan.
4. Lower the fan assembly into the instrument until the bottom of the assembly rests on the three spring-loaded supports attached to the chassis.
5. Verify that the U-shaped indentations in the fan plate line up with the spring-loaded supports.
6. Push the fan assembly down onto the spring-loaded supports.
7. Replace the retaining bracket above the fan assembly.
8. Put the two Phillips-head screws used to secure the bracket in their original positions.
9. Replace the three Phillips-head screws that fasten the top of the fan assembly to the chassis.
10. Replace the side frame and protective screen with the 11 hex-head screws.

Changing the New-Style Fan Assembly

The new-style Fan Assembly has an integral power supply with two power modules: one provides -12 VDC and another provides $+5$ and $+12$ VDC. They are located at the bottom of the unit ([Figure 5-24](#)).

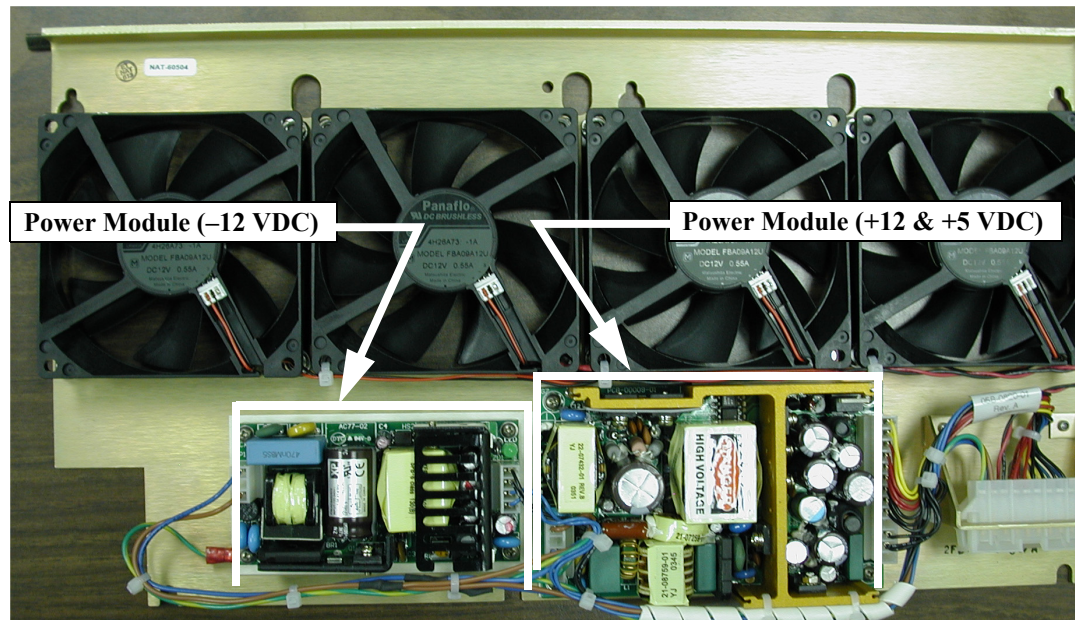


Figure 5-24 Fan Assembly with Integral Power Supply

Unlike the initial-style Fan Assembly, all the steps in the removal procedure for the new style are performed inside the enclosure.

Removal

1. Power the instrument off.
2. Remove the power cord.
3. Remove the instrument's cover.
4. Remove the two Phillips-head screws that hold the top retaining bracket ([Figure 5-22](#)).



The two screws that secure the retaining bracket are different lengths ([Figure 5-22](#)). The outer screw is 1/4" and the inner screw is 3/8". When replacing the bracket during reassembly, replace each screw in its original position.

5. Loosen the Phillips-head screws that secure each end of the assembly. These screws fit inside oblong holes on the assembly rail ([Figure 5-25](#)).

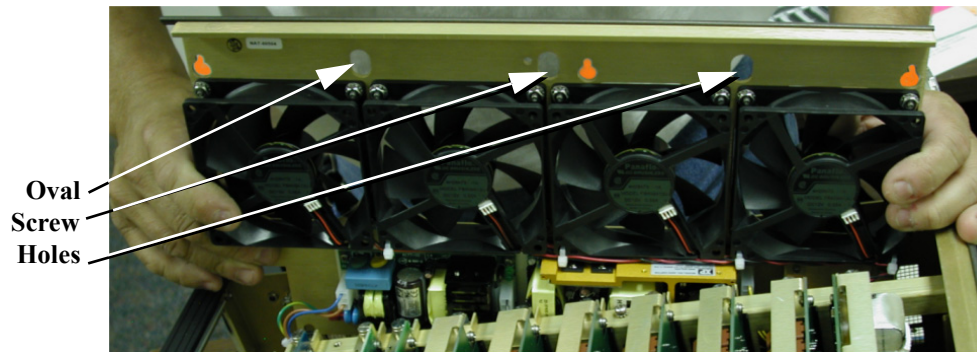


Figure 5-25 Screw Holes on Fan Assembly Rail

6. Slide the board upward, tilt it forward, and pull it up and out of the chassis. Make sure that you do not snag or nick any wires on the assembly.
7. Study the instrument chassis with the fan assembly removed ([Figure 5-26](#)). Before replacing the fan assembly, locate the electrical connector, three standoffs, and three mounting screws.

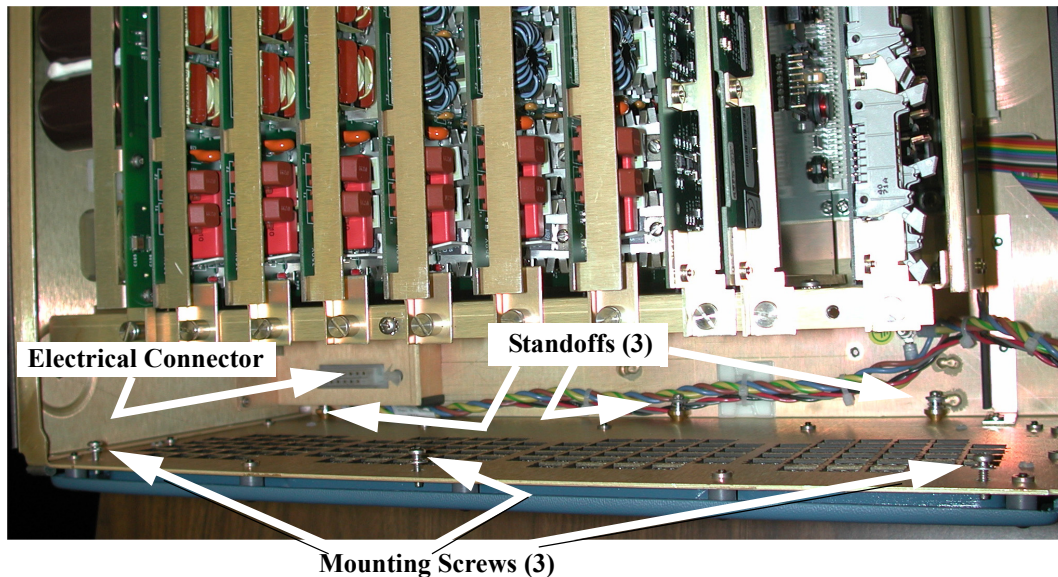


Figure 5-26 Instrument Chassis with Fan Assembly Removed

Installation

1. Ensure that the three Phillips-head screws are backed out of their holes, but not removed.
2. Carefully lower and align the fan assembly over the connector, the three standoffs, and the three mounting screws.
3. Press the assembly into place, ensuring that the male connector (on the fan assembly) is seated with the connector socket.
4. Tighten the two end screws to secure the fan assembly rail.

5. Install the center bracket with the appropriate screws.

Verify the Replacement

To determine whether the replacement procedure is successful:

1. Power the instrument on.
2. Monitor the messages on the front panel as the instrument goes through its startup sequence.
3. Check the status indicator light on the left side of each amplifier board.
If the replacement is successful, the status indicator lights are green and the error message on the front panel is cleared.
4. Repeat the test sequence that led to the error.
5. Check the instrument's front panel for error messages.
6. Check F6ControlPanel for source errors.

Replaceable Components and Cables

Table 5-2 lists part numbers for field-replaceable components.

Table 5-2 Field-Replaceable Components

Description	Old Part No. (CPU1)	New Part No. (CPU2)
115 V Power Supply Board (Type 1)	04S-0676-01	04S-0676-03
230 V Power Supply Board (Type 1)	04S-0676-02	04S-0676-04
Power Supply w/ VOBS (Universal) (Type 2)	04S-0794-01	04S-0794-01
3 A Fuse for Power Supply Board	384-0167	384-0167
5A Fuse for I and V/I Amplifiers	384-0169	384-0169
Analog I/O Board	04S-0673-01 04S-0825-01	04S-0673-01 04S-0825-01 (-02 for F6350)
Analog Input Measurement (AIM) Board (Option)	Not Applicable	04S-0797-01
Battery Simulator Board (Fixed Output)	04D-0598-01	04D-0598-01
Battery Simulator Board (Variable Output)	04S-0598-02	04S-0598-02
Convertible Voltage/Current Amplifier Board	04S-0679-01	04S-0679-01 or 04S-0679-02

Table 5-2 Field-Replaceable Components (Continued)

Description	Old Part No. (CPU1)	New Part No. (CPU2)
Current Amplifier Board	04S-0678-01	04S-0678-01 or 04S-0678-02
DC Meter Board	04S-0680-01	04S-0680-01
F6 Communications Board	04S-0674-01	04S-0801-01
F6 CPU Board	04S-0670-01 (CPU1)	04S-0799-01 (CPU2)
Fan Assembly (Initial Style)	03D-1371-01	03D-1371-01
Fan Plate Assembly w/Integral DC Power Modules	03D-1587-01	03D-1587-01
Front Panel Assembly	03D-1356-03	03D-1356-03
Logic I/O Board	04S-0672-01	04S-0672-01 (Type 1) 04S-0742-01 (Type 2) 04S-0820-01 (Type 4) 04S-0837-01 (Type 5)
Main Circuit Breaker	384-0176	384-0176
Output Terminal Board	04S-0675-01	04S-0675-01

Table 5-3 lists cables and adapters used with the F6150. A number in the Qty column indicates the number shipped with each unit.

If a system failure is traced to a cable, ensure that the cable is properly seated and connected before replacing it. Contact Doble Customer Service to order replacement cables.

Table 5-3 Cable and Adapter Shipping/Replacement List

Qty	Description	Old Part No. (CPU1)	New Part No. (CPU2)
1	Adapter, Crossover Cable, RJ-45, M/F	—	401-0303
4	Adapter, Small, Spade Lug, 4 mm, Black	212-0527	212-0527
15	Adapter, Small, Spade Lug, 4 mm, Red	212-0528	212-0528
9	Adapter, Small, Spade Lug, 4 mm, White	212-0529	212-0529
2	Cable, Adapter, #4 R Lug, 3 x 4 mm, F	05B-0619-01	05B-0619-01
1	Cable, Ethernet C5E, RJ-45/RJ-45, 10 ft / 3 m	—	401-0243

Table 5-3 Cable and Adapter Shipping/Replacement List (Continued)

Qty	Description	Old Part No. (CPU1)	New Part No. (CPU2)
3	Cable, I Output	05B-0616-01	05B-0616-01
1	Cable, V Output	05B-0617-01	05B-0617-01
9	Cable, Logic I/O	05B-0618-01	05B-0618-01
1	Cable, USB, 6 ft / 2 m, A/B	—	181-0585
	Cable, RG58C/U, 50-ohm, 20 A, M/M	181-0118	—
	Cable, RS-232, Instr-PC, 10 ft / 3 m	401-0167	401-0167
2	Clip, Crocodile, 4 mm, Black, Socket	212-0542	212-0542
2	Clip, Crocodile, 4 mm, Red, Socket	212-0543	212-0543
1	Cord, Power, 14AWGX3, USA Plug	181-0088	181-0088
	Terminator, In-line, 50-ohm, BNC	401-0157	—

Table 5-4 lists other components shipped with the F6150. A number in the Qty column indicates the number shipped with each unit.

Table 5-4 Additional Component Shipping/Replacement List

Qty	Description	Old Part No. (CPU1)	New Part No. (CPU2)
1	Carry Strap	2FD-3184-01	2FD-3184-01
1	Small Cable Bag	2FB-3450-01	2FB-3450-01
3	Zip-all Bag, 10.5 x 8.0 in. / 27 x 20 cm	903-0011	903-0011
1	F6150/F6150A User Guide	500-0574	500-0574
1	F6000 Marketing Release Notice	500-0213	500-0213
1	F6000 Utilities CD	08A-0133-01	08A-0133-01



6. Safety and Maintenance

This chapter discusses rules for the safe operation of the F6150, as well as several topics related to maintenance of the unit.

F6150 Rules for Safe Operation

Safe operation of the system requires adherence to the following guidelines:

- Do not use the F6150 unless a safety ground is connected.
- Do not, for any reason, cut or remove the grounding prong from the power cord.
- Do not defeat the AC power input source ground connection, and verify that the power connections have proper hot and neutral polarity.
- Use the correct electrical line voltage, to avoid an electrical short circuit, overheating, and shocks. If in doubt, check the electrical rating label attached to each unit.
- Always turn the power off and disconnect the instrument from line power before reaching into the chassis.



The F6150 contains capacitors capable of storing hazardous voltages even after the instrument is turned off and the power cord is removed. Always proceed with caution when reaching into the instrument.

- Never insert metal objects, such as screwdrivers or paper clips, inside the instrument while power is on.
- Unplug the instrument if it is not to be used for an extended period of time or before cleaning.
- If the instrument is dropped and not physically damaged, have it checked by a qualified service technician before placing it back in service. Dropping the instrument can disturb the insulation system.
- Do not place the instrument in excessively warm or humid locations.
- If the instrument is dropped or physically damaged, or if spilled liquid penetrates the instrument case, return the instrument to Doble for repair.

The F6150 output and measurement terminals are intended for Installation Category I usage. The instrument's power input is intended for connection to an Installation Category II (overvoltage category) AC main supply. The F6150 is intended for indoor use only.

Cleaning the F6150

To clean the instrument, sponge the instrument covers and panels with a mild soap solution. Observe the following precautions whenever the instrument is cleaned:

- Disconnect the instrument's power cord and all other external cables before cleaning or removing the instrument's cover.
- Do not use household cleaners containing chlorinated or abrasive compounds.
- Do not spray liquids directly onto the instrument.
- Do not use flammable liquids, such as gasoline or lighter fluid, for cleaning electrodes, electrical components, or moving parts.

Customer Service

To request assistance with any question or problem, call Doble Engineering Customer Service at 617-926-4900 or send e-mail to customerservice@doble.com. Before contacting Customer Service for help, please take the following preliminary steps:

- Review the pertinent portions of this user guide.
- Check all cable connections.
- Work through the [“Troubleshooting Flowcharts”](#) on p. 4-2 to identify and isolate problems.
- Perform the [“Component Checkout Procedures”](#) on p. 4-13 to verify component operations.
- If the instrument fails during a relay test and another instrument is available, try the test using the second instrument.
- If the instrument fails during a relay test, compare the requirements in the test plan to your test setup and source configuration.

If possible, have the instrument set up near a telephone, to facilitate telephone assistance. Please have the following available when calling customer service:

- Date of purchase.
- The instrument's serial number, found on the bottom outer case.
- The hardware configuration and software revision, which are displayed on the instrument's front panel during bootup.
- A precise description of the problem. Include any error messages that have appeared and the sequence of events leading to the messages.
- The solutions that have been tried.
- Electronics tool kit and digital multimeter, in case customer service suggests that a board or subassembly be removed.

Write down the name of the customer service representative and ask to speak to the same person during subsequent calls. Write down any instructions the representative gives during a service call.

Returning the F6150

If troubleshooting checks and replacing defective parts in the field fail to correct a problem, the F6150 may need to be returned to Doble for servicing. Before returning the instrument, contact Doble Engineering customer service at 617-926-4900 to obtain a Return Material Authorization (RMA) number. The RMA number must be attached to the instrument, as it is used to track the instrument through the repair cycle.

To prepare the F6150 for shipping, disconnect all external cables and attach the cover that protects the front panel of the instrument. Use the original packing materials if they are available. If the original packing materials are not available, pack the instrument for shipment as you would for any fragile electronic equipment.

Triple-wall shipping containers (903-0045) can be ordered from customer service for a nominal charge. Alternately, the instrument may be packed using either of the following methods:

- Double-wall cardboard box with a minimum of 2-inch thick poly foam padding all around
- Wooden crate with a minimum of 2-inch thick poly foam padding all around



Doble Engineering is not responsible for shipping damage. Carefully protect each instrument from shipping and handling hazards. Ensure that protective covers are securely in place.

Do not return instruction manuals and cables with the instrument, unless Doble customer service requests these items.

Send the instrument to Doble Engineering, freight prepaid, unless other arrangements have been authorized in advance by Doble customer service. The shipping address is:

Customer Service Manager
Doble Engineering Company
85 Walnut Street
Watertown, MA 02472-4037
USA

Appendix A. Firmware Maintenance

Use the following utilities to accomplish routine maintenance of the software:

- F6000 Flash Loader: Installs revised firmware.
- F6000 Key Code Update: Installs F6150 options

Open both utilities from the Tools menu in the F6ControlPanel menu bar.



When the F6150 powers up, the current firmware revision number and the options installed appear in the display on the instrument's front panel.

Flash Loader

Operation of the F6150 requires the correct firmware version:

- 2.11 (or higher) for CPU1 instruments
- 4.11 (or higher) for CPU2 instruments

The F6150 requires a firmware package file, *.pkg. This file must contain F6150 in its name.

Flash Loader installs revised firmware in the F6150. Select **Tools** → **F6000 Flash Loader** to open the program. (The virtual devices must be closed to do this.) The Flash Loader dialog box appears (Figure A-1).

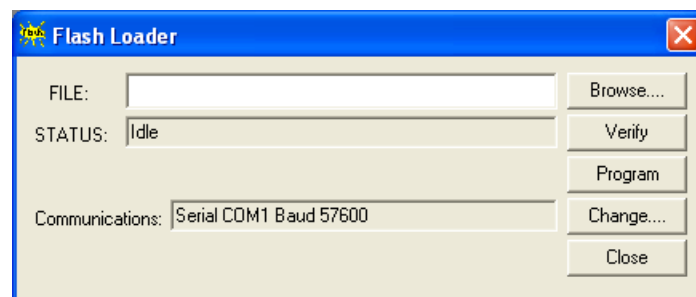


Figure A-1 Flash Loader

The fields and buttons in the Flash Loader dialog box perform the following functions:

- **File** — Displays the name of the package file to load.
- **Status** — Shows the progress of the last action.
- **Communications** — Displays the current settings for communication between the computer and the F6150.
- **Browse** — Browses for the location of the package file to load.

- **Verify** — Verifies that the current firmware version is compatible with the selected package file.
- **Program** — Downloads the selected package file to the F6150.
- **Change** — Changes the communication settings.
- **Close** — Closes Flash Loader and aborts any actions in progress.



Click **Verify** to determine whether a package file is already in Flash Loader. You can also do this by comparing the software revision number of the F6150 with the number in the package file. The software revision number appears when you turn the unit on.

A package file consists of ASCII data followed by **Control-z** (DOS end-of-file character) followed by binary data. The software revision is in the second line of the package file as an ASCII string. The package file can be viewed in a text editor such as Notepad or by using the `type` command in a DOS window.

Loading New Firmware

Firmware is supplied on a CD or downloaded from the Doble website (www.doble.com/support/download_fseries.html) and is loaded from your computer using a USB (newer CPU2) or RS-232 (CPU1 and older CPU2) serial connection.



Check the Marketing Release Notice to ensure that the firmware enables all required options and enhancements and is compatible with the installed version of F6ControlPanel.

To update the F6150 firmware:

1. Open F6ControlPanel and ensure that the communications are set up correctly.
If necessary, click **Change** to modify the settings for communication between the computer and the F6150. The communication cable must connect directly to the F6150.
2. Select **Tools** → **F6000 Flash Loader**.
3. Click **Browse** and locate the package file to be loaded.
The release notice contains the name and location of the package file. The name of the package file appears in the File field.
4. Click **Verify** to confirm that the current firmware version is compatible with the selected package file (see the Note above).
The Status field displays the progress of the verification. When complete, the Status field displays Idle.
5. Click **Program** to update the firmware with the selected package file.



Do not power-cycle the F6150 or disconnect the computer until the Flash Loader download is complete.

If the flashload is successful, a dialog box appears, confirming this.

6. Click **OK** to close the dialog boxes and power-cycle the instrument.



If the flashload fails, see the next sections for procedures to attempt to remedy the problem.

Communications Parameters

If the revised firmware does not load successfully, confirm that you have communication between the computer and the F6150.

To verify or change the communication settings:

1. Click **Change** in the Flash Loader dialog box (or any of the other Tools menu utilities with a Change button).

The Set Communications Parameters dialog box appears (Figure A-2).

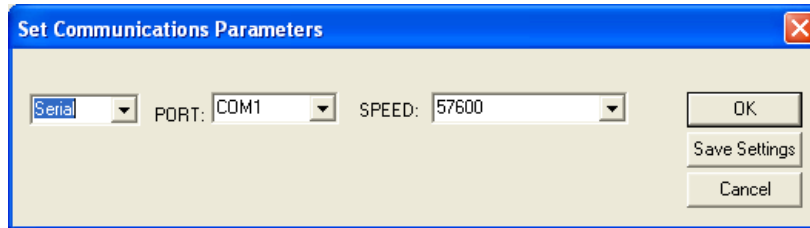


Figure A-2 Set Communications Parameters

2. Select the correct setting from each of the dropdown menus:
 - To change the serial COM port, select a different port from the center dropdown menu.
The connection speed must remain at 57,600 baud.
 - To set the IP address using an Ethernet connection:
 - a. Select **Network** from the first drop-down menu. An IP Address field appears (Figure A-3).

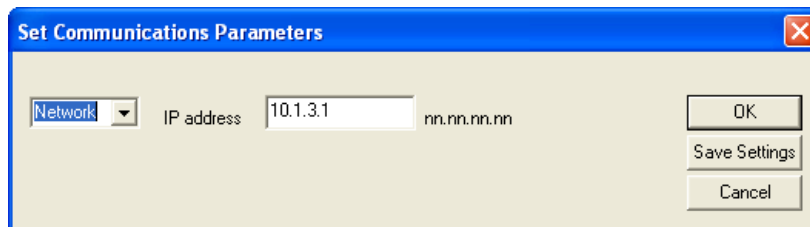


Figure A-3 Set Communications Parameters – Network

Enter the current IP address of the F6150.

The IP address appears in the front panel display when the F6150 is turned on and the firmware loads.

3. Click **OK** or, to make the settings in the Set Communications Parameters dialog box the default settings for future firmware updates, save them in the software's .ini file, as follows:
 - a. Click **Save Settings**. The Save Communication Settings dialog box appears (Figure A-4).

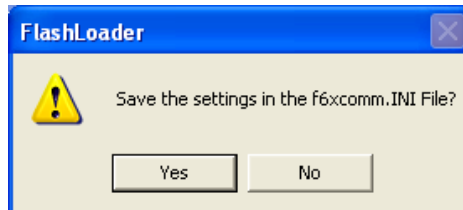


Figure A-4 Save Communications Settings

- b. Click **Yes**. You are returned to the initial dialog box.
 4. Click **OK**.
 5. Click **Get**.
 - If you are using a serial connection, the utility obtains the IP address of the F6150 via the specified COM port. The IP address and subnet mask appear in the top two fields.
 - If you are using an Ethernet connection, the utility attempts to connect to the IP address specified in the Communications field of the Set F6000 IP Address dialog box. If it is successful, the IP address and subnet mask of the F6150 appear in the top two fields.
- If the utility is not successful, you will receive an error message.
- Make sure you have an Ethernet cable connected between the Ethernet connection on your PC and the Ethernet (Network) connection on the F6150.
6. To change the IP address and subnet mask, enter the desired settings in the top two fields. Enter an IP address in the same subnet as the desired IP address.
 7. Click **Set**.
 8. To enable the new IP address and firmware, turn the unit off and then back on.

Flash Loader normally updates the flash by communicating with the application that is already in the flash. The link is made using either serial or Ethernet communication. If no valid application is in the flash, the loader updates the flash by communicating with the bootloader that is already in the flash. In this case, the update can be done only using serial communication.

Flashload Failure Recovery Techniques

If the bootloader is OK, but the flashload fails, the unit will display a message with `waiting` in it. The recovery procedure depends on the type of instrument involved.



These procedures will work only with a serial connection, not with Ethernet.

CPU1 Instruments

1. Connect the serial cable.
2. Run Flash Loader and reload the firmware.
3. Turn the instrument off and then back on.

CPU2 Instruments

1. Turn off the instrument.
2. Connect the serial cable.
3. Open HyperTerminal on your computer.
4. Enter these parameters:
 - **Bits per second:** 57,600
 - **Data bits:** 8
 - **Parity:** None
 - **Stop bits:** 1
 - **Flow Control:** None
5. Turn on the instrument.

A series of messages will display. The series ends with a prompt.
6. At the prompt, type `£6xs` and press **Enter**.
7. Shut down HyperTerminal or use the disconnect on the toolbar.
8. Run Flash Loader and reload the firmware.



If the bootloader is defective, the CPU card or the entire unit must be returned to Doble.

Key Code Update

The Key Code update utility installs options available for the F6150. These options require a Doble Engineering software key for access. Obtain the software key from Doble Engineering when the option is purchased. You can identify available F6150 options by numbers that scroll in the instrument display after startup.



The Key Code utility is required only when options are to be installed in the field. All options ordered with the unit are installed before delivery.

To update F6150 options:

1. Select **Tools** → **F6000 Key Code**.

The Key Code Update dialog box appears (Figure A-5).

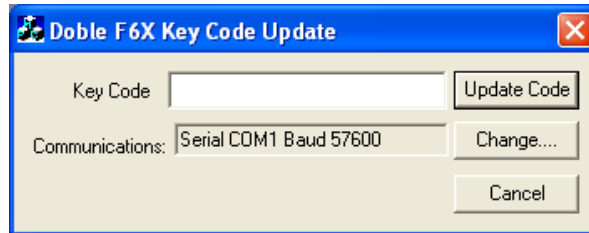


Figure A-5 Key Code Update

2. Type the software key in the Key Code field.
3. Click **Update Code**.
 - If the code you entered was correct, the KeySet dialog box appears (Figure A-6), indicating that the unit's capabilities will change as a result of the update. This is a normal message.

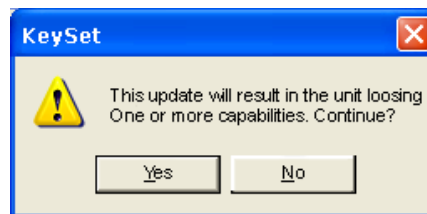


Figure A-6 KeySet Dialog Box – Change in Capabilities

- a. Click **Yes**.

A message appears, indicating a successful update (Figure A-7).
- b. Click **OK**.

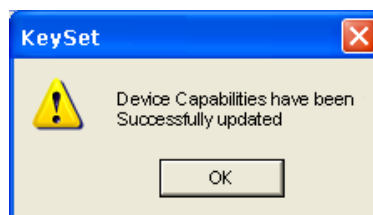


Figure A-7 KeySet Dialog Box – Successful Update

- If the code you entered was incorrect, an error message appears (Figure A-8).



Figure A-8 KeySet Dialog Box – Error Message

- a. Click **OK**
 - b. Return to Step 2.
4. If necessary, click **Change** to enter new communications parameters. (See [“Communications Parameters”](#) on p. A-3 for the procedure.)

Appendix B. Ethernet Communications

If the control PC is configured for Ethernet communications, it can communicate with the F6150 on a private network using the UDP/IP protocol. When it initiates two-way communication, the PC sends its IP address to the instrument. Both the F6150 and the PC must have an IP address assigned.



One PC can control multiple F6150 instruments via an Ethernet connection, to execute end-to-end protection scheme tests under laboratory conditions. Controlling multiple F6150s using one PC eliminates the need for GPS synchronization.

Connecting the Control PC to the F6150

CPU1 Instruments

On CPU1 models, use the two 50-ohm terminators and a 50-ohm coaxial 10Base2 network cable supplied with the instrument.

1. Connect one of the 50-ohm terminators to the network port on the right side of the instrument's front panel.
2. Connect the second 50-ohm terminator to the connector on the Ethernet card in the control PC.
3. Connect the supplied RG-58 coaxial cable to both the F6150 and the control PC.

Figure B-1 illustrates two ways to make these connections, using either a BNC connector with a built-in 50-ohm terminator or a right-angle BNC connector with a separate 50-ohm terminator.

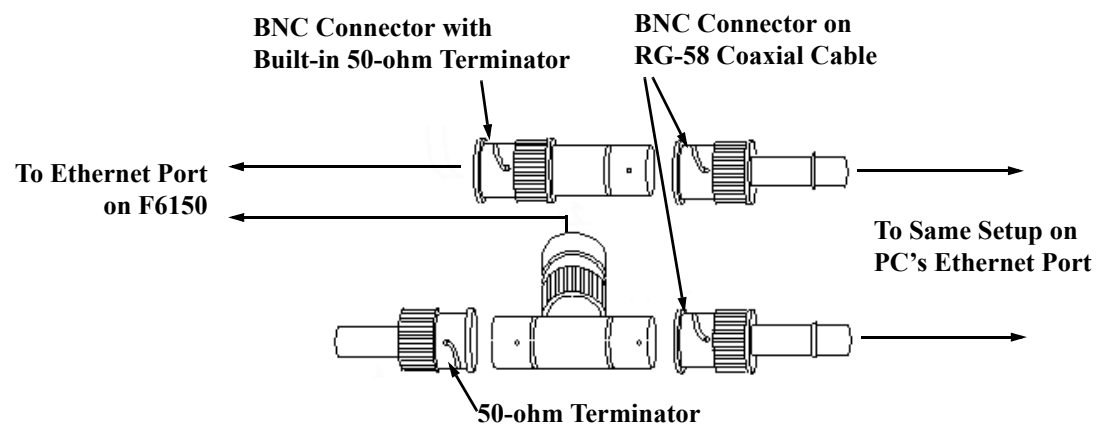


Figure B-1 Alternate 50-Ohm Terminator CPU1 Connections for Coaxial Cable

CPU2 Instruments

If connecting to the F6150 directly from a PC, plug the crossover adapter (401-0303) supplied with the instrument into the Ethernet connector on the F6150 and then use the supplied standard Ethernet cable between the adapter and the PC.

If connecting to the F6150 through a hub, use the standard Ethernet cable supplied with the instrument between the hub and the instrument. The crossover adapter is not necessary.

Configuring the Control PC

Establish the IP Address

To configure Windows for communication with the F6150 on a private network:

1. Right-click the **Network** icon on the desktop (or go to the **Start** menu, select **My Network Places**, and right-click) and select **Properties** (Figure B-2).

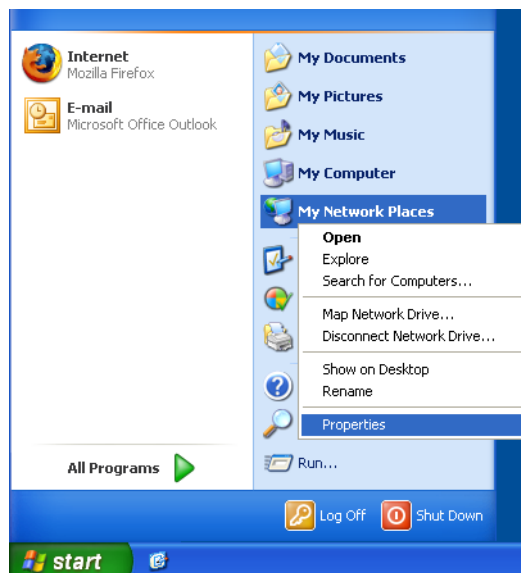


Figure B-2 Accessing Network Properties

2. Right-click on **Local Area Connection** and select **Properties**.
The network dialog box (Local Area Connection Properties in Windows XP) appears (Figure B-3).

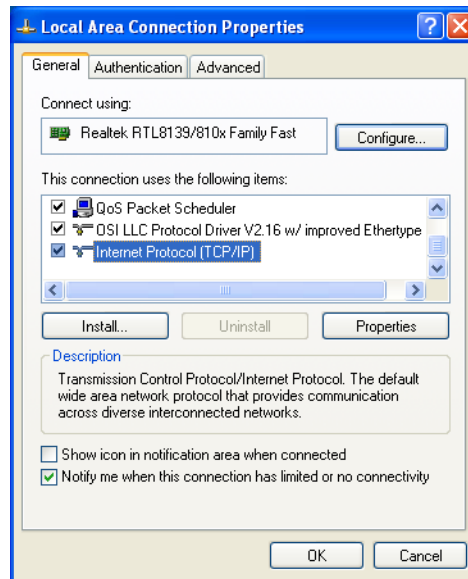


Figure B-3 Network Dialog Box: Scroll to the TCP/IP Component

3. On the General tab, scroll down the list of network components and select the appropriate component:
 - **For CPU2-based instruments:** Internet Protocol (TCP/IP)
 - **For CPU1-based instruments:** the Ethernet card for the control PC
4. Click **Properties** under the list of network components.

The TCP/IP Properties dialog box appears (Figure B-4). If there is data in any of these fields, copy it down in case you wish to restore it later.

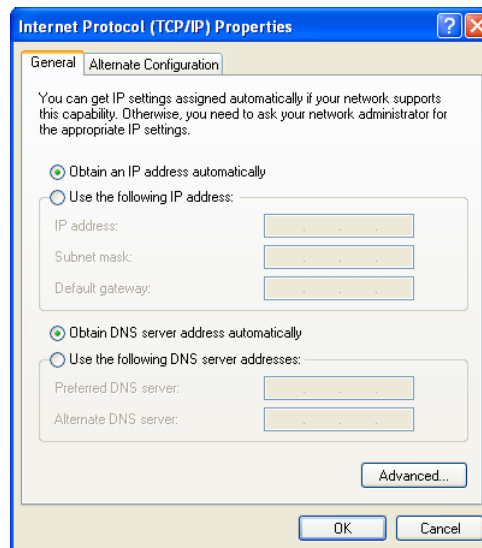


Figure B-4 TCP/IP Properties Dialog Box

5. On the General tab, click the option button for **Use the Following IP Address** (Figure B-5).
6. In the IP Address field, enter an IP address in the same subnet as the IP address displayed on the F6150 when it is powered on.
7. Enter the Subnet Mask.
8. Click **OK**, then click **OK** again.
9. For systems using Windows 98, restart the computer for these changes to take effect. For systems using , Windows XP, or Vista, you do not need to restart.

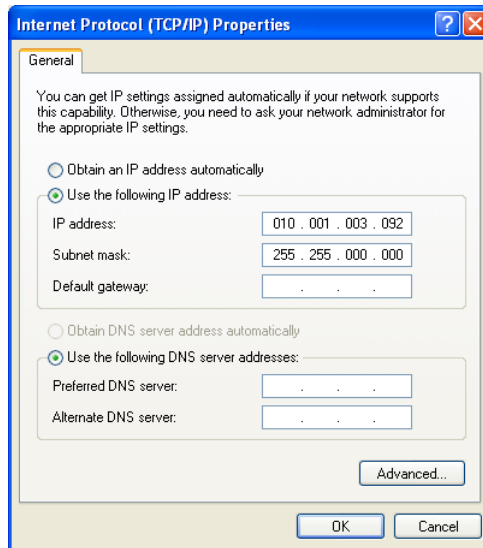
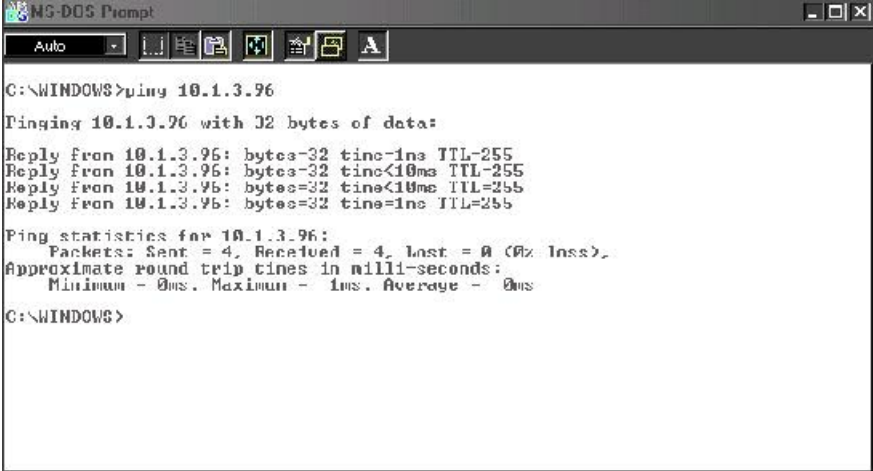


Figure B-5 IP Address and Subnet Mask in TCP/IP Properties Dialog Box

Ping the Network

Test the IP address by pinging it using the Windows command prompt.

1. Click **Start** and select **Run**.
2. For systems using Windows 2000, Windows XP, or Vista, type `cmd` in the Run window and click **OK**.
The MS-DOS command prompt window appears.
3. Type `ping` after the prompt, followed by a space and the IP address of the F6150.
If the Ethernet connection is working, four replies from the F6150 appear (Figure B-6).



```

C:\WINDOWS>ping 10.1.3.96
Pinging 10.1.3.96 with 32 bytes of data:
Reply from 10.1.3.96: bytes=32 time=1ms TTL=255
Reply from 10.1.3.96: bytes=32 time<10ms TTL=255
Reply from 10.1.3.96: bytes=32 time<10ms TTL=255
Reply from 10.1.3.96: bytes=32 time=1ms TTL=255

Ping statistics for 10.1.3.96:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\WINDOWS>

```

Figure B-6 Successful Ping

If the ping is unsuccessful, check the network connections, terminators, connecting cable, and network properties. Then try again.

Configure F6ControlPanel

1. In F6ControlPanel, with the application running but the virtual devices closed, select **Tools** → **Setup** on the menu bar.
The Setup dialog box appears. (For more information on setup, see [“Getting Started” on p. 3-1.](#))
2. In the F6 Instrument section, click the **Ethernet** option button.
3. Enter the IP address of the F6150. The IP address appears in the front panel display when the instrument is turned on and the firmware loads.
4. Click **OK**.
5. Click the menu bar icon for the appropriate virtual device. The device opens and provides manual control of the instrument.



If the control PC is subsequently connected to any kind of local-area or wide-area network, return to the Network TCP/IP Properties dialog box in Windows and select Obtain IP Address Automatically or restore your settings as indicated below.

Restoring Your Network Settings

To restore your PC’s original network settings:

1. Follow steps 1 through 4 in [“Establish the IP Address” on p. B-2.](#)
2. Restore the original settings that you copied down in step 4.
3. Click **OK**, then click **OK** again.
4. For systems using Windows 98, restart the computer for these changes to take effect. For systems using Windows 2000, Windows XP, or Vista, you do not need to restart.

Set the F6000 IP Address

The Set IP Address utility sets or changes the IP address the instrument uses for Ethernet and wireless communications. The current IP address of the instrument, if assigned, appears in the front panel display when the instrument is turned on and the firmware loads.

To set the instrument's IP address:

1. Select **Tools** → **F6000 IP Set**.

The Set F6000 IP Address dialog box appears (Figure B-7).

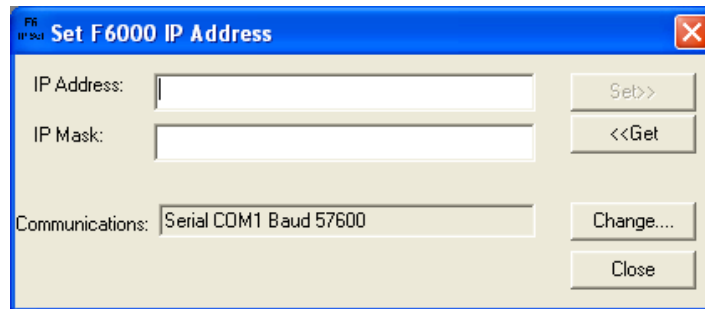


Figure B-7 Set F6000 IP Address Dialog Box

2. Click **Get**.

- If you are using a serial connection (the default), the utility obtains the IP address of the F6150 via the specified COM port. The IP address and subnet mask appear in the top two fields.
- If you are using an Ethernet connection, the utility attempts to connect to the IP address specified in the Communications field of the Set F6000 IP Address dialog box. If it is successful, the IP address and subnet mask of the F6150 appear in the top two fields.

If the utility is not successful, you will receive an error message.

Make sure you have an Ethernet cable connected between the Ethernet connection on your PC and the Ethernet (Network) connection on the F6150.

3. If necessary, click **Change** to enter new communications parameters. (See “Communications Parameters” on p. A-3 for the procedure.)
4. Click **Set**.
5. To enable the new IP address, power the unit off and then back on.

Appendix C. Global Positioning System

The receiver and antenna available for the F6150 are useful for end-to-end testing, where two instruments must be precisely synchronized to simulate a power system fault accurately. Each instrument synchronizes its internal clock with the 1 pulse per second signal transmitted by satellites in the Global Positioning System (GPS). This setup enables multiple F6150s to synchronize to a common reference signal without the need for networking.

GPS Synchronization

End-to-end testing of a protection scheme requires that two F6150 instruments not connected to the same network be precisely synchronized. These instruments inject the same fault at each end of the line at the same moment. When an actual fault occurs, the relay at the near end of the line and the relay at the far end both detect the fault simultaneously. The only way to simulate what each relay sees is to apply the fault to each relay at exactly the same time.

End-to-end testing using GPS synchronization permits evaluation of a complete protection scheme. The test evaluates the performance of the system's protective relays and its communication equipment. [Figure C-1](#) gives an overview of the components required to conduct an end-to-end test using GPS synchronization.

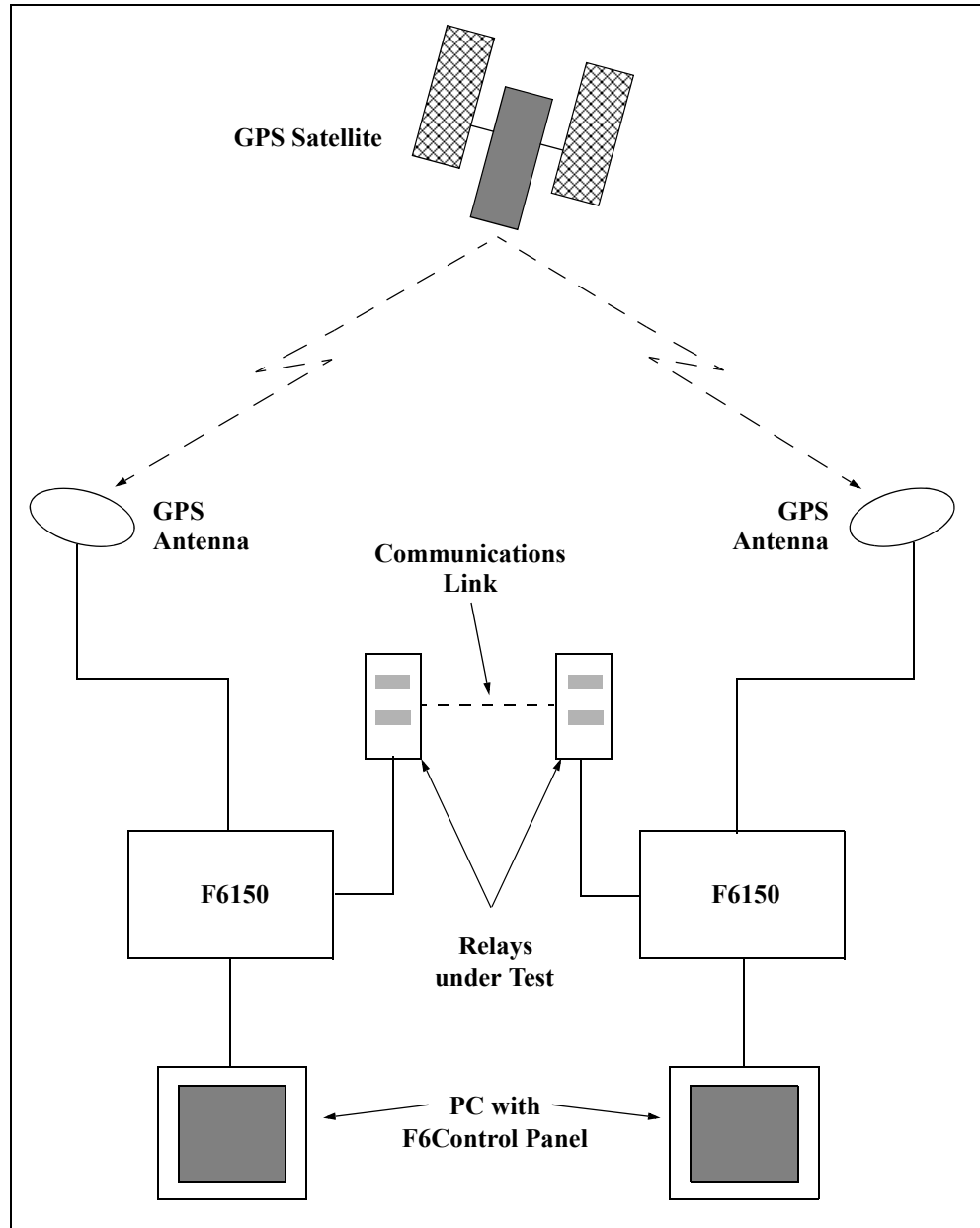


Figure C-1 End-to-End Testing with GPS Synchronization

Setting Up Your GPS Equipment

GPS synchronization requires a GPS satellite receiver (option F6885) and a GPS antenna (option F6895). When the antenna is connected to the GPS port on the instrument's front panel, it sends the satellite's timing signal to the F6150.

The GPS antenna comes with the following components:

- 100-foot cable
- Connector for the F6150 (15-pin)
- Connector for the F2000 (9-pin)
- 12 VDC power supply, with power cord and connecting line

Set up GPS synchronization as follows:

1. Connect the 15-pin adapter cable for the F6150 to the GPS port on the instrument's front panel.
2. Connect the 100-foot cable to the adapter cable.
3. Place the 8-inch-diameter GPS antenna outside in an open area. The antenna should be 2–3 meters from walls or other obstructions to get 360° coverage.
4. Connect the 100-foot cable to the antenna.
5. Connect the 12 VDC power supply to the adapter cable.
6. Plug the power supply into a 115 VAC or 230 VAC outlet.
7. Turn the F6150 on.

When the power supply is plugged in and the GPS antenna is properly positioned, the antenna receives signals from the satellite. The antenna transmits a pulse-per-second signal to the instrument, along with a serial communication stream to identify the time of day. [Figure C-2](#) shows the equipment required for the test.

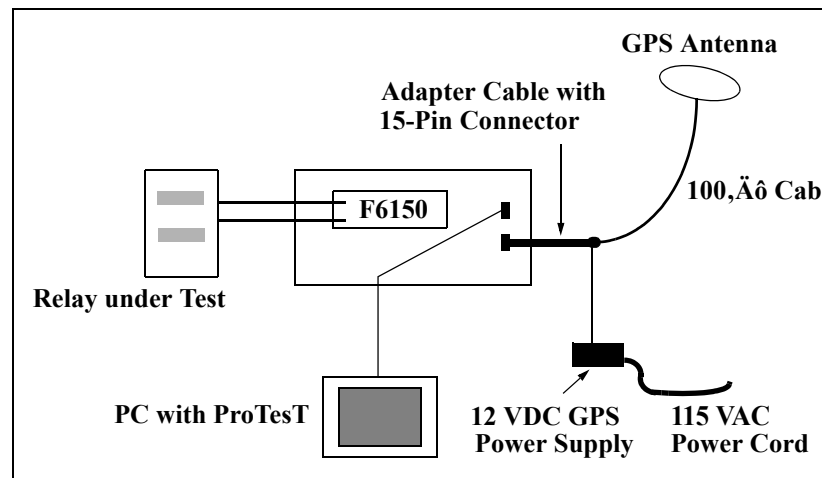


Figure C-2 Equipment Setup for GPS Synchronization

The normal sequence of messages in the VFD confirms a successful bootup. At the end of the sequence, the message GPS 0 Sats indicates that the GPS receiver is initializing. Allow several minutes for the initialization process.

When the system is ready, “GPS 6 Sats” appears, followed by the time in Universal Time Coordinates; e.g., “GPS 17:04:26 UTC”. This message indicates that the components are connected correctly and that the instrument is synchronized to the GPS clock.

Conducting the Test

ProTesT includes the control software needed for end-to-end testing with GPS synchronization.

You can obtain files for end-to-end tests in various ways:

- Use SS1 files generated by programs such as CAPE, ASPEN, or ProTesT itself. If using ProTesT, the State Simulation (SSIMUL) macro generates the SS1 file. You can also use the Power System model provided with ProTesT to populate the State Simulation states.
- Use COMTRADE files generated by EMTP or ATP programs. With COMTRADE files, you can use the TRANS ProTesT macro.

To set up the test:

1. With the technician at the other end of the transmission line, define the exact time to conduct the test.
2. Enter the agreed time in the Go At field of the ProTesT window.

Once each second, the F6150 receives the exact time from the GPS receiver. When the reference time is the same as the common Go At time specified for each test instrument, the two instruments apply the specified fault to each relay.

For example, the technicians agree by phone to conduct the test at 17:00:00 UTC. They program each instrument to deliver the same fault to each relay at the same time. Since both instruments key on UTC, their internal clocks are synchronized, and they both inject the fault at precisely 17:00:00 UTC.

You can obtain the UTC via either the antenna/receiver arrangement or the Doble F6050 Universal Time Synchronizer. The advantage of the F6050 is that it does not require access to open sky once it has been synchronized.

Appendix D. Specifications

Sources

Total Sources

The F6150 can provide up to 12 simultaneous user-configurable AC/DC sources, including six convertible sources and six current sources.

Convertible Sources

Each 150 VA convertible source can be used as a voltage source or optionally as a high-power, low-range current source. The F6150 has up to 6 convertible sources.

Source Configurations

Table D-1 Source Configurations for Convertible Sources

Output Power (VA)		Number of Sources
Continuous	Transient for 1.5 Seconds	
75	97.5	6
150	195	3
300	390	1 + 1 (150 VA) or 1 + 2 (75 VA)
450	585	1

Each 150 VA convertible source can be split into two 75 VA sources.

Two 150 VA convertible sources can be combined in parallel into one 300 VA current source.

Three 150 VA convertible sources can be combined in parallel into one 450 VA current source.

Ranges and Resolution

Table D-2 Range and sResolution for Convertible Sources

	Source (VA)			
	75	150	300	450
AC Voltage	75, 150 V RMS (0.01 V)	75, 150 V RMS (0.01 V)		

Table D-2 Range and sResolution for Convertible Sources (Continued)

DC Voltage	106, 212 V DC (0.01 V)	106, 212 V (0.01 V), 300 V DC (0.1 V)		
AC Current				
Transient for 1.5 Seconds	0.75, 1.5 A RMS (0.0001 A)	0.75, 1.5, 3.0 A RMS (0.0001 A)	1.5, 3.0, 6.0 A RMS (0.001 A)	2.25, 4.5, 9.0 A RMS (0.001 A)
Continuous	0.5, 1.0 A RMS (0.0001 A)	0.5, 1.0, 2.0 A RMS (0.0001 A)	1.0, 2.0, 4.0 A RMS (0.001 A)	1.5, 3.0, 6.0 A RMS (0.001 A)
DC Current				
Transient for 1.5 Seconds	0.53, 1.06 A DC (0.0001 A)	0.53, 1.06 A (0.0001 A), 2.12 A DC (0.001 A)	1.06 A (0.0001 A), 2.12, 4.24 A DC (0.001 A)	1.59 A (0.0001 A), 3.18, 6.36 A DC (0.001 A)
Continuous	0.354, 0.707 A DC (0.0001 A)	0.354, 0.707 A (0.0001 A), 1.41 A DC (0.001 A)	0.707 A (0.0001 A), 1.41, 2.83 A DC (0.001 A)	1.06, 2.12, 4.24 A DC (0.001 A)

Current Sources

The F6150 has up to 12 current sources available: 6 current sources and 6 high-power, low-range convertible sources.

Source Configurations

Table D-3 Source Configurations for Current Sources

Output Power (VA)		Number of Sources
Continuous	Transient for 1.5 Seconds	
75	112.5	6
150	225	3
300	450	1 + 1 (150 VA) or 1 + 2 (75 VA)
450	675	1

Each 150 VA current source can be split into two 75 VA current sources.

Two 150 VA current sources can be combined in series or in parallel into one 300 VA current source.

Three 150 VA current sources can be combined in parallel into one 450 VA current source.

Ranges and Resolution

Table D-4 Ranges and Resolution for Current Sources

	Source (VA)			
	75	150	300	450
AC Current				
Transient for 1.5 Seconds	15, 30 A RMS (0.001 A)	15, 30 A (0.001 A), 60 A RMS (0.01 A)	15, 30 A (0.001 A), 60, 120 A RMS (0.01 A)	15, 30 A (0.001 A), 45, 90, 180 A RMS (0.01 A)
Continuous	7.5, 15 A RMS (0.001 A)	7.5, 15 A (0.001 A), 30 A RMS (0.01 A)	7.5, 15 A (0.001 A), 30, 60 A RMS (0.01 A)	7.5, 15, 22.5 (0.001 A), 45, 90 A RMS (0.01 A)
DC Current				
Transient for 1.5 Seconds	10, 20 A DC (0.01 A)	10, 20, 40 A DC (0.01 A)	10 A (0.001 A), 20, 40, 80 A DC (0.01 A)	10 A (0.001 A), 20, 30, 60, 120 A DC (0.01 A)
Continuous	5 A (0.001 A), 10 A DC (0.01 A)	5 A (0.001 A), 10, 20 A DC (0.01 A)	5 A (0.001 A), 10, 20, 40 A DC (0.01 A)	5 A (0.001 A), 10, 15, 30, 60 A DC (0.01 A)

General

Table D-5 General Information

Specification	Description
Quality Assurance Management System	Third-party certification to ISO 9001:2000
Calibration	Certification traceable to N.I.S.T. standards
Electrostatic Discharge Immunity	<ul style="list-style-type: none"> IEC 801-2 I.E.C. performance level 1 @ 10 kV: normal performance within specifications IEC 801-2 I.E.C. performance level 2 @ 20 kV: no permanent damage
Surge Withstand Capability	ANSI/IEEE C37.90. The F6000 instrument functions as a source during surge withstand capability tests, when the ANSI/IEEE-specified isolating circuit is interposed between the instrument and the relay under test.

Table D-5 General Information (Continued)

Specification	Description
AC Amplitude Accuracy at 50/60 Hz	<ul style="list-style-type: none"> • Voltage and current sources: From 20° to 30° C: < 0.02% typical, 0.09% guaranteed. Typically 0.02% of reading. • Convertible source in current mode: From 20° to 30° C: < 0.5% guaranteed
Distortion and Noise at 50/60 Hz Output (10 Hz –2 KHz Bandwidth)	Voltage and current sources: Total Harmonic Distortion (THD) < 0.02% typical; <0.1% guaranteed
Phase Angle	Range: 0° to +359.9° (Lead) / 0 to –359.9° (Lag) Accuracy: ±0.25° at 50/60 Hz Resolution: ±0.1° at 50/60 Hz
Frequency	Bandwidth: DC to 3 kHz at full power for transient playback Range: DC, AC from 0.1 Hz to 2 kHz at full power, continuous load Resolution: 0.001 Hz Accuracy: <ul style="list-style-type: none"> • 0.05 ppm: Typical • 1.5 ppm: 20° to 30° C • 10 ppm: 0° to 50° C
Ramp/Set	Ramp: Increments/decrements voltage, current, phase angle, and frequency at user-defined ramp rates. Ensures smooth, linear changes in value.
Metering Functions	DC Meter Inputs <ul style="list-style-type: none"> • Input Range: 0 to ±10V DC or 0 to ±20 mA DC • Accuracy: <0.003% typical, <+0.05% guaranteed AC Sources <ul style="list-style-type: none"> • Accuracy: <0.02% for typical meter loads Logic Inputs as Counters <ul style="list-style-type: none"> • Frequency: 10 kHz • Pulse Width: >175 microseconds

Table D-5 General Information (Continued)

Specification	Description
Logic Inputs	8 total Isolated Inputs <ul style="list-style-type: none"> • Number: 2, configurable as Voltage Sense or Contact Sense • Voltage Sense: Up to 250 V AC or DC • Open Circuit Test Voltage: 12 VDC nominal • Short Circuit Test Current: 20 mA DC nominal • Response Time: 0.1 millisecond max pickup and dropout • Isolation: ± 500 V peak Paired Logic Inputs <ul style="list-style-type: none"> • Number: 3 pairs (6 total), configurable as Voltage Sense or Contact Sense • Voltage Sense: Up to 250 V AC or DC • Open Circuit Test Voltage: 4 Volts DC nominal • Short Circuit Test Current: >50 mA DC nominal • Response Time: 0.1 millisecond max pickup & dropout • Isolation: ± 500 V peak
Logic Outputs	8, configurable as Normally Open (NO) or Normally Closed (NC) switches High-Speed Electronic Switches <ul style="list-style-type: none"> • Number: 4 • Input Voltage: 250 V DC or AC • Switching Current: 0.5 A make or break, maximum • Response Time: 0.1 millisecond maximum pickup and dropout • Isolation: ± 500 V peak Outputs <ul style="list-style-type: none"> • Relays: 4 • Breaking Capacity AC: 2000 VA with V_{max} 250 V, I_{max} 8 A • Breaking Capacity DC: 50W with V_{max} 300 V, I_{max} 8 A • Response Time: <10 millisecond max pickup and dropout • Isolation between Pairs: ± 500 V peak
Variable Output Battery Simulator	Range: Adjustable 6 to 300 VDC Resolution: 0.3 V Power: 90 W, 1.5 A max 50/60 Hz Ripple: $<0.2\%$ of range
Analog Input Measurement (F6820 Option)	Recording: 8 external analog and digital channels Source Recording: 12 internal sources Ranges: 250 mV RMS, 2.5 V RMS, 25 V RMS, 250 mV RMS Accuracy: $\pm 0.06\%$ typical, $\pm 0.15\%$ maximum Bandwidth: DC to 5 kHz Input Impedance: 150k ohms Max. Input Voltage: 250 V RMS/DC Isolation: ± 500 V peak channel-to-channel

Table D-5 General Information (Continued)

Specification	Description
Timers and Triggers	Timers <ul style="list-style-type: none"> • Number: 8 • Max. Recording Time: <24 Hours • Accuracy: $\pm 0.0005\%$ of reading, ± 50 microseconds • Resolution: 100 microseconds • Time can be displayed as milliseconds, seconds, or cycles. Triggers <ul style="list-style-type: none"> • Number: 8 • Boolean combination of logic inputs can be used to define triggers
Interfaces	USB or Ethernet remote control to computer
Diagnostics and Error Checking	Hardware performs self-diagnostics at each startup. Automatic supervision and error checking on voltage and current source outputs during testing.
Input Power Supply	105 to 264 VAC at 47 to 63 Hz, 15A maximum
Electromagnetic Compatibility (EMC)	CE conform (89/336/EEC) and EN 61326-1
Emission	FCC 47 CFR Part 15 Class A and EN 61326
Safety	EN61010-1, EN61010-2, IEC 61010-1
Temperature	Operating temperature: 0° to 50° C (32° to 122° F) Storage temperature: -25° to +70° C (-13° to 158°F)
Humidity	Up to 95% relative humidity, non-condensing
Enclosure	High-impact, molded, flame-retardant ABS. Meets National Safe Transit Association testing specification No. 1A for immunity to severe shock and vibration.
Dimensions	15 x 9.5 x 18 in. / 38 x 24 x 46 cm
Weight	38.3 lb / 17.4 kg (with front cover and carrying strap)

Specifications are subject to change without notice.

Appendix E. Defining Triggers

If a start condition or a stop condition requires an input signal from the relay under test or from any other source, specify the input via the Triggers display (Figure E-1). To access the Triggers dialog box, go to the Logic Settings dialog box in F6 Control Panel or ProTest, or other application, and click the **Timers** tab. From the Timers tab, click **Define Triggers**. A dialog box similar to the following should appear.

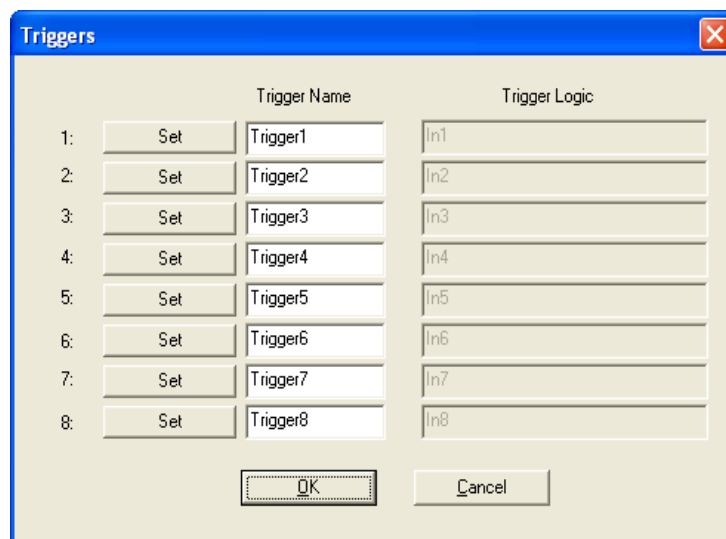


Figure E-1 F6 Control Panel Define Triggers Dialog Box

Click the **Set** button for Trigger 1 in the Triggers dialog box to open the Set Trigger Logic dialog box (Figure E-2).

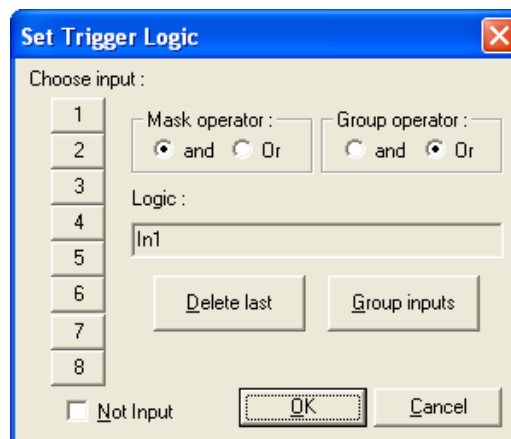


Figure E-2 Set Trigger Logic Dialog Box

Use this dialog box to select the inputs needed to make the trigger true. For example, click **1** under Choose input: to put In1 * In1 in the Logic field.

You can use Boolean operators with the inputs to configure multiple inputs as a trigger logic setting. Valid Boolean operators are And (*), Or (+), and Not (~). To put more than one input in the Logic field, select And or Or under Mask Operator to connect them logically.

- Connecting the logic inputs with the And operator requires that all the inputs be true to assert the trigger.
- Connecting the logic inputs with the Or operator requires that any of the inputs be true to assert the trigger.

Click the **Not Input** check box to place a tilde (~) before a logic input. In this case, the trigger is asserted when the logic input is not true.

In the **Set Trigger Logic** dialog box, select the **And** operator (*) or the **Or** operator (+) under Mask Operator to set the logical relationship for two or more inputs. These three examples illustrate the logic for three distinct triggers:

In1*In2 The trigger is asserted when both Input 1 and Input 2 are true.

In1+In2 The trigger is asserted when either Input 1 or Input 2 is true.

In1*~In2 The trigger is asserted when Input 1 is true and Input 2 is not true.

Click **Group inputs** to place parentheses around a series of inputs in the Logic field. Then, select a group operator to set the logical relationship between the group and another input or group of inputs. For example:

(In1*In2*In3*In4*In5*In6*In7)+In8
The trigger is asserted when Inputs 1 through 7 are true *or* when Input 8 is true.

(In1+In2+In3+In4+In5+In6+In7)*In8
The trigger is asserted when one of the first seven inputs is true *and* Input 8 is true.

Two restrictions govern the formation of logical expressions that use a group operator:

- The mask operator for all of the inputs inside the parentheses must be the same.
- The group operator outside the parentheses must be the opposite of the mask operator inside the parentheses.

Click **Delete last** to delete the last input entered in the Logic field. To clear all the inputs from the Logic field, click **Delete last** until all the inputs are deleted.

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