

# F6 Hardware

## User Guide



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# LEGAL NOTICES

## FCC Notices

*This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:*

- Reorient or relocate the receiving antenna.*
- Increase the separation between the equipment and receiver.*
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- Consult the dealer or an experienced radio/TV technician for help."*

*This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

## **FCC and IC Radiation Exposure Statement**

	<p><b><i>This portable equipment with its antenna complies with FCC's and IC's RF radiation exposure limits set forth for an uncontrolled environment. This equipment has shown compliance with FCC's and IC's Specific Absorption Rate (SAR) limits. To maintain compliance follow the instructions below.</i></b></p>
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***This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.***

## **Federal Communication Commission Interference Statement**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**FCC Caution:** Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

## **INDUSTRY CANADA STATEMENTS**

*This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.*

*Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.*

**If detachable antennas are used:**

*This radio transmitter **Doble PN.401-0404** has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.*

*Wiznet antenna Model W5I-BO-07 Doble PN.401-0406*

*Maximum Gain 2.0+/-1(dBi), Impedance 50 Ohms, Antenna Element size 48x8x1mm*

**OEM  
Responsibilities to  
comply with FCC  
and Industry  
Canada Regulations**

The **Doble PN.401-0404** Module has been certified for integration into products only by OEM integrators under the following conditions:

1. The antenna(s) must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times.
2. The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

**IMPORTANT NOTE:** In the event that these conditions can not be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

## End Product Labeling

The *Doble PN.401-0404* Module is labeled with its own FCC ID and IC Certification Number. If the FCC ID and IC Certification Number are not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

**“Contains Transmitter Module FCC ID: QQO4010404**

**“Contains Transmitter Module IC: 3158A-401-0404**

The OEM integrator must only use the approved antenna(s) listed above, which have been certified with this module.

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

**To comply with FCC and Industry Canada RF radiation exposure limits for general population, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.**

### **Commission fédérale des communications (FCC) – Déclaration sur les interférences**

Ce matériel a été testé et déclaré conforme aux limites imposées aux appareils numériques de Classe B par la Section 15 de la réglementation FCC. Ces limites sont destinées à offrir une protection raisonnable contre les interférences et les parasites nuisibles dans une installation résidentielle. Ce matériel génère, utilise et rayonne de l'énergie aux fréquences radioélectriques ; s'il n'est pas installé conformément aux instructions, il peut provoquer des parasites dans les communications radio. Cependant, il n'est pas garanti que des interférences ne se produiront pas dans une installation particulière. Si ce matériel provoque des interférences parasites nuisibles sur des appareils de réception de radio ou de télévision, ce qui se détermine en éteignant puis en rallumant l'appareil, l'utilisateur est invité à corriger le problème en prenant une des mesures suivantes :

- Réorienter ou déplacer l'antenne de réception.
- Augmenter l'espace entre le matériel et le récepteur.

- Brancher le matériel sur une prise d'un circuit différent de celui sur lequel le récepteur est branché
- Consulter le fournisseur ou un technicien radio/TV qualifié.

Cet appareil est conforme à la Section 15 de la réglementation FCC. Son utilisation est soumise aux deux conditions suivantes : (1) L'appareil ne peut pas provoquer d'interférences nuisibles ; (2) l'appareil doit supporter tout type d'interférence parasite, y compris celles qui sont susceptibles de provoquer un dysfonctionnement.

**Mise en garde FCC:** toute modification qui n'est pas expressément homologuée par l'organisme responsable de la conformité peut annuler le droit de l'utilisateur à utiliser le matériel.

### **DÉCLARATIONS INDUSTRIE CANADA**

*Cet appareil est conforme aux normes d'Industrie Canada sur les appareils radio exempts de licence. Son utilisation est soumise aux deux conditions suivantes : (1) L'appareil ne peut pas provoquer d'interférences ; (2) l'appareil doit supporter tout type d'interférence parasite, y compris celles qui sont susceptibles de provoquer un dysfonctionnement de l'appareil.*

*Conformément aux réglementations d'Industrie Canada, cet émetteur radio ne peut pas fonctionner sans antenne d'un type et ayant un gain maximal (ou inférieur) aux caractéristiques homologuées pour l'émetteur par Industrie Canada. Pour réduire les interférences radio potentielles imposées aux autres utilisateurs, le type de l'antenne et son gain doivent être choisis de façon que la puissance isotrope rayonnée équivalente ne soit pas supérieure à ce qui est nécessaire pour des communications suffisantes.*

#### **Si des antennes démontables sont utilisées :**

*L'émetteur radio **Doble PN.401-0404** est homologué par Industrie Canada pour fonctionner avec les types d'antennes indiqués ci-dessous avec le gain maximal et l'impédance autorisés pour chaque type d'antenne. L'utilisation avec cet appareil des types d'antennes ne figurant pas dans cette liste et ayant un gain supérieur au gain maximal indiqué pour ce type, est strictement interdite.*

*Antenne Wiznet – Modèle W5I-BO-07 Doble PN.401-0406*

*Gain maximal 2.0+/-1(dBi), impédance 50 Ohms, taille 48 x 8 x 1 mm*

**Responsabilités des OEM concernant la conformité avec les réglementations FCC et Industrie Canada**

Le module *Doble PN.401-0404* est homologué pour l'intégration dans d'autres produits par des OEM uniquement dans les conditions suivantes :

1. La(les) antenne(s) doivent être installées pour maintenir à tout moment une distance minimale de 20 cm entre le composant rayonnant (antenne) et toute personne.
2. Le module émetteur ne doit pas être placé à proximité ou utilisé avec une autre antenne ou un autre émetteur.

Si les deux conditions ci-dessus sont remplies, aucun autre test de l'émetteur n'est nécessaire. Cependant, l'OEM/intégrateur est toujours responsable des tests finaux de ses produits concernant des exigences de conformité supplémentaires lorsque ce module est installé (exemple : normes sur les émissions d'appareils numériques, de périphériques d'ordinateurs, etc.)

**IMPORTANT** : si s'il n'est pas possible de remplir ces conditions (pour certaines configurations ou installation avec un autre émetteur), les autorisations accordées par la FCC et Industrie Canada ne sont plus valables : l'identifiant FCC et le numéro d'homologation IC ne peuvent pas être utilisés sur le produit final. Dans ces cas, l'OEM/intégrateur est responsable d'une nouvelle évaluation du produit final (y compris l'émetteur) et de l'obtention d'une autorisation FCC et Industrie Canada séparée.

**Étiquetage du produit final**

Le module *Doble PN.401-0404* est étiqueté avec son propre identifiant FCC et son numéro d'homologation Industrie Canada. Si ces références ne sont pas visibles lorsque le module est installé dans un autre appareil, la partie extérieure visible de ce dernier doit également afficher une étiquette faisant référence au module intérieur. Dans ce cas, le produit final doit être étiqueté dans une partie visible et indiquer :

**“Contains Transmitter Module FCC ID: QO4010404**

**“Contains Transmitter Module IC: 3158A-401-0404**

L'OEM/intégrateur doit utiliser uniquement les antennes indiquées ci-dessus et homologuées avec ce module.

L'OEM/intégrateur ne doit pas oublier qu'il ne doit pas fournir d'informations à l'utilisateur final concernant l'installation ou la dépose de ce module HF module ou la modification des paramètres HF dans le manuel d'utilisation du produit final.

**Ce manuel d'utilisation doit faire figurer en évidence les informations suivantes :**

**« Pour la conformité aux limites FCC et Industrie Canada d'exposition aux radiations HF de la population générale, l'antenne utilisée pour cet émetteur doit être installée de façon à maintenir à tout moment une distance minimale de 20 cm entre le composant rayonnant (antenne) et toute personne et ne doit pas être placée à proximité ou utilisée avec une autre antenne ou un autre émetteur. »**

## **Warranty**

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# Preface

## Who Should Read This Guide

This guide is intended for anyone who works with the Doble F series Power System Simulators. It is assumed that the reader is familiar with professional standards and safety practices.

## Notes, Cautions, and Warnings

Note, Caution, and Warning icons denote information of special interest. The icons appear in the column to the left of the text and are reproduced below with explanations of their meanings. Failure to observe a Caution or Warning could cause a dangerous condition.

	<p>The <b>NOTE</b> icon indicates information that can affect the success of a procedure.</p>
	<p>The <b>CAUTION</b> icon indicates information that prevents damage to hardware or data.</p>
	<p>The <b>WARNING</b> icon signifies information that denotes a potential hazardous situation that, if not avoided, can result in death or serious injury.</p>

## Use of Ground Adapter

Your instrument comes with a ground adapter that protects it. The ground adapter is to be used in environments where a neutral ground is suspect or non-existent through the power cord. The ground adapter is included in the cable bag, and is shown in [Figure 1 on page -xii](#).



**Figure 1 Ground Adapter**

To properly use the ground adapter, plug it into the AC power connector on the instrument, then plug the power cord into the adapter, as shown in [Figure 2](#). Connect the ring lug on the connector to a good electrical ground.



**Figure 2**

# 1. Introduction

The F6 hardware series includes the following instruments:

- F6150 (CPU1)
- F6150 (CPU2)
- F6150 (CPU3)
- F6150A
- F6150e (including -D, -SP, and -IRC models)
- F6150sv (including -SGD and -IEC models)
- F6300
- F6300e
- F6350
- F6350e

Note: Use of the term “F6150” in this help file may refer to any of the current F6150 versions; F6150, F6150A, F6150e, or F6150sv.

The following are the current F6150 instruments:

**Table 1**

Instrument	Features			
	CPU	Amplifiers	Front Panel	Additional Features
F6150sv	CPU3 with sampled values	3 Voltage amplifiers 3 Enhanced Current amplifiers	See <a href="#">“Input/Output and Communications”</a> on page 49	New Comm board, IEC 61850 Sampled Values and GOOSE, AIM board support, Wi-Fi
F6150sv-SGD	CPU3 with sampled values	2 Voltage amplifiers 2 Enhanced Current amplifiers		New Comm board, IEC 61850 Sampled Values and GOOSE, AIM board support, Wi-Fi
F6150sv-IEC	CPU3 with sampled values	None		New Comm board, IEC 61850 Sampled Values and GOOSE, AIM board support, Wi-Fi
F6150e	CPU3	3 Voltage amplifiers 3 Enhanced Current amplifiers		Optional Wi-Fi
F6150e-D	CPU3	2 Voltage amplifiers 2 Enhanced Current amplifiers		Optional Wi-Fi
F6150e-SP	CPU3	1 Voltage amplifiers 1 Enhanced Current amplifiers		Optional Wi-Fi
F6150e-IRC	CPU3	None		Optional Wi-Fi
F6150	CPU1	3 Voltage amplifiers 3 Current amplifiers		NO modular comm board, BNC/Ethernet
	CPU2	3 Voltage amplifiers 3 Current amplifiers		RJ-45, Ethernet, AIM board support
	CPU3	3 Voltage amplifiers 3 Current amplifiers		RJ-45, Ethernet, AIM board support
F6150A	CPU2	2 Voltage amplifiers 2 Current amplifiers	Modular comm, 3 Ethernet, AIM board support	

The F6150 is a power system simulator for testing protection devices used in industrial and power systems. It enables you to test any type of protection. The current amplifier has power to test high-burden electro-mechanical 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, as well as complex protection schemes, such as communication-assisted line protection, and protection schemes that use IEC61850-compliant IEDs (intelligent electronic devices).

The F6150sv adds sampled values, Wi-Fi, and enhanced current amplifiers to the F6150 platform.

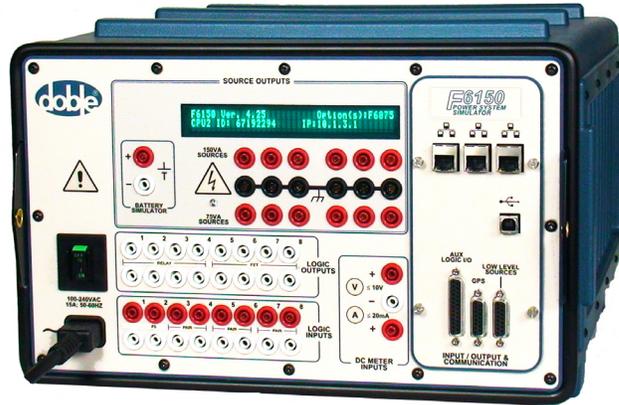


**NOTE: The F6150 has three current amplifiers and three voltage/current convertible amplifiers.**

The following are the current F6300 series devices:

Features	F6300	F6300e	F6350	F6350e
CPU	CPU1 or CPU2	CPU3	CPU2	CPU3
Analog I/O	04s-0771-01	04x-1035-02	04s-0825-01	04x-1035-02
Amplifiers	6 Current amplifiers	6 enhanced current amplifiers	3 voltage amplifiers 3 current amplifiers	3 voltage amplifiers 3 enhanced current amplifiers
Number of Sources	6 sources available	12 sources available	12 sources available	12 sources available
Front Panel	See <a href="#">“Input/Output and Communications” on page 49</a>			
Additional Features		battery simulator	battery simulator	battery simulator

# F6150



**Figure 3 F6150**

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, F6300, or F6350 yields higher output for testing high-burden relays or protection schemes.

## F6150e

The F6150e models include the F6150e, F6150e-D, F6150e-IRC, and the F6150e-SP.



**Figure 4 F6150e**

## F6150e

The F6150e model features:

- 12 sources at maximum power output.
- optional enhanced ratings
- optional Wi-Fi communications

## F-6150e-D

The F6150e-D is the “distribution” model, which features a total of 8 sources for compliance testing needs.

## F6150e-IRC

The F6150e-IRC is the IntelliRupter<sup>®</sup> Pulse Recloser Model. Designed with low level source outputs to test S&C Electric’s IntelliRupter pulse recloser, it can be used to provide low level sources for any device. The F6150e-IRC controls the F5850 interface using Doble protection software. There are no amplifiers in the F6150e-IRC.

## F6150e-SP

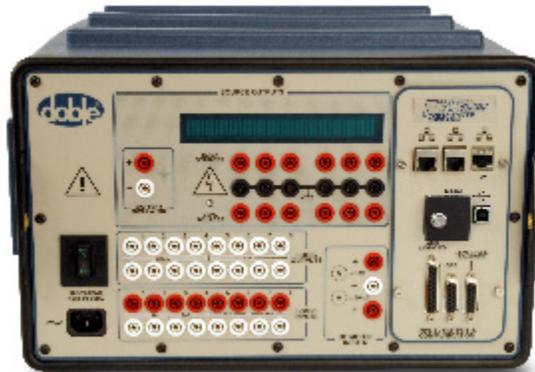
The F6150e-SP has 1 voltage amplifier and 1 current amplifier, and is for testing single phase relays.

## F6150sv

The F6150sv models include the F6150sv, F6150sv-SGD, and the F6150sv-IEC.

The F6150sv is designed to test IEC 61850-based protection devices and schemes. It can test IEC 61850-based systems at the process level and station level, using until 3 streams of IEC 61850 9-2LE sampled values through one fiber optic port and one copper port and Simulation and subscription of IEC 61850 GOOSE messages involving multiple IEDs.

Optional capabilities include IEC 61850, a Sampled Value board and GSE capability.



**Figure 5 F6150sv**

### F6150sv-SGD

The F6150sv-SGD is used for testing digital 3-phase systems, and single-phase and low burden 3-phase relays. It provides a maximum of eight high-level analog sources or a maximum of 12 low-level analog sources.

### F6150sv-IEC

The F6150sv-IEC is used for testing the S&C Electric IntelliRupter and other devices using low-level sources. It provides a maximum of 12 low-level analog sources or 24 Sampled Value sources for testing IEC 61850 schemes.

## F6300 External Amplifiers

The F6300 external amplifier provides additional current sources where no additional voltage sources are needed.



Figure 6 F6300

## F6300e

The F6300e provides a battery simulator and 12 enhanced current sources where no additional voltage sources are needed.

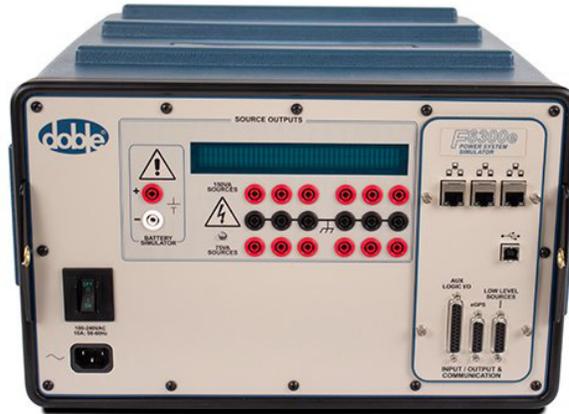


Figure 7 F6300e

## F6350

The F6350 has a different analog I/O card which allows injecting of low-level signals from an external signal generator.



Figure 8 F6350

## F6350e

The F6350e provides a battery simulator, 6 voltage amplifiers and 6 enhanced current amplifiers.



**Figure 9 F6350e**

## Conversions

### F6150 to F6350

It is possible to convert an F6150 to an F6350. It requires:

- Replacement of an I/O card
- Installation of new firmware

You can convert the F6350 back to an F6150 by replacing the original I/O card and installing new firmware. Conversion of an original F6350 to an F6150 is more complex, and not recommended as a field procedure.

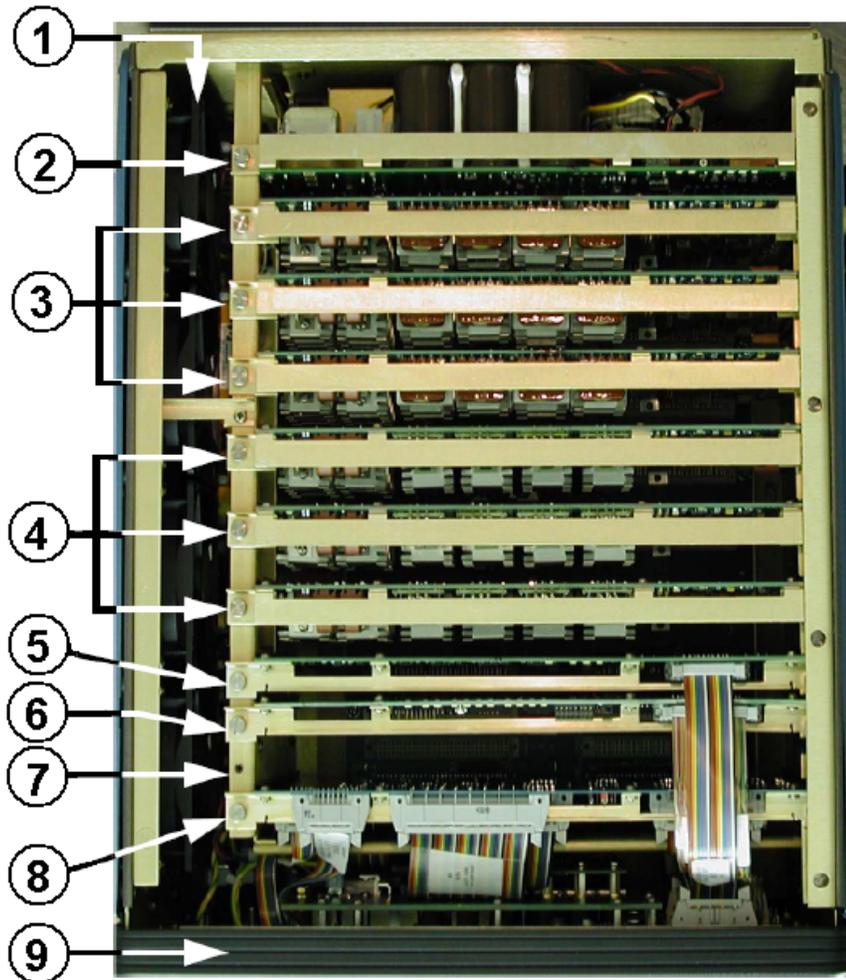
### F6150sv/F6150e to F6350e

It is also possible to convert an F6150sv or F6150e to an F6350e.

With the old Analog I/O board, conversion involved several steps. (For more information on this conversion, see [Chapter 16, “Conversion - F6150sv to F6350e.”](#)) With the new Analog I/O board (04s-1035-02, option code F6351) and FW 5.5.x and higher, conversion is easier, with a web browser setting option.

## Hardware Architecture: F6150, F6150sv, F6150e, and F6350

The components of the F6150 and F6350 include:



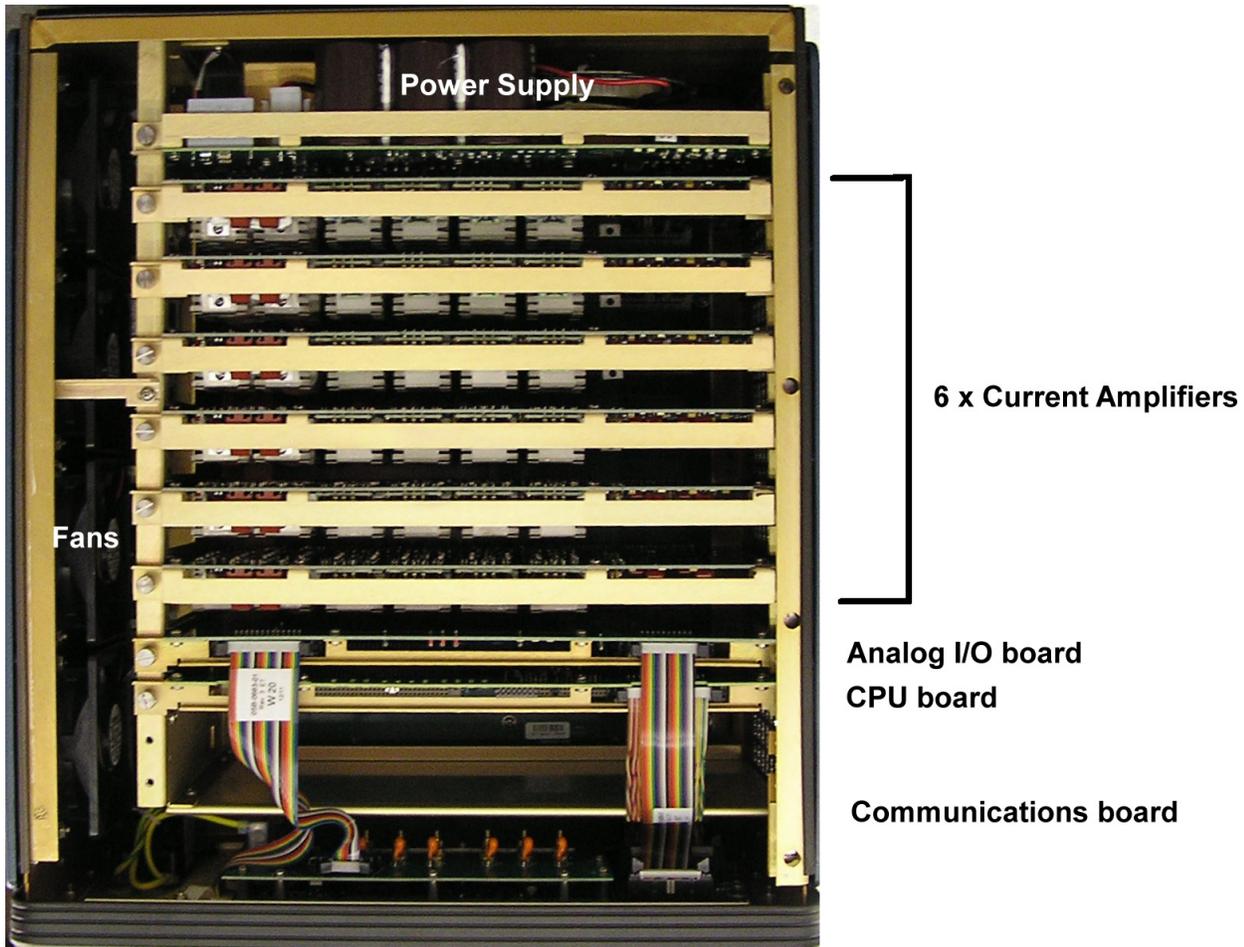
**Figure 10 F6150, F6150e, F6150sv and F6350 Components**

There are 11 slots:

<b>Number (Figure 10)</b>	<b>Slot</b>	<b>Board</b>
2	11	Power Supply with Battery Simulator
3	10	Voltage Amplifier 3
	9	Voltage Amplifier 2
	8	Voltage Amplifier 1
4	7	Current Amplifier 3
	6	Current Amplifier 2
	5	Current Amplifier 1
5	4	Analog I/O
6	3	CPU (SV board, sv model only)
7	2	Analog Input Measurement (optional)
8	1	Logic I/O
9	-	Front Panel

## Hardware Architecture, F6300

The components of the F6300 include:



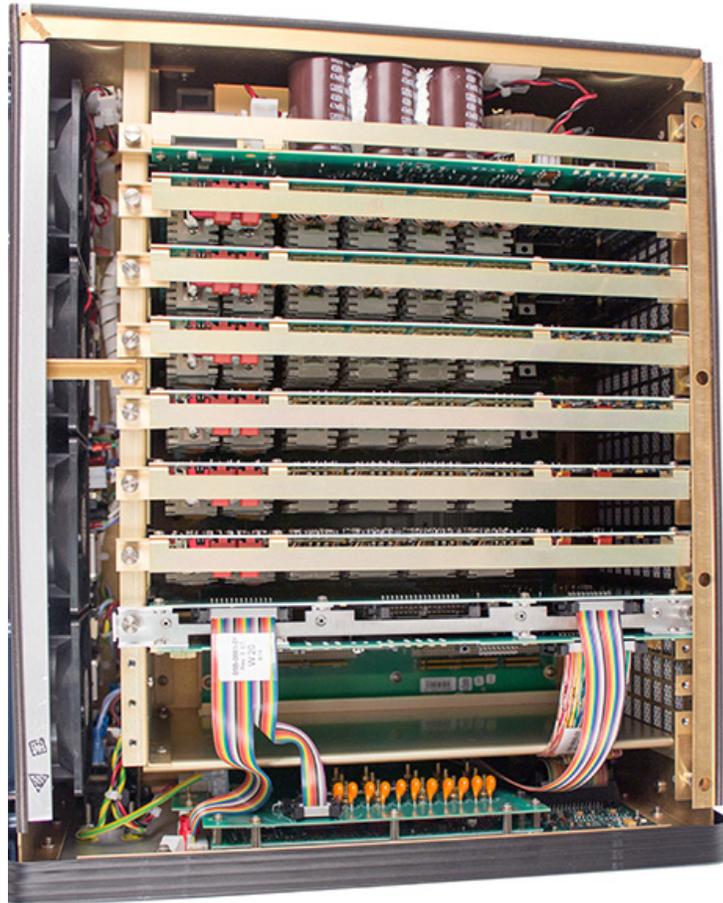
**Figure 11 F6300 Components**

There are 11 slots:

<b>Slot</b>	<b>Board</b>
11	Power Supply
10	Current Amplifier 6
9	Current Amplifier 5
8	Current Amplifier 4
7	Current Amplifier 3
6	Current Amplifier 2
5	Current Amplifier 1
4	Analog I/O
3	CPU
2	Analog Input Measurement (optional)
1	

## Hardware Architecture, F6300e

The components of the F6300e include:



**Figure 12 F6300e Components**

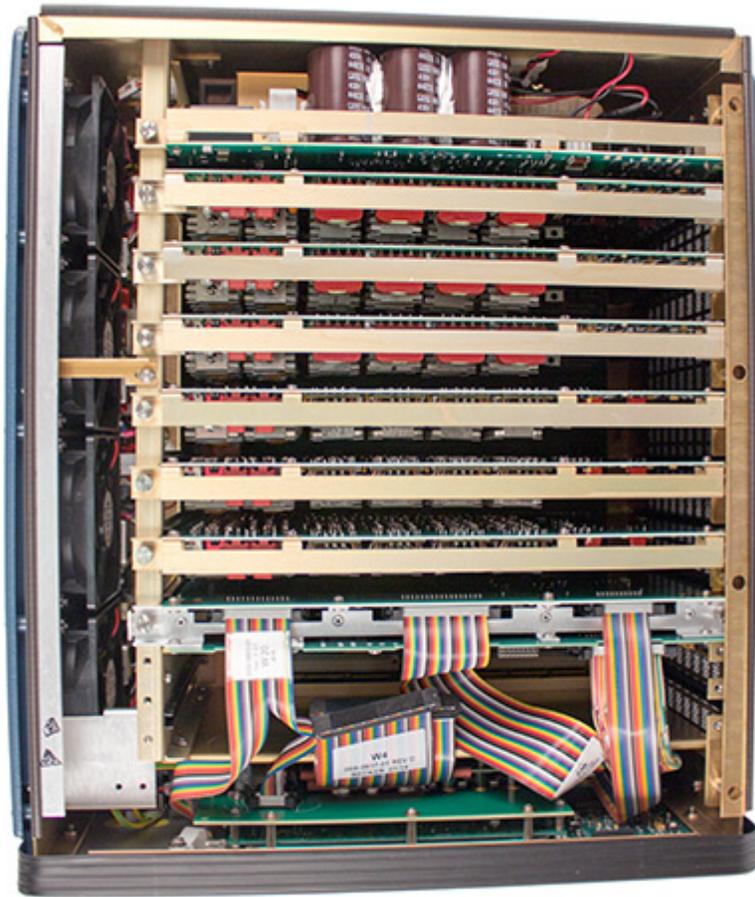
There are 11 slots:

Slot	Board
11	Power Supply with Battery Simulator
10	Current Amplifier Board
9	Current Amplifier Board
8	Current Amplifier Board
7	Current Amplifier Board

<b>Slot</b>	<b>Board</b>
6	Current Amplifier Board
5	Current Amplifier Board
4	Analog I/O
3	CPU
2	
1	

## Hardware Architecture, F6350e

The components of the F6350e include:



**Figure 13 F6350e Components**

There are 11 slots:

Slot	Board
11	Power Supply with Battery Simulator
10	Convertible Voltage/Current Amplifier Board
9	Convertible Voltage/Current Amplifier Board
8	Convertible Voltage/Current Amplifier Board

<b>Slot</b>	<b>Board</b>
7	Current Amplifier Board
6	Current Amplifier Board
5	Current Amplifier Board
4	Analog I/O
3	CPU
2	
1	

## F6 Utilities

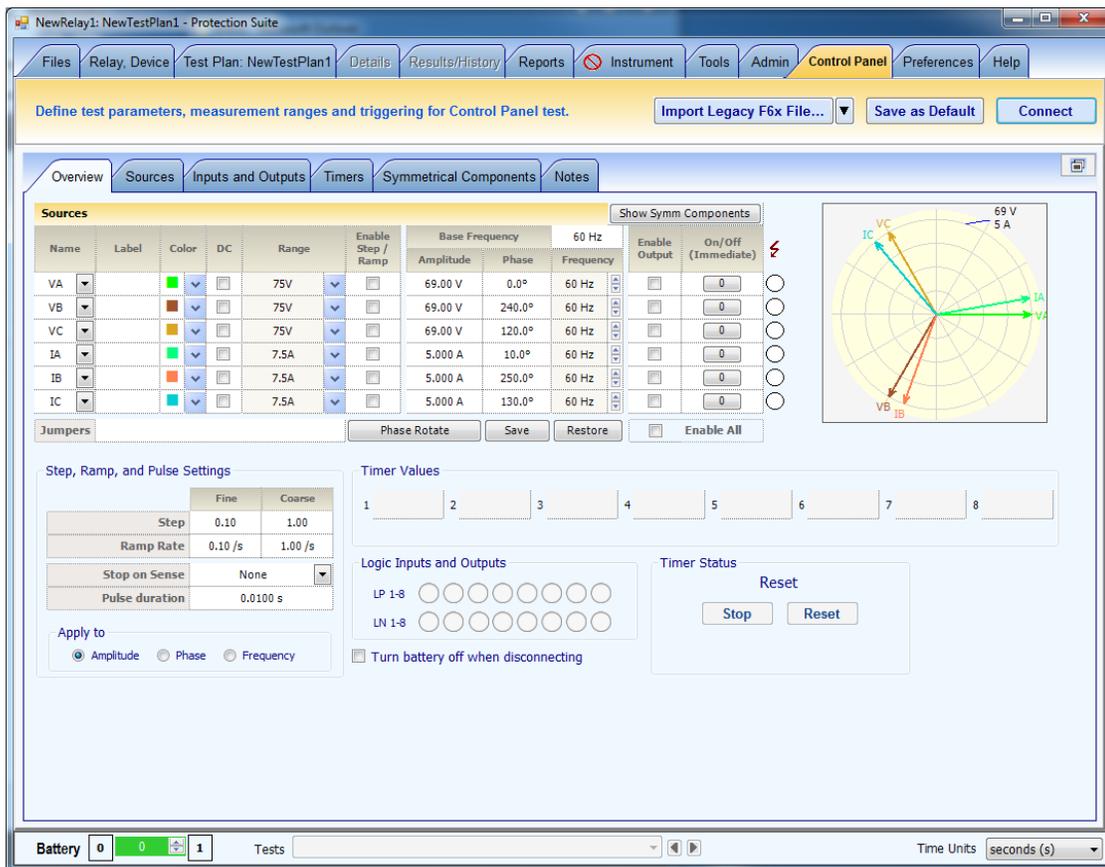
### Control Panels

There are three control panels, any of which you can use for configuring:

- [Protection Suite Control Panel](#)
- [Mobile Control Panel Application](#)
- [F6ControlPanel](#)

### Protection Suite Control Panel

The Protection Suite control panel is embedded in the Protection Suite application:



**Figure 14 Protection Suite Control Panel**

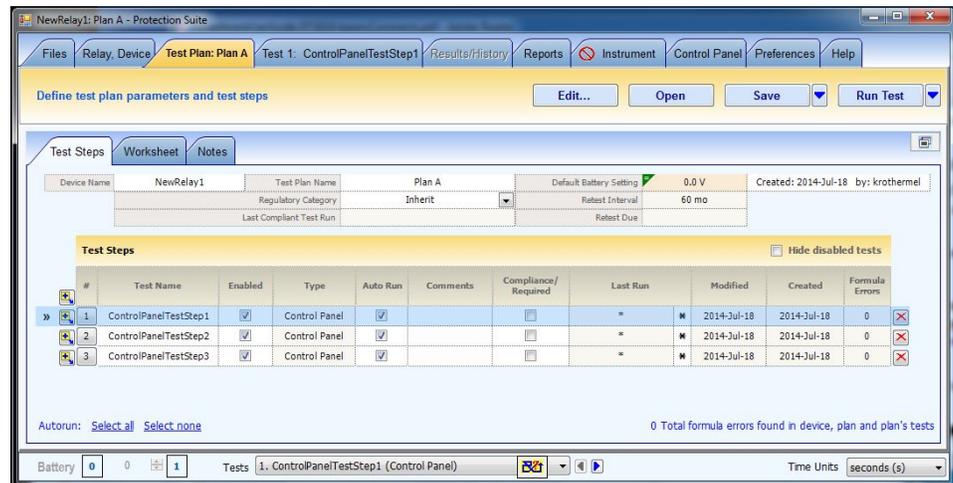


Figure 15 Control Panel Test Steps

To access the control, add it to Test Steps, then go to the tab with the name that you gave the control panel.

## Mobile Control Panel Application

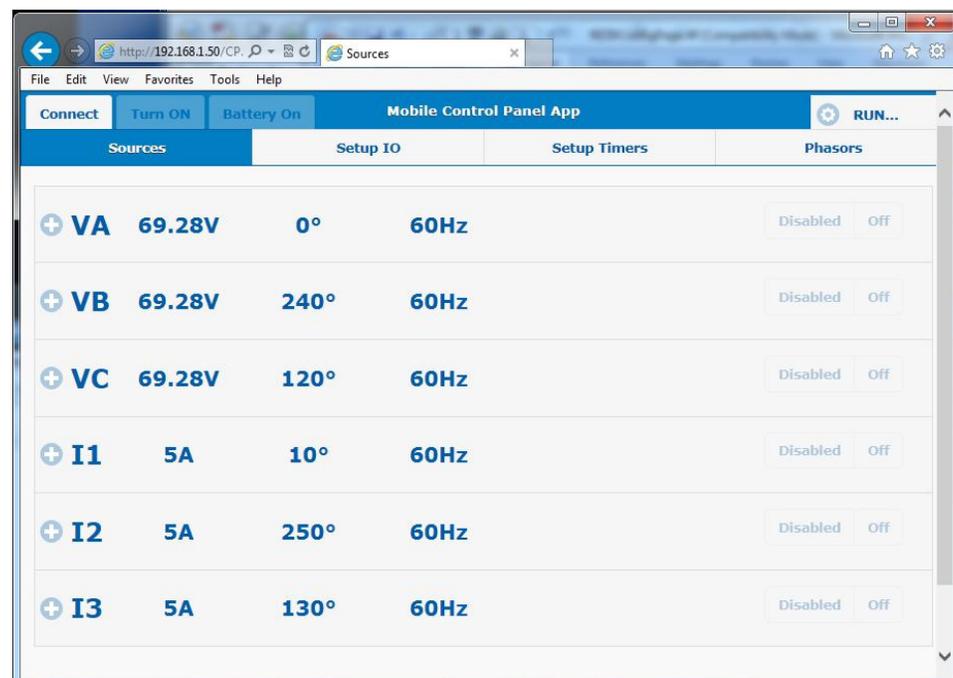
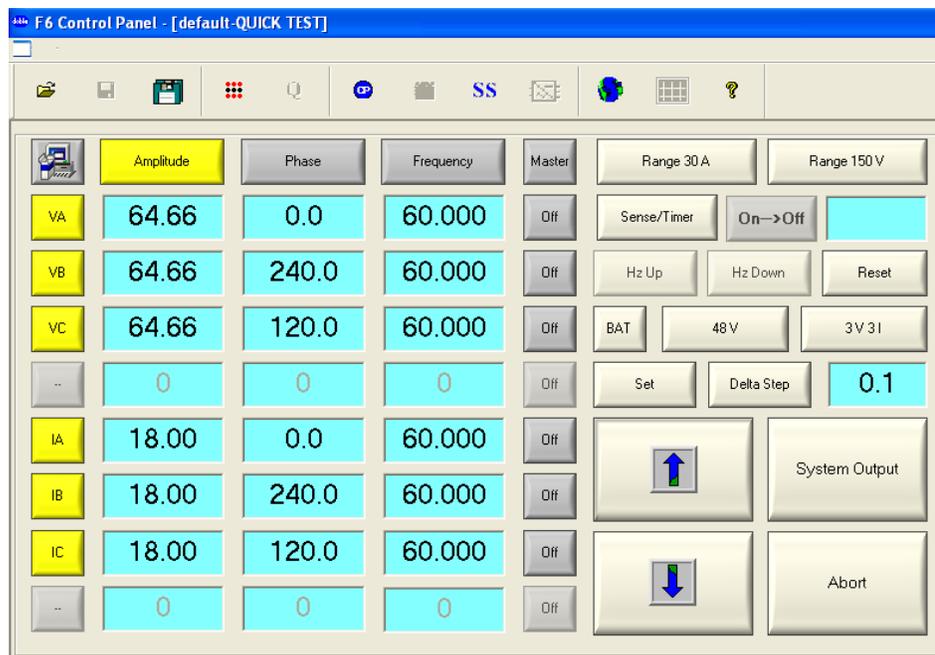


Figure 16

The F6011 Mobile Control Panel Application runs basic, manual protection testing from any device connected to a web browser. Whether you are testing with a PC, tablet or smart phone, Doble’s F6011 option allows you to connect to and control your Doble power system simulator without the need for additional software. See “[Mobile Control Panel Application](#)” on page 229 for more information.

## F6ControlPanel

**(NOT WINDOWS 7 COMPLIANT!)**



**Figure 17 F6ControlPanel**

F6ControlPanel is software for Windows XP PCs and earlier that 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.

F6 Control Panel contains the functions and controls needed to conduct tests with the F6150.

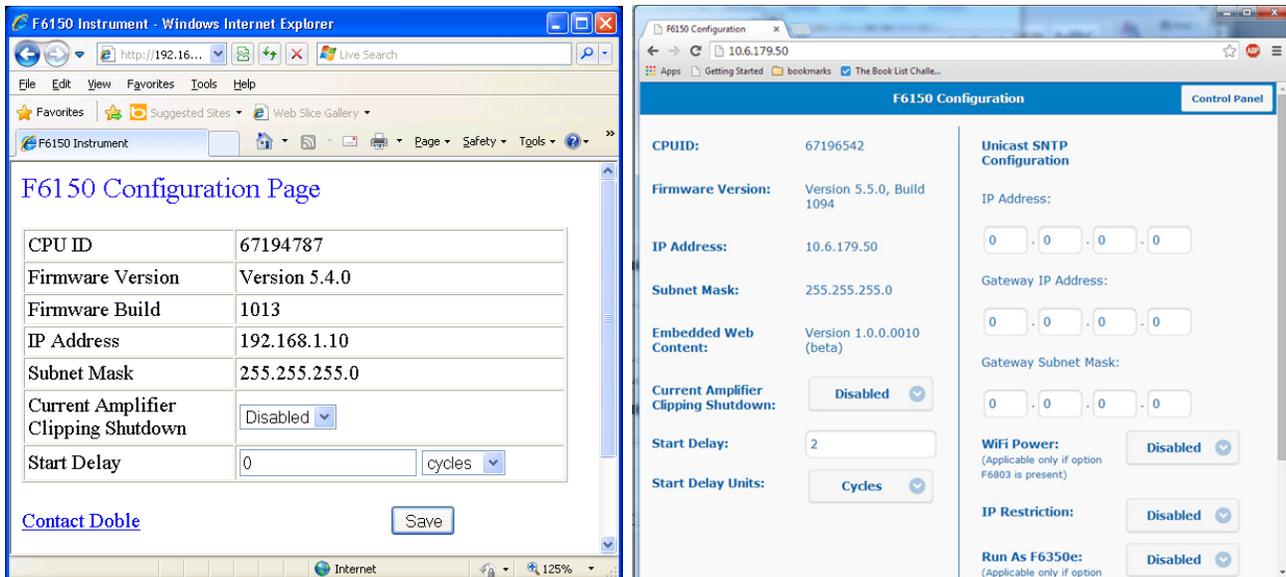


**CAUTION:** If the computer is not connected to an instrument or if the instrument is switched off when F6 Control Panel is opened, an error message appears. Acknowledge the error message, then check the box for Control Panel Simulation or switch the instrument on.

A stand-alone version of F6ControlPanel is shipped with each F6000 instrument. F6 Control Panel is also available from the Tools menu of ProTesT. For complete details on using F6 Control Panel, see the *F6 Control Panel User Guide* (72A-2342-01).

## F6150 Configuration Page

Enter the IP Address of your F6150 in a web browser to access its Configuration Page. The instrument must be powered on and connected via LAN or Wi-Fi. Firmware versions V5.5 / V4.31 and newer have more options in the configuration. Your view of the configuration page may be slightly different from the figures below based on the browser you use.



**Figure 18 Early (FW V. 5.4/4.30 and earlier) and New (FW 5.5/4.31 and newer) Configuration Page**

### **CPU ID**

The unique identifier for the connected instrument

### **Firmware Version**

The currently-installed firmware version for the connected instrument

### **IP Address**

The IP address of the connected instrument

### **Subnet Mask**

Part of the network parameters of the instrument.

### **Embedded Web Content**

Current version of the web page specifications you are viewing.

### **Current Amplifier Clipping Shutdown**

If you have severe amplifier clipping, enter the IP address of the instrument in a web browser to open the F6150 Configuration Page. By default, Current Amplifier Clipping Shutdown is enabled; you may change the setting to disable it for F6150e and F6150sv instruments.

### **Start Delay**

Used to coordinate GPS start times of the instruments in relationship to the designated start time for a test. Default is two cycles.

### **Start Delay Units**

Time units associated with the delay time. Units are milliseconds, cycles, and seconds.

### **Unicast SNTP Configuration**

The F6150 can synchronize time to either GPS or to a SNTP server. If both are present GPS is used as it is a better time reference. If the F6150 is not connected to GPS then it tries to synchronize with a SNTP server.

### **Wi-Fi Power**

The Wi-Fi power button enables or disables the Wi-Fi on *F6150e instruments only*. The Wi-Fi module is always on for all other models.

## IP Restriction

Gives your IP address exclusive access to the instrument. To release, you must reboot the F6 instrument.



**Figure 19 IP Restriction**

## Run As F6350

See [“Conversions” on page 9](#).

## 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 (USB-Driver folder) or downloaded from the Doble website ([www.doble.com/support/download.html](http://www.doble.com/support/download.html)).

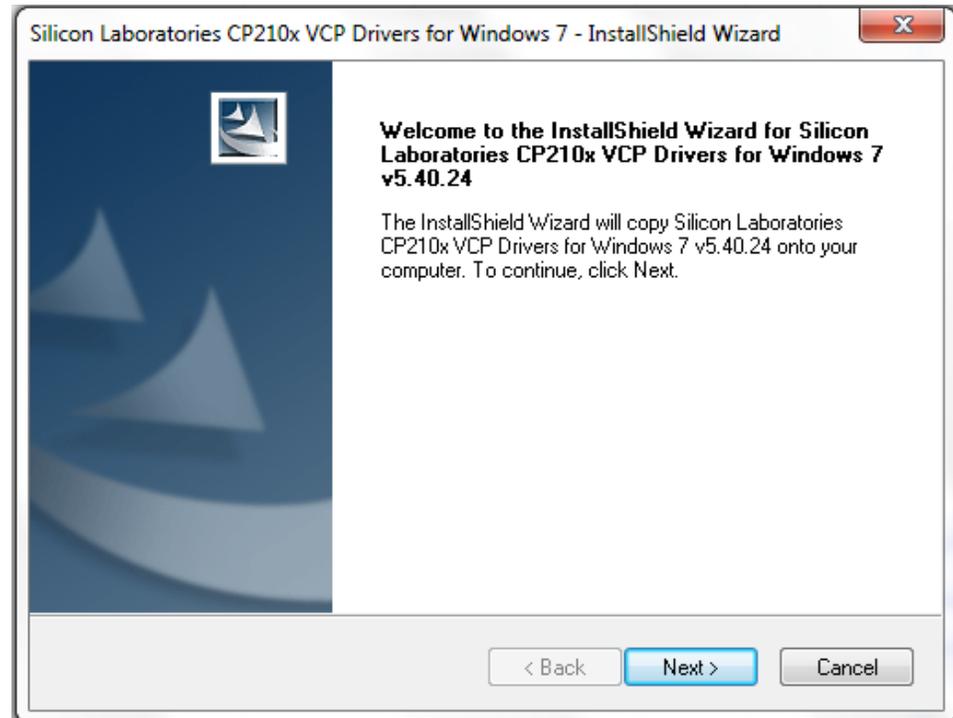
### USB Driver Installation Notice

(This is from the USB driver notice, P/N 72A-3108-01, Rev. B, 03/08.)

#### Install the Driver

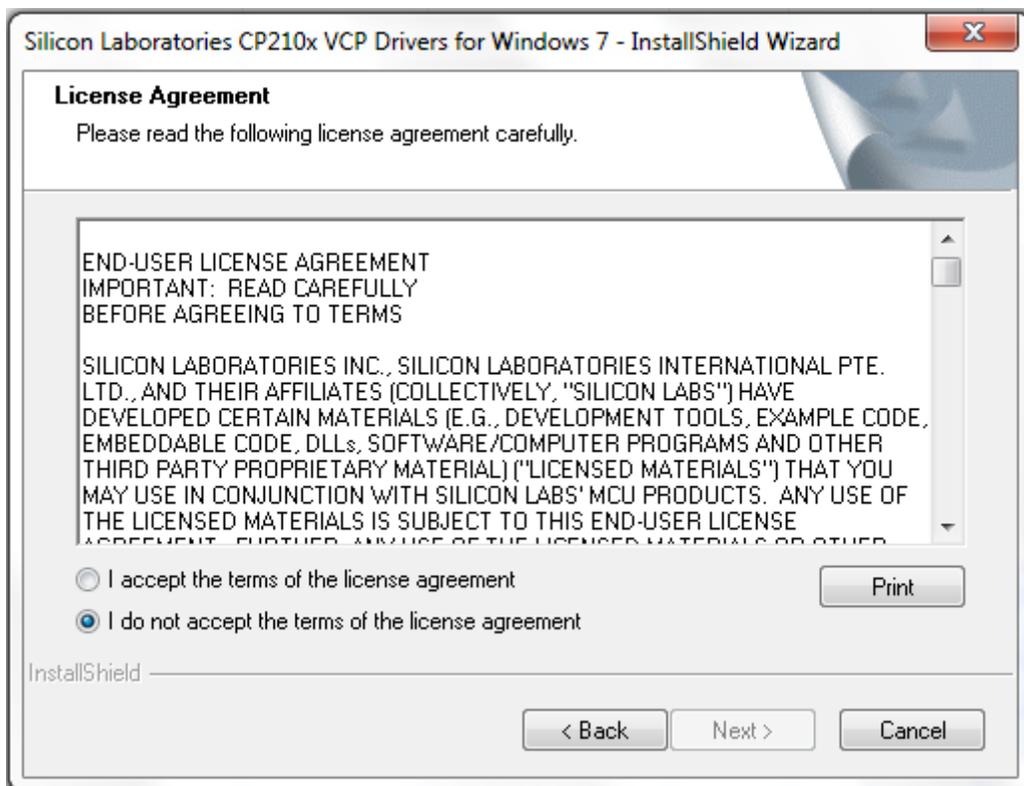
1. Insert the CD in your computer's CD or DVD drive or download the driver from the Doble website.
2. If using the CD:
  - a. Browse to the USB-Driver folder.
  - b. Double-click the folder to open it.

3. Double-click the driver (CP210x\_VCP\_Win7.exe for Windows 7) to install it. A splash screen appears, followed by the driver installation wizard (Figure 20 on page 25).



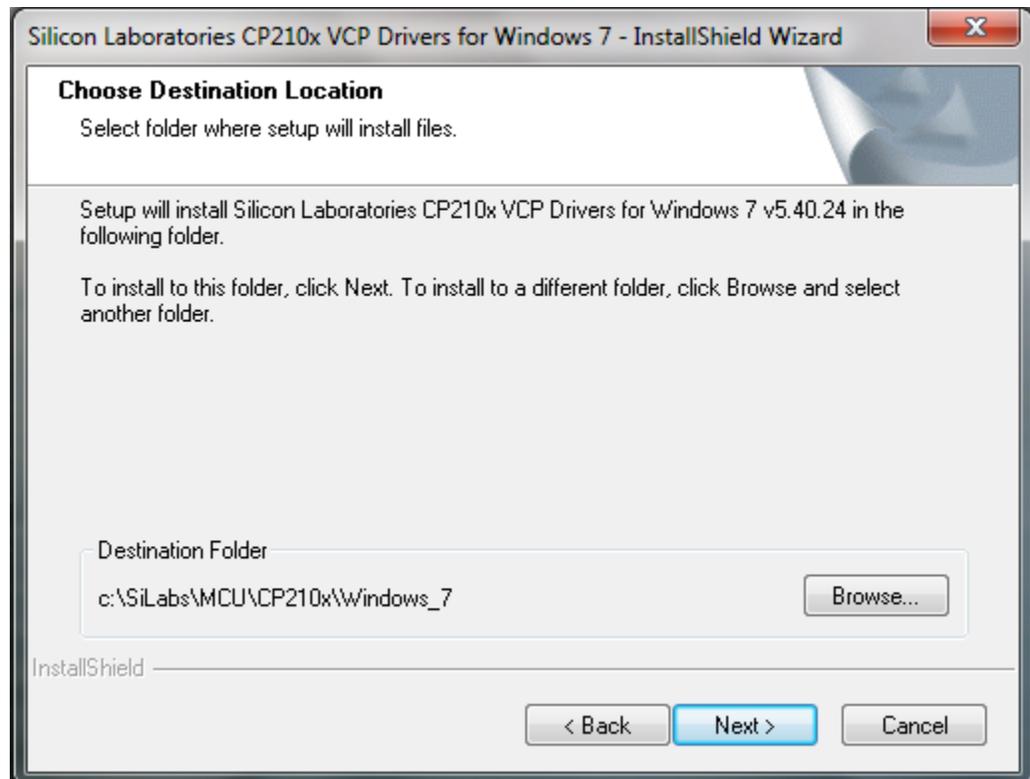
**Figure 20 Installing the Driver**

4. Click **Next>**. The License Agreement appears (Figure 21).



**Figure 21 License Agreement**

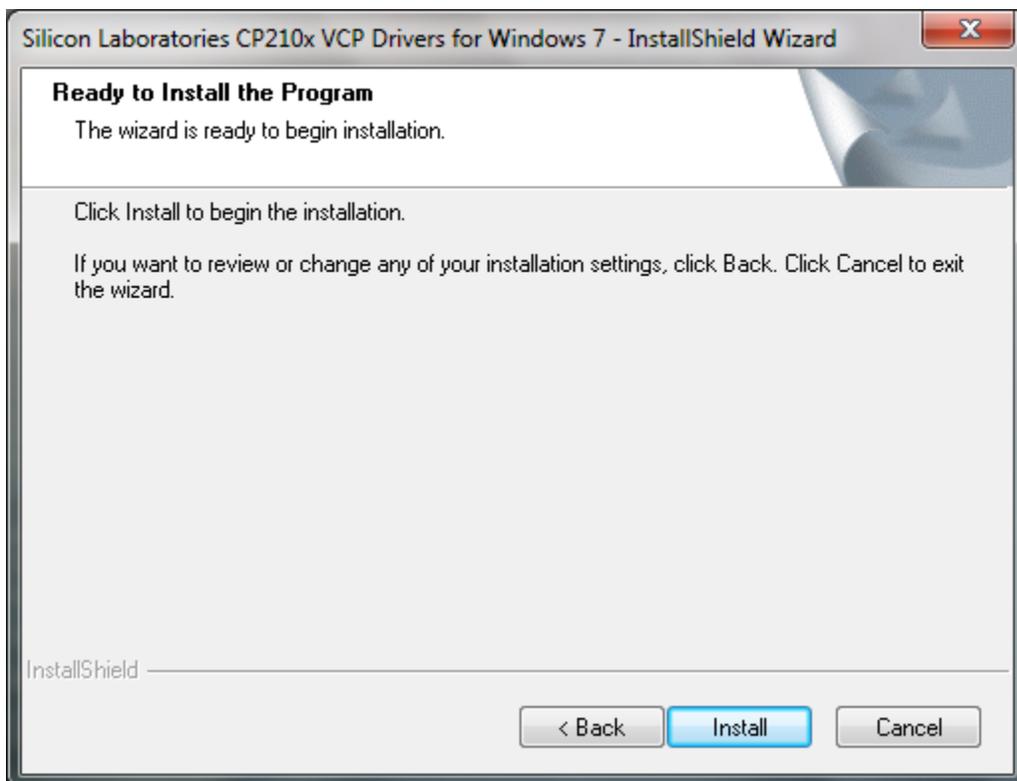
5. Click the **I Accept** option button.
6. Click **Next>**. The Destination dialog box appears (next page).



**Figure 22 Destination Folder**

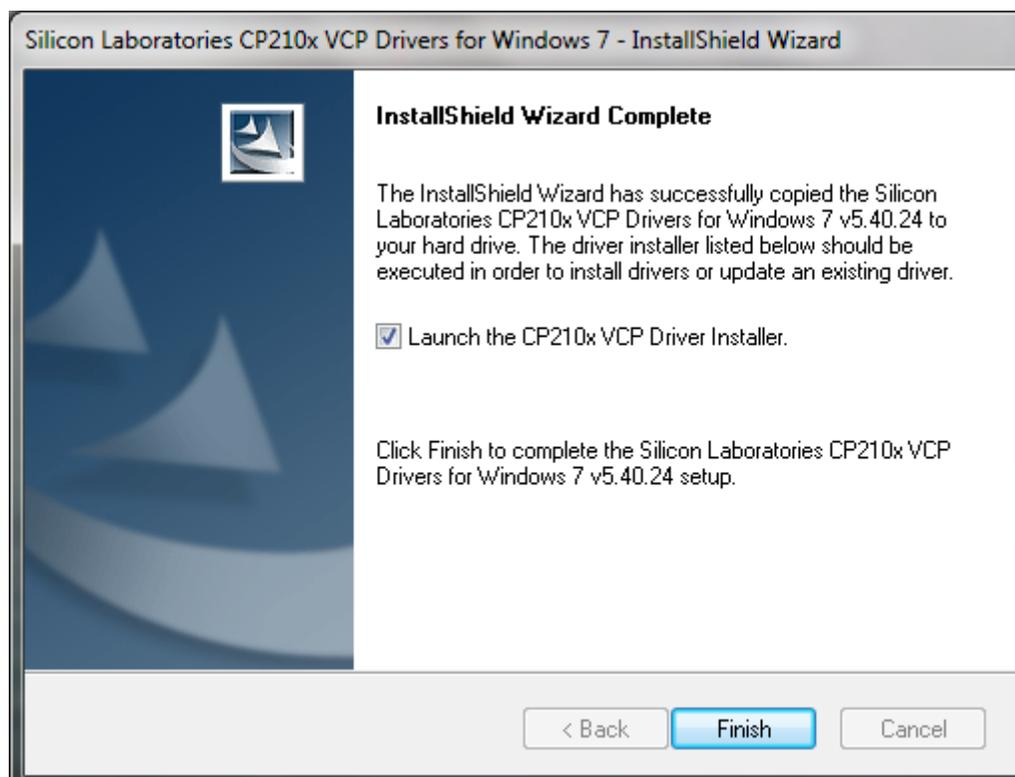
7. To accept the default destination (recommended), click **Next>**. To select a different location, click **Browse...**
8. When you have navigated to the desired location, click **Next>**.

9. The Ready To Install dialog box appears (Figure 23).



**Figure 23 Ready to Install Dialog Box**

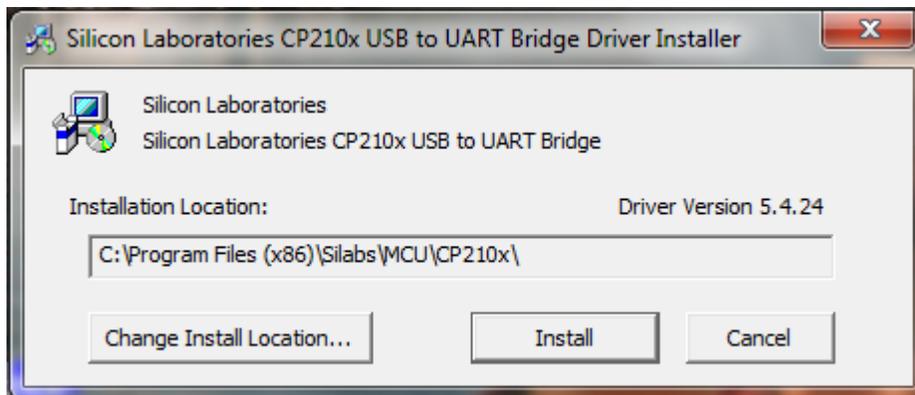
10. Click **Install**. The Setup Status dialog box appears briefly, showing the progress of the installation. Then, a dialog box appears, indicating that the installation is complete (Figure 24).



**Figure 24 Installation Complete Dialog Box**

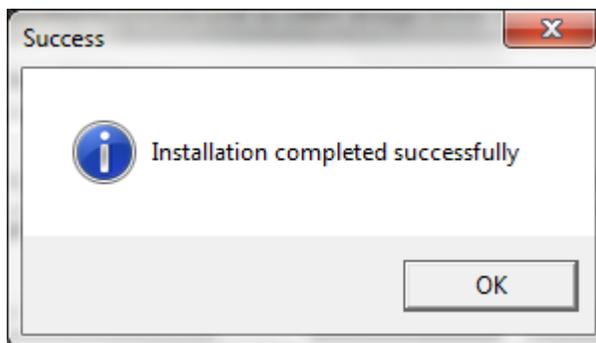
11. Check the **Launch the CP210x VCP Driver Installer** box. If you don't check the box, you can launch the driver installer manually by going to the driver location (default is `C:\SiLabs\MCU\CP210xWindows_2K_XP_S2K3_Vista`) and double-clicking the file (`CP210xVCPInstaller.exe`).

12. Click **Finish**. The Driver Installer dialog box appears (Figure 25).



**Figure 25 Driver Installer Dialog Box**

13. Click **Install**. A dialog box appears indicating a successful installation (Figure 26).



**Figure 26 Successful Installation**

## Select the Driver for Your Instrument

14. Connect the instrument to your computer. A message may appear, saying that the computer has found new hardware (Figure 27). No action is required on your part.



Figure 27 Found New Hardware

## F6150, F6150e, F6150sv Internal Options

Here are some of the internal options available:

Option No.	Name	Description
F6001	1 I Amplifier board	
F6002	2 I Amplifiers boards	
F6003	Support for Low-level analog outputs only w/o amplifiers	
F6005	Enhanced Current Ratings Amplifiers	Enhanced current amplifiers allowing higher ranges. <i>Not in F6150, standard in F6150sv, optional in F6150e.</i>
F6010	1 V Amplifier board	
F6011	Internal Wi-Fi embedded web server	Optional in F6150, F6150e, and F6150sv. Required to use the Mobile Control Panel.
F6020	2 V Amplifiers boards	
F6351	Conversion option	For converting F6150e/sv to F6350e
F6800	Metering & Transducer Interface	Enables the DC meter inputs on the F6150. Includes Meter Measurement Studio software.
F6803	Wi-Fi Wireless network connection	Optional in F6150e, standard in F6150sv, not available for F6150.

Option No.	Name	Description
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.
F6812	12 Analog sources	
F6816	Additional I/O support	
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.
n/a	CPU1	Early, low-speed processor
F6825	High-Speed CPU2/CPU3 (sv)	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.
F6835	CPU3	
F6841	Logic I/O Board	Type 1 (04S-0672-01) <sup>a</sup>
F6842	Logic I/O Board	Type 2 (04S-0742-01) <sup>a</sup>
F6843	Logic I/O 3 board	
F6844	Logic I/O Board	Type 4 (04S-0820-01) <sup>a</sup>
F6845	Logic I/O Board	Type 5 (04S-0837-01) <sup>a</sup>
F6860	IEC 61850 GSE Interface Module & GSSE messaging	Supports inputs from protective relays that support IEC 61850 protocol.
F6865	20 kHz Transient	
F6870	IEC 61850 Sampled Values	Instrument is capable of generating sampled values packets per IEC 61850
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).

Option No.	Name	Description
F6895	GPS Antenna	The antenna/receiver that is connected to the F6150 and receives the GPS signal.
F6909	Control Panel Enable, Front Panel Interface	Permits control panels to communicate with the F6150.
F6910	Simulator Control and Automation Module	Permits the F6150 to communicate with automated software applications like Protection Suite, ProTesT, F6TesT, and F6ControlPanel.
F6920	Auto-synchronizer	

<sup>a</sup> 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. CPU3 (sv) requires Firmware 5.0 or greater.

Notes:

CPU 1 instruments use the Type 1 I/O board.

CPU2 instruments up to serial number with “0105” use the Type 1 I/O board.

Instruments after “0205” serial number use the Type 4 I/O board.

I/O board types 2 and 5 are available by special order only.



## 2. Front Panel

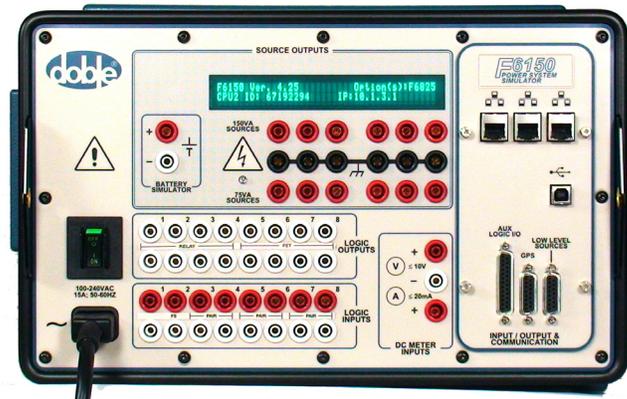
### Introduction

Located on the F6150x front panel are:

- Outputs for up to six 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
- DC meter inputs
- MT-RJ optical fiber port (F6150sv models only)

All test functions are controlled from a computer.

### F6150



**Figure 28 F6150 Front Panel**

## F6150e



Figure 29 F6150e Front Panel

## F6150sv

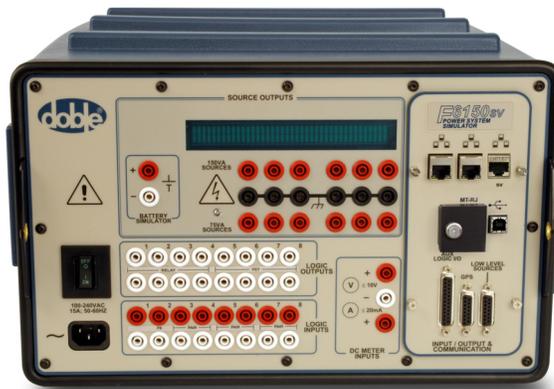


Figure 30 F6150sv Front Panel

## Optical Port

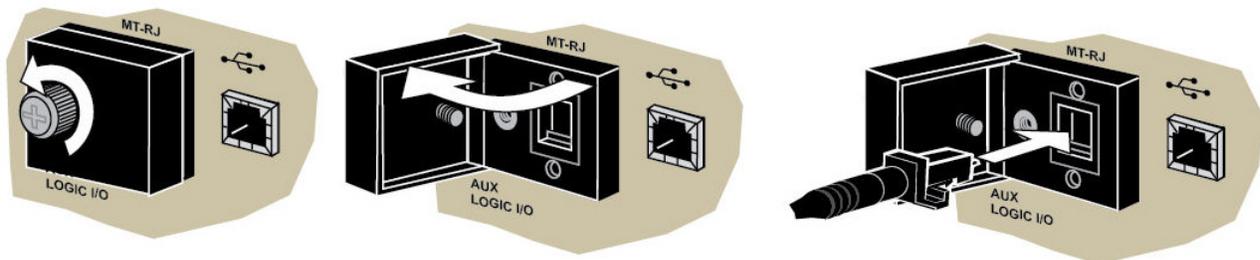
The MT-RJ port is located on the front panel of the F6150sv. It provides a fiber communications link with protective devices on the station Local Area Network (LAN) that prescribes to the new IEC 61850 standard.



**CAUTION!** Use caution when handling the optical fiber cable. The cable must NOT be twisted, bent, or wound into a tight loop. Doing so can break the fibers and require an expensive replacement.

To access the MT-RJ optical port:

1. Turn the thumbscrew counter-clockwise.
2. Open the door.
3. After removing the protective cover from the optical cable plug, carefully insert it into the jack until the plug retainer engages.



**Figure 31 Using Optical Port**

When you are done using the MT-RJ optical port:

1. Press the clip on the top of the plug and carefully remove the plug from the jack.
2. Close the door.

Turn the thumbscrew clockwise to lock the door.

## F6300



**Figure 32 F6300 Front Panel**

The F6300 has a minimal number of connectors, in keeping with its limited role of providing additional current sources.

Located on the F6300 front panel are:

- 6 current sources
- Battery simulator
- Modular communications panel
- On/off switch and AC power connection
- Instrument display

## F6300e

The F6300e has the following:

- 12 enhanced current sources
- Battery simulator
- Modular communications panel
- On/off switch and AC power connection
- Instrument display



**Figure 33 F6300e Front Panel**

## F6350

The F6350 has the same connectors as the F6150 and F6150A, except that it does not have the auxiliary connection, unless it is converted from an F6150.



Figure 34 F6350 Front Panel

## F6350e

The F6350e has enhanced amplifiers to provide more amplitude and power.



Figure 35 F6350e Front Panel

## Source Outputs

The Source Outputs section of the F6150 and F6350 front panels contain 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. The F6300 does not contain any outputs for voltage, but does have the VFD.

### F6150 Sources

The highlighted selection is the default.

- 6 Voltages and 1 450VA Current
- 6 Currents (Current Sources)
- 6 Voltages (V/I Sources)
- 6 Low Range Currents (V/I Sources)
- 2 Voltages and 2 Currents
- 2 Voltages and 1 300 VA Current
- 1 Voltage and 2 Low Range Currents
- (Custom Configuration)**

### F6150A Sources

The highlighted selection is the default.

- 4 Voltages and 4 Currents
- 4 Voltages and 4 Currents (6150A)
- 4 Voltages and 2 150 VA Currents (6150A)
- 4 Voltages and 1 300 VA Currents (6150A)
- 3 Voltages and 3 Currents**
- 3 Voltages and 1 450VA Current
- 3 Voltages and 3 450VA Currents - F6300 Required
- 3 Voltages and 9 150VA Currents - F6300 Required

### F6150 with F6300

- 3 Voltages and 3 450VA Currents - F6300 Required
- 3 Voltages and 9 150VA Currents - F6300 Required

## F6150sv

The sampled values section is located at the bottom of the Voltage and Current Sources window. Note enhanced current amplifiers (“Current Sources”) on the right side of the diagram.

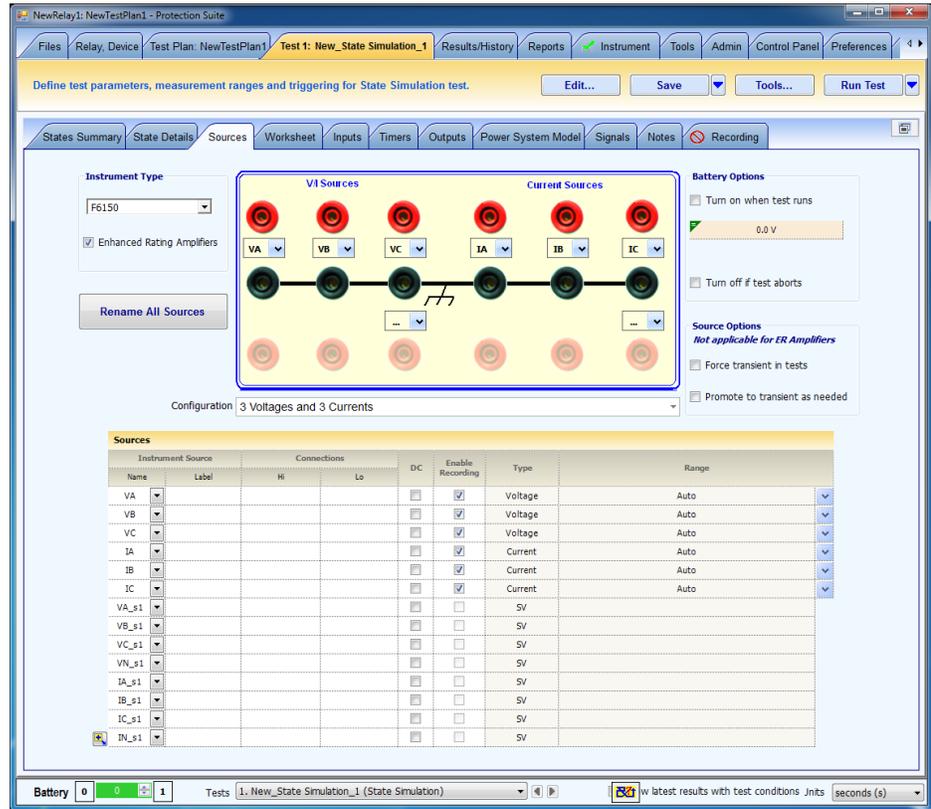
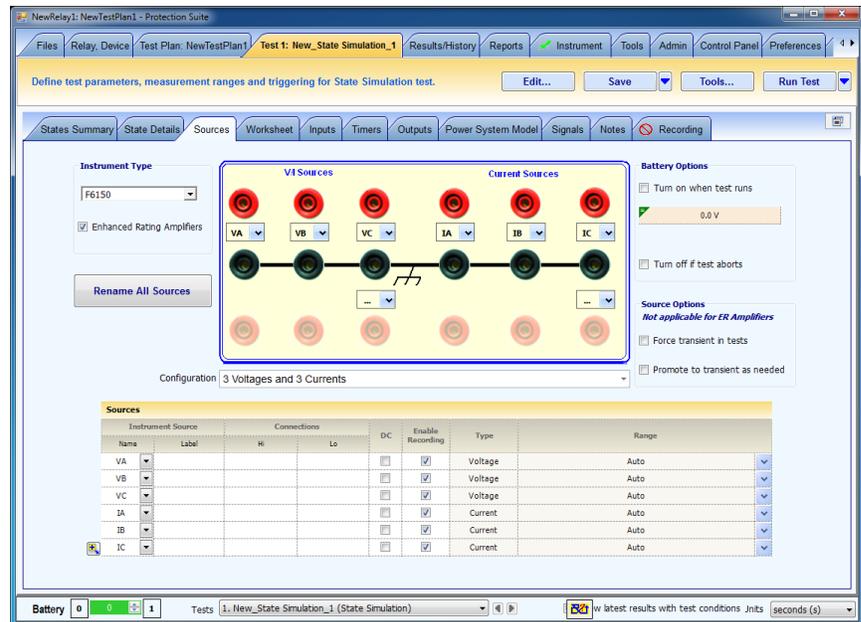


Figure 36 SV with Sampled Values Section

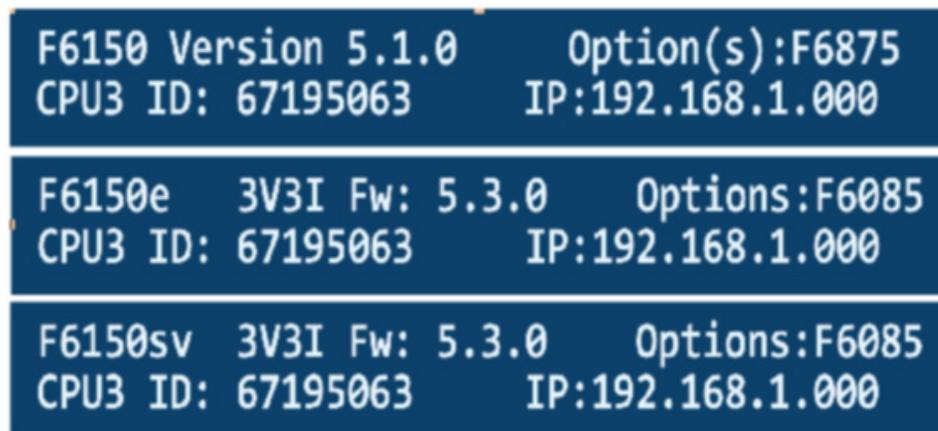
## F6150e



**Figure 37 Enhanced Sources**

## Instrument Display

Starting with Firmware V5.3, the instrument display will identify (in the upper left corner) the model of instrument being used, the firmware version (in the upper center) and a list of the options installed in the instrument (in the upper right corner), as shown in [Figure 38](#).



**Figure 38 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 or F6350)

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.

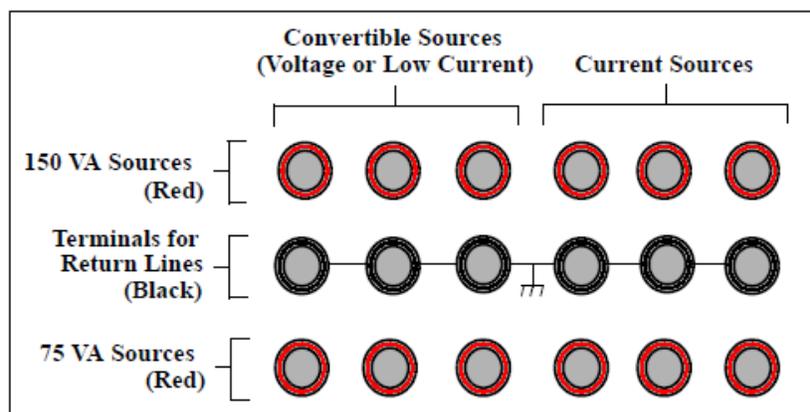
	<b>NOTE:</b> When a source is enabled, the source label uses a lowercase identifier (for example, va, vb, vc, i1, i2, and i3). When a source is on, the label uses an uppercase identifier (for example, VA, VB, VC, I1, I2, and I3).
---	---

## Voltage and Current Sources

The following figure shows the voltage (left bank) and current (right bank) sources on the (F6150/F6150e without F6005 option) 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.



**WARNING!** 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 page 76](#).



**Figure 39 Voltage and Current Sources**

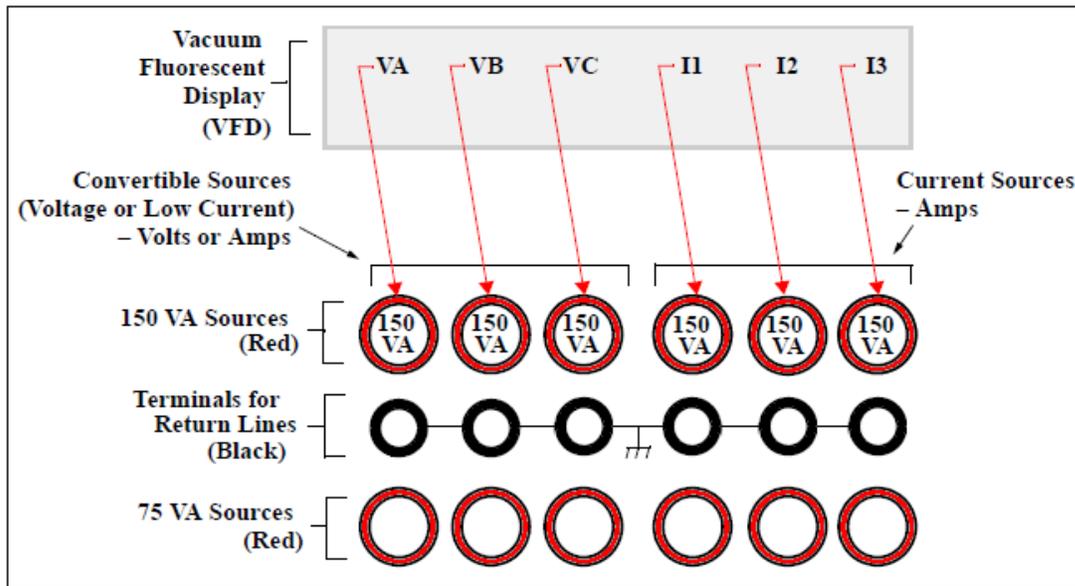
The F6150/F6150e/F6150sv voltage sources optionally may be converted into current sources. A convertible source, when used in current mode, provides a low-range current at a high compliance voltage. The following table shows the current ranges for 150 VA sources.

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

	<p><b>WARNING!</b> 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.</p>
---	---

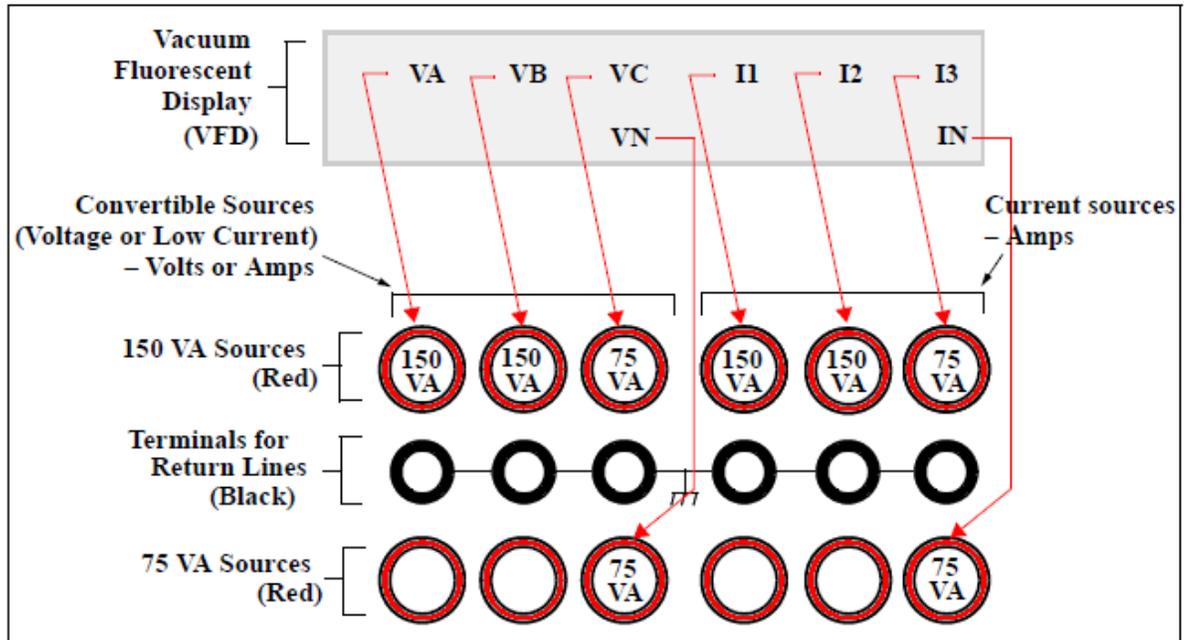
Amplifiers can be split into a total of two sources per amplifier.

The F6150/F6150e/F6150sv supplies **three convertible voltage/current sources and three current sources**. Each source is rated at 150 VA of continuous power (see following figure). The F6150A supplies two convertible voltage/current sources and two current sources.



**Figure 40 Convertible Sources**

These six sources can be switched to eight sources by splitting two of the 150 VA sources into four 75 VA sources, as shown below:



**Figure 41 Splitting 150 VA Sources**

The **source outputs** on the F6150/F6150e (without F6005) 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 42 on page 48](#) illustrates the front panel source configuration when six 150 VA voltage sources are split into twelve 75 VA sources.

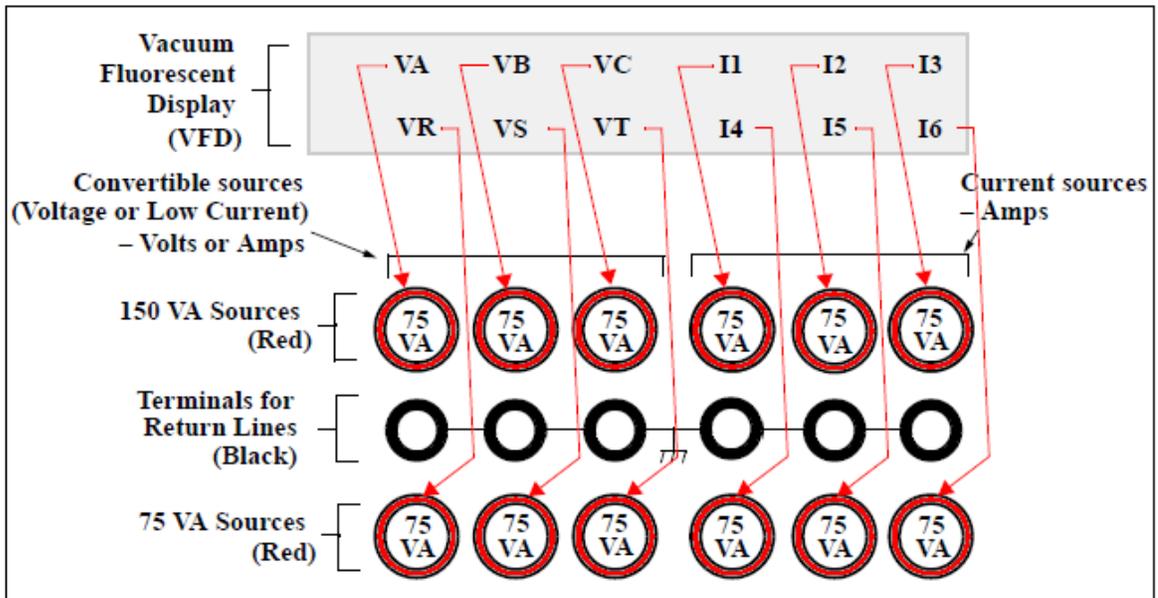


Figure 42 Splitting More 150 VA Sources

 **NOTE:** The F6150sv/F6150e (with F6005 option) has an increased current rating and VA capacity.

## CPU3 (sv)

Refer to the specifications for information on the CPU3 (sv).

## Battery Simulator

The battery simulator can be used to power digital and static relays. The Variable Output Battery Simulator 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.

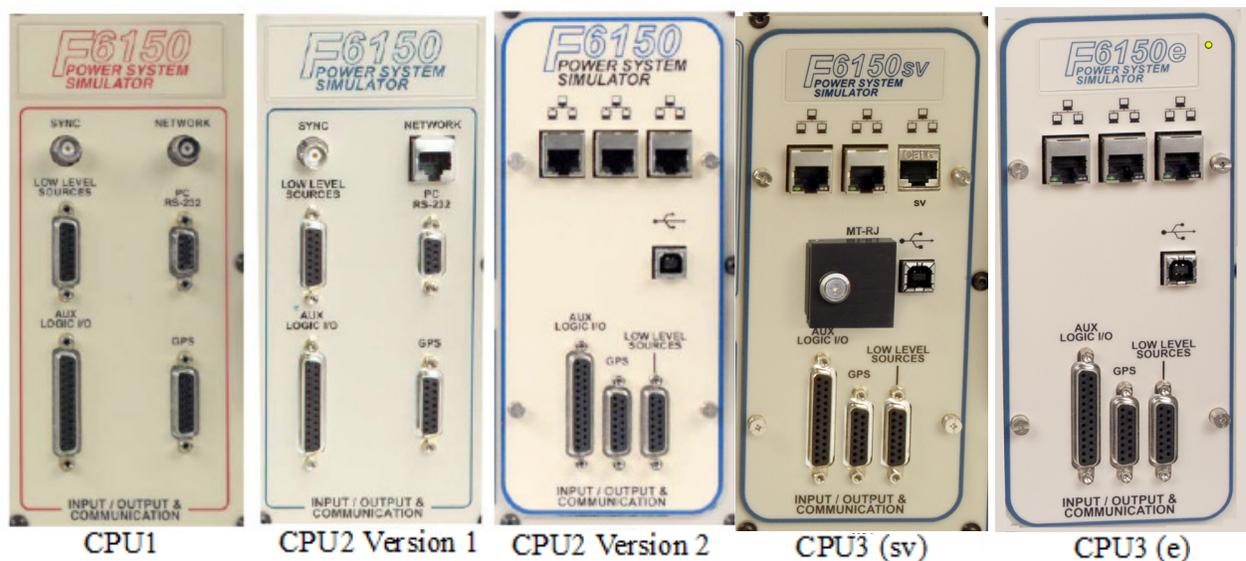
The Fixed Output Battery Simulator provides up to 90 W of output power, with a choice of three discrete voltage settings: 48, 125 or 250 VDC. The current limit for the battery simulator is 1.5 A DC.

# Input/Output and Communications

## F6150 Versions

The Input/Output & Communication section of the F6150 front panel 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 (CPU2 Version 1 units)
  - 2 Ethernet connectors, 1 Type-B USB connector, and 1 sampled values output (sv units)
  - 1 Ethernet connector and 1 RS-232 serial connector (CPU2 Version 1 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 page 60](#)).
- GPS. For use with the Global Positioning System antenna (see [Global Positioning System](#)).
- Aux Logic I/O. For future applications.
- Sync. (CPU1 and CPU2 Version 1 units.) Not used.
- MT-RJ optical connector (sv units only)



**Figure 43 Input/Output and Communications Sections**



**NOTE:** You can upgrade the Input/Output & Communication section on the older models by replacing the front panel. See [“Removing and Replacing Front Panel”](#) on page 137.

## F63xx Versions

The Input/Output & Communication section of the F6300 front panel contains the following connectors:

- 1 BNC Sync connector (not used)
- 1 MMJ Network connector
- 1 Low-level input connector
- RS-232 serial connector

The Input/Output & Communication section of the F6350 front panel contains the following connectors:

- 3 Ethernet network connectors
- 1 Type-B USB connector
- 1 Auxiliary I/O connector
- GPS. For use with the Global Positioning System antenna (see [“Setting Up your GPS Equipment”](#) on page 201).

- Low-Level Sources. Allows injecting of low-level signals from an external signal generator.



**Figure 44 F6300 and F6350 Communications Panels**

## Network and PC

Connect your PC to the F6150 using an Ethernet or USB connector on present sv models or CPU2 version 2 models. On CPU1 and CPU2 Version 1 models, use the RS-232 serial port. See the next sections, below, for connection examples.



**WARNING!** 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 [“Setup & Configuration” on page 71](#) for an outline, or the *F6ControlPanel User Guide* for detailed information. The following table summarizes the requirements for both serial and Ethernet connections for CPU1, CPU2, and CPU3 (sv).

	<b>Serial Connection</b>	<b>Ethernet Connection</b>
<b>CPU1</b>		
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: 1-Base2 (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
<b>CPU2 Version 1</b>		
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

**CPU2 Version 2**

	<b>Serial Connection</b>	<b>Ethernet Connection</b>
Connector	Type B USB port <sup>a</sup>	RJ-45
Computer	Type A USB port <sup>a</sup>	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

<sup>a</sup> For your computer to be able to communicate with the F6150 using the USB serial connection, the USB driver, included on the CD supplied with the instrument, must be installed. See [“USB Driver” on page 24](#).

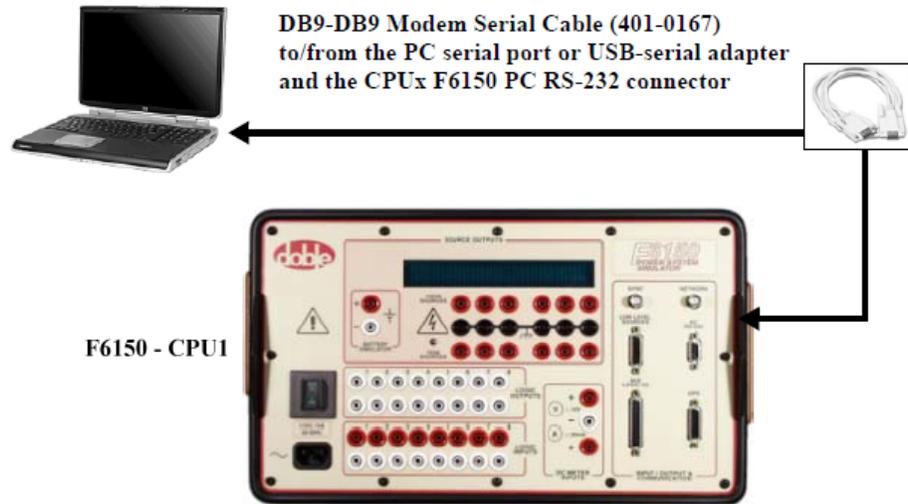
**CPU3 (e)**

	<b>Serial Connection</b>	<b>Ethernet Connection</b>	<b>Wi-Fi</b>
Connector	Type B USB port <sup>a</sup>	RJ-45	802.11 B + G bands
Computer	Type A USB port <sup>a</sup>	10 or 10/100 Mbps Ethernet card	Wi-Fi-enabled
Cable	USB	Cat 5 to hub or Cat 5 crossover cable direct to PC	n/a
Setup (in F6ControlPanel)	COMx (COM1 by default)	IP address (10.1.3.1 by default)	IPS address configurable
Baud Rate (in F6ControlPanel)	57,600	n/a	n/a

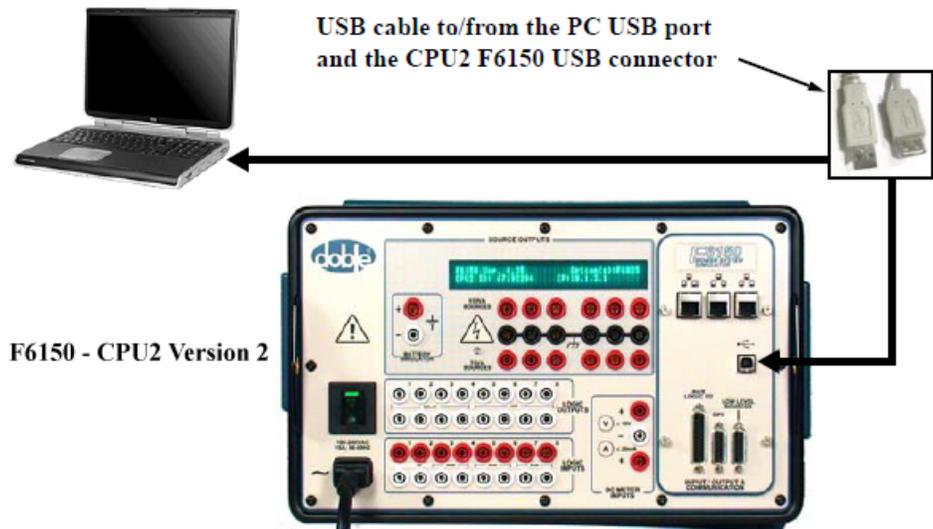
**CPU3 (sv)**

	<b>Serial Connection</b>	<b>Ethernet Connection</b>	<b>Optical Fiber Connection</b>	<b>Wi-Fi</b>
Connector	Type B USB port	RJ-45	MT-RJ	802.11 B + G bands
Computer	Type A USB port	10 or 10/100 Mbps Ethernet card	n/a	Wi-Fi-enabled
Cable	USB	Cat 5 to hub or Cat 5 crossover cable direct to PC	fiber	n/a
Setup (in F6ControlPanel)	COMx (COM1 by default)	IP address (10.1.3.1 by default)	n/a	IPS address configurable
Baud Rate (in F6ControlPanel)	57,600	n/a	n/a	n/a

## Serial Connect Examples



**Figure 45 Serial Connection – Computer to CPU1 or CPU2 Version 1 F6150**



**Figure 46 Serial Connection – Computer to CPU2 Version 2 F6150**

The connections for the USB connector on an F6150sv are the same as for the CPU2 Version 2 F6150 shown above.

## Ethernet Connect Examples

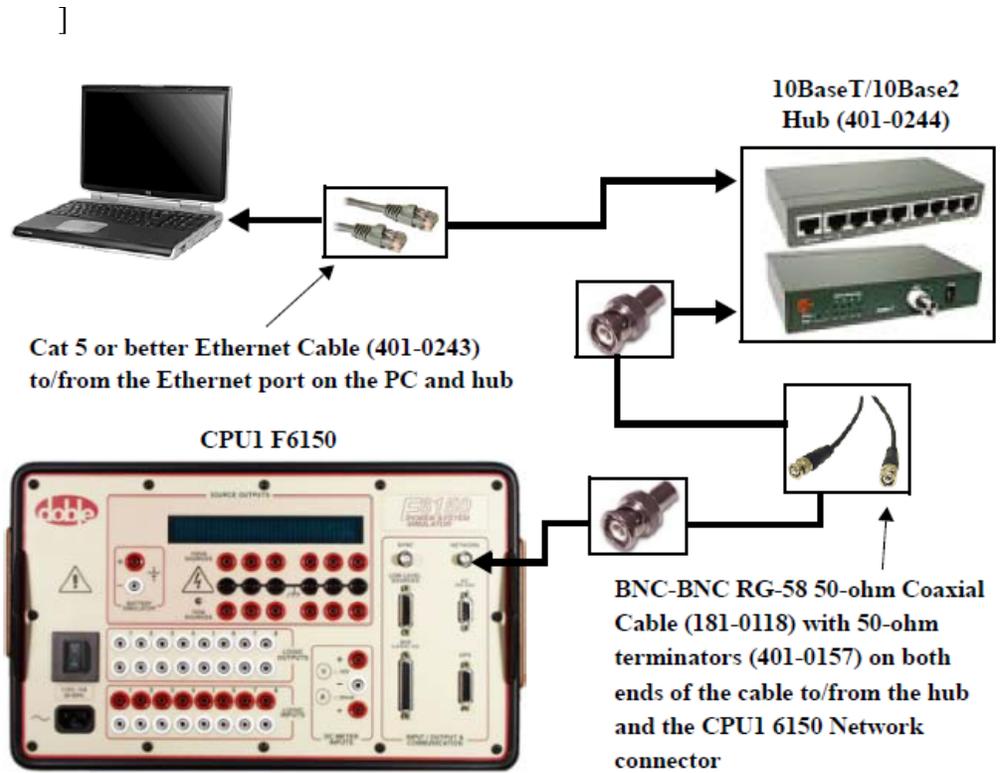
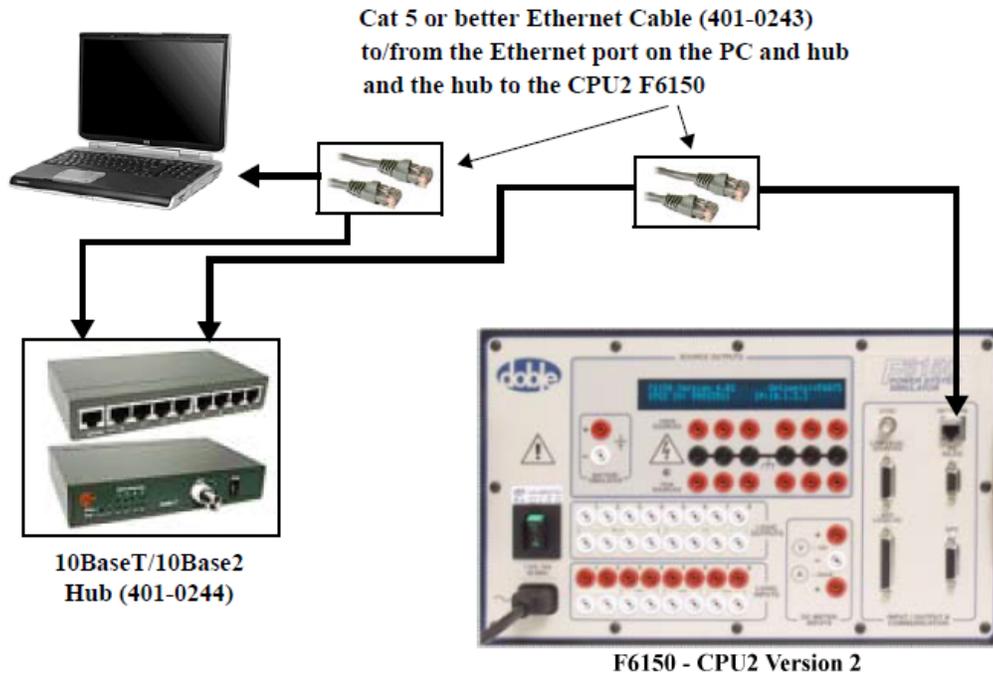


Figure 47 Ethernet Connection - PC to CPU1 F6150 with Switch



**Figure 48 Ethernet Connection - PC to CPU2 Version 2 F6150 with Switch Hub**

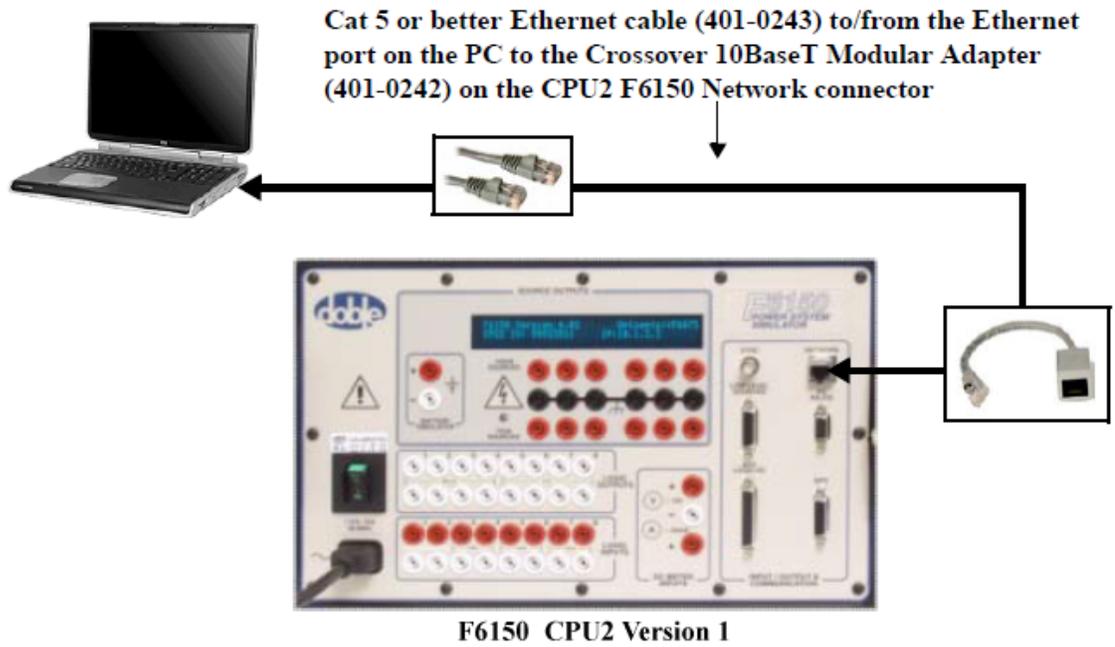
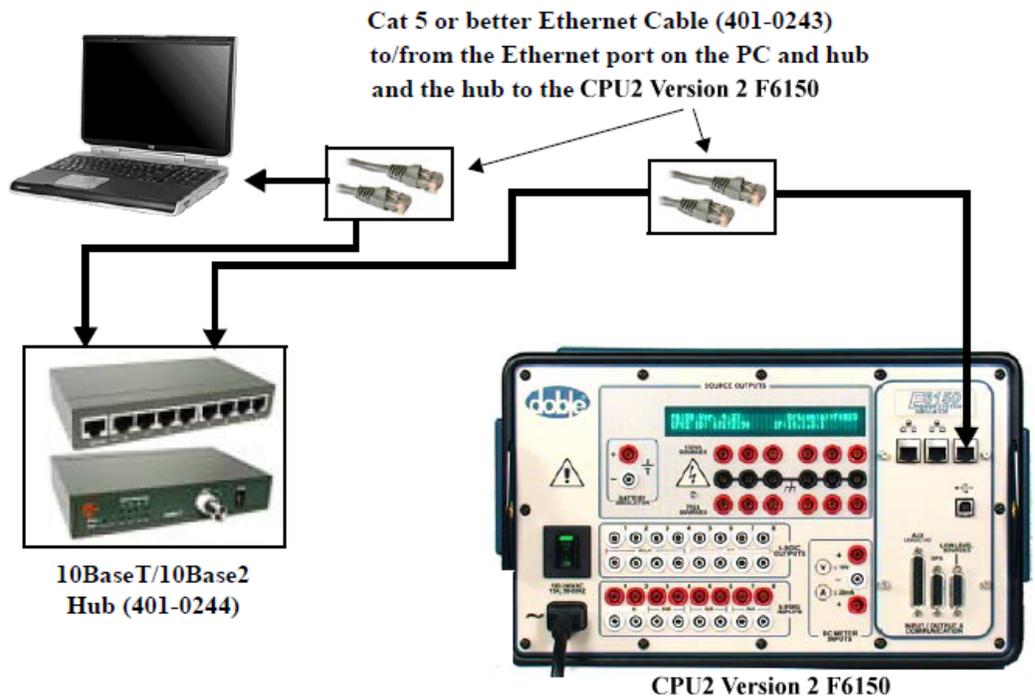
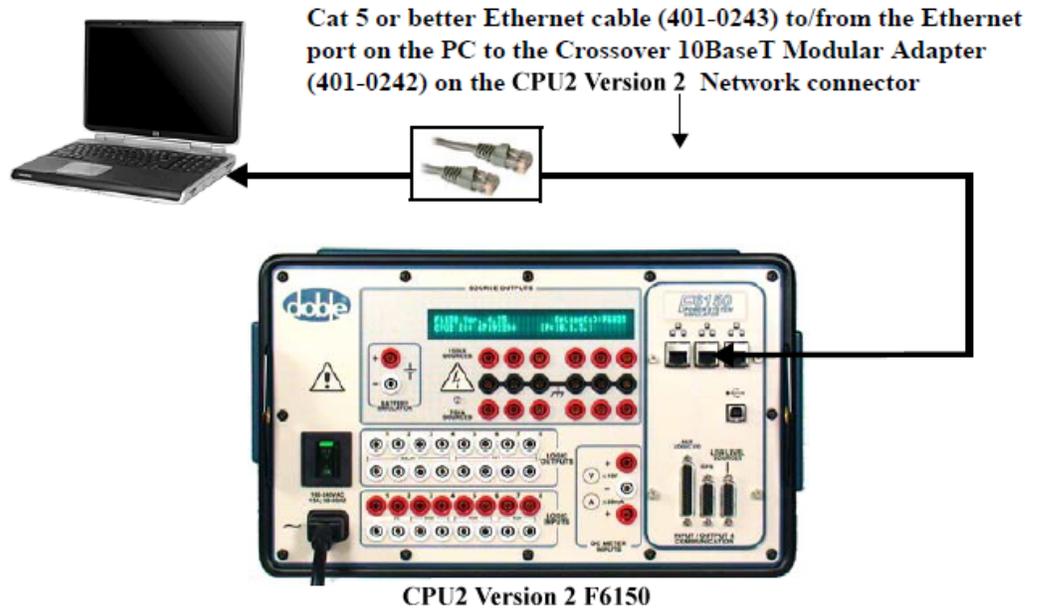


Figure 49 Ethernet Connection - PC to CPU2 Version 1 F6150 with Cat 5 Crossover Cable



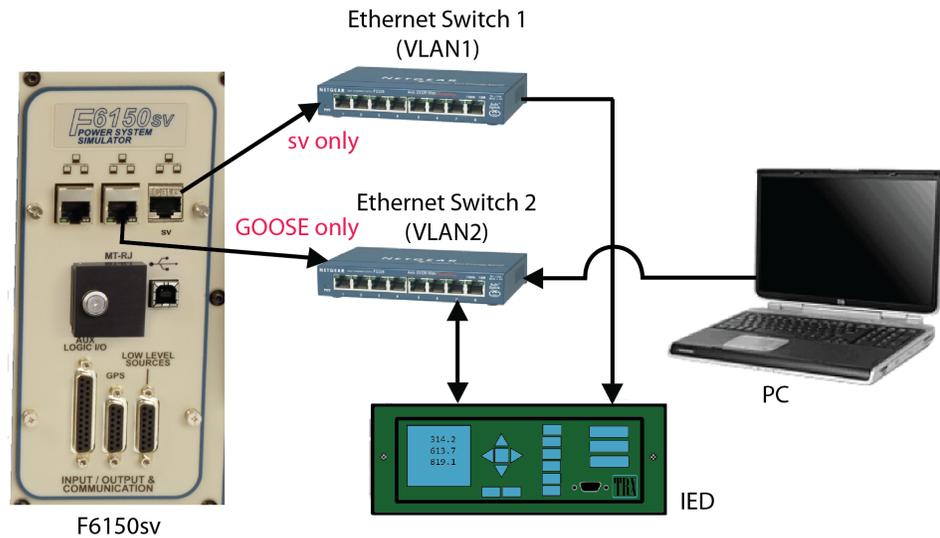
**Figure 50 Ethernet Connection - PC to CPU2 Version 2 F6150 with Switch/Hub**



**Figure 51 Ethernet Connection - PC to CPU2 Version 2 F6150 with Cat 5 Crossover Cable**

## F6150sv IEC61850 Connections

Refer to [Figure 52](#) for F6150sv IEC61850 connectivity. Note that the sv and GOOSE signals are separated by going through different Ethernet switches.



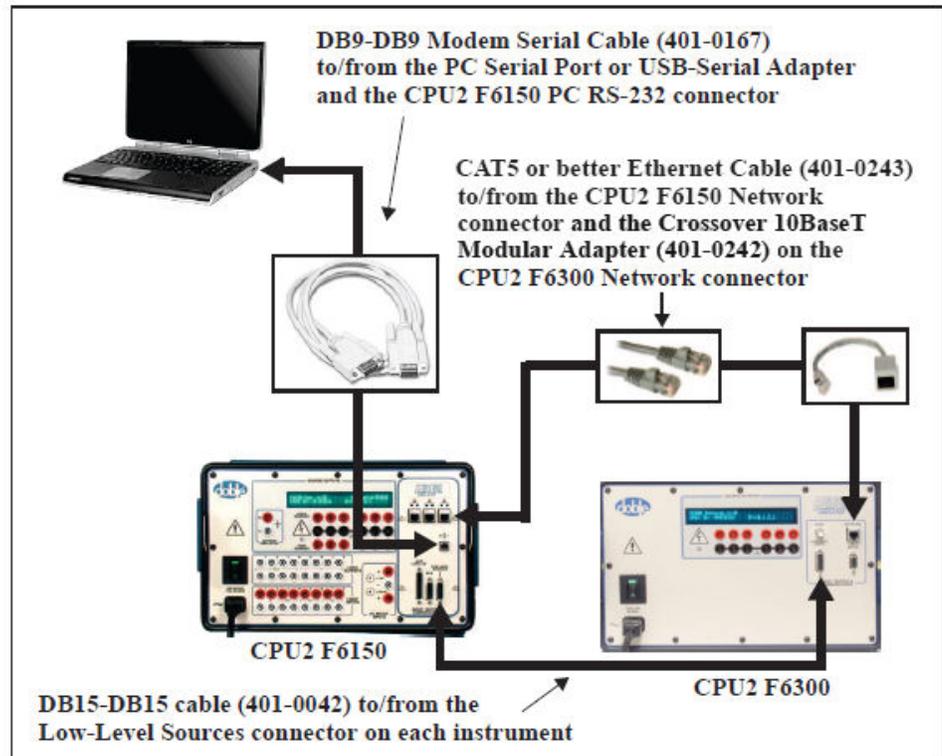
**Figure 52 IEC61850 Connections**

## Low-Level Sources

The low-level sources connector is used when connecting an F6300 to the F6150. The following figure shows the most common configuration, a connection between a PC and a CPU2 F6150 and CPU2 F6300.



**NOTE:** The crossover connector below is not required when it is connected to an F6150 CPU2 Version 2 or F6150 CPU3.



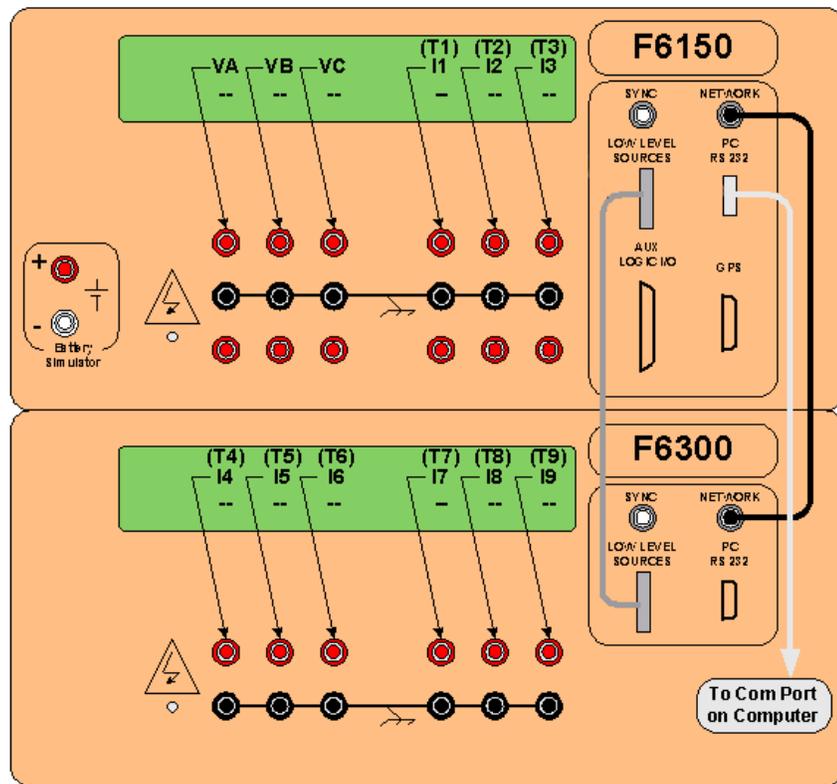
**Figure 53 Computer to CPU2 F6150/CPU2 F6300**



**NOTE:** 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 communication for 3 voltages and 9 currents (see [Figure 54 on page 62](#)) or 3 voltages and 3 currents:

1. If you are connecting the F6150 CPU2 Version 1 directly to the F6300, connect a crossover cable adapter (401-0303) to the Network connector of either instrument.
2. If you are connecting the two instruments through a hub or to a F6150 CPU 2 version 2 or F6150 CPU 3, no crossover cable is necessary.
3. 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).
4. Connect a male-male DB-15 cable to the Low-Level Sources (or Input) connector of each instrument.
5. Connect an RS-232 cable with male and female ends (CPU1 and CPU2 Version 1) or a USB cable (present CPU2) from the F6150 to the COM port of your PC.



**Figure 54 Low-Level Source Connections - 3 Voltages and 9 Currents**

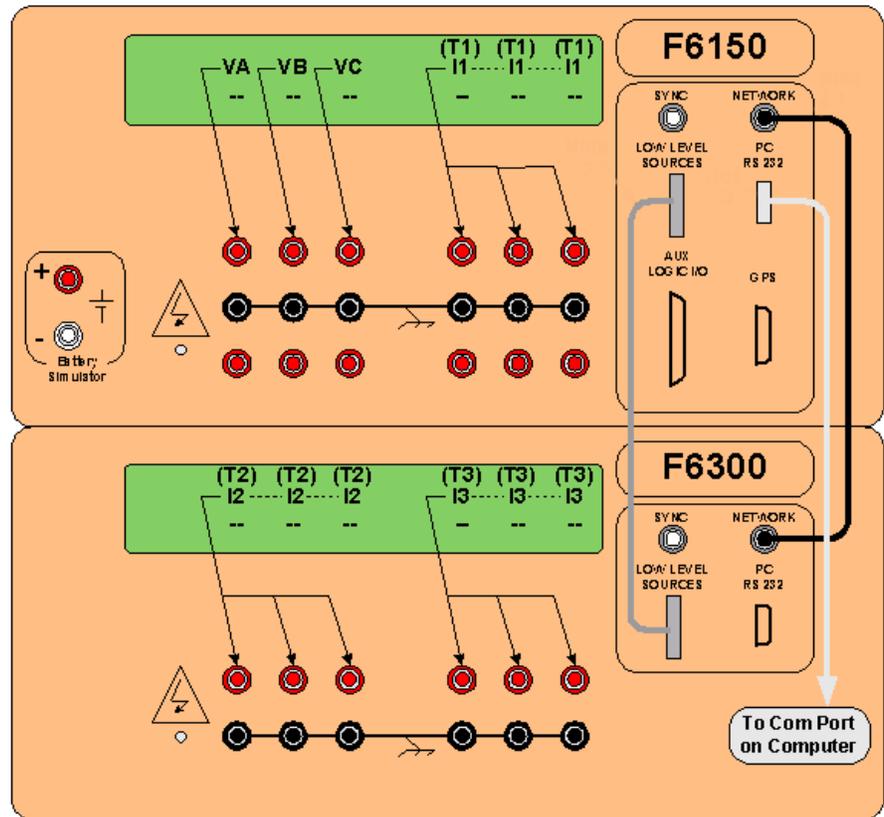
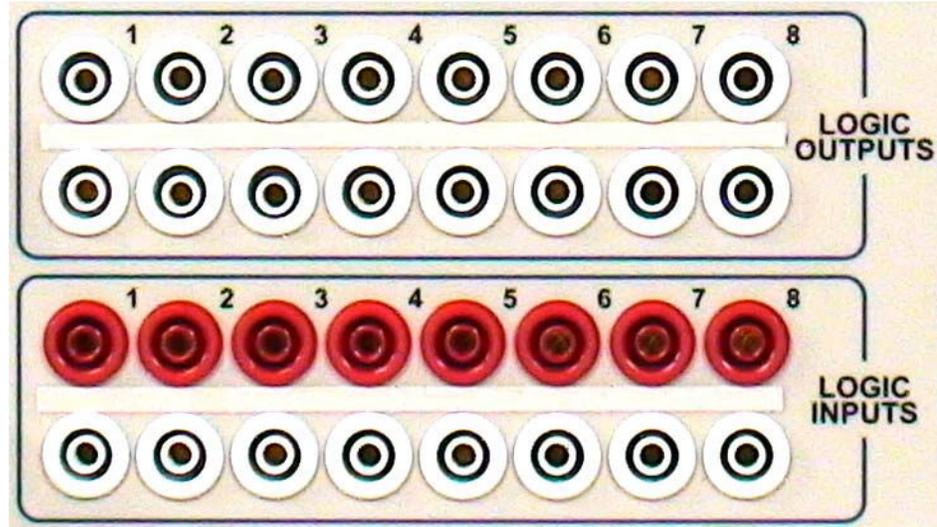


Figure 55 Low-Level Source Connections - 3 Voltages and 3 Currents

## 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. The following four figures show the four logic I/O section variations. See the two tables after the figures for logic details.



**Figure 56** Logic I/O Section - Instrument with I/O 1 Board (Option 6841)



**NOTE:** For Option 6841, all the Logic Outputs are FETs and all the Logic Inputs are Isolated.

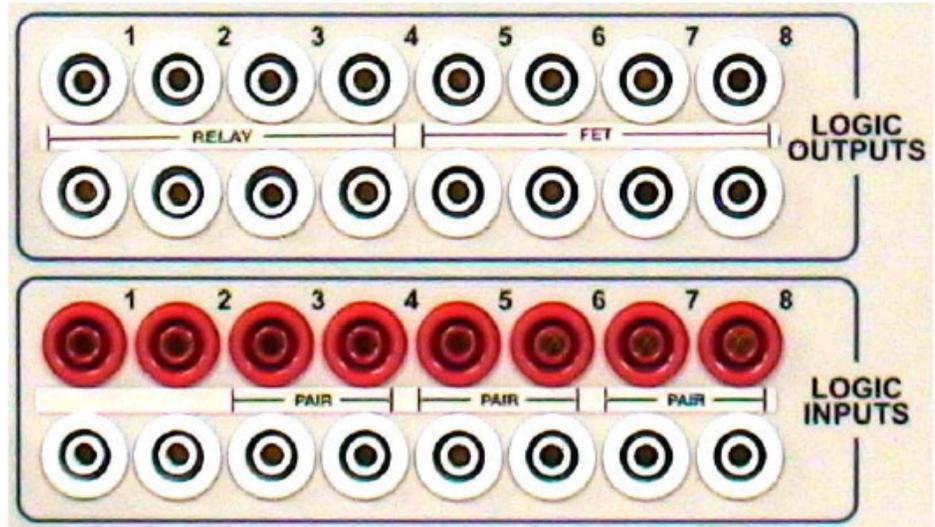


Figure 57 Logic I/O Section - Instrument with I/O 4 Board (Option 6842)

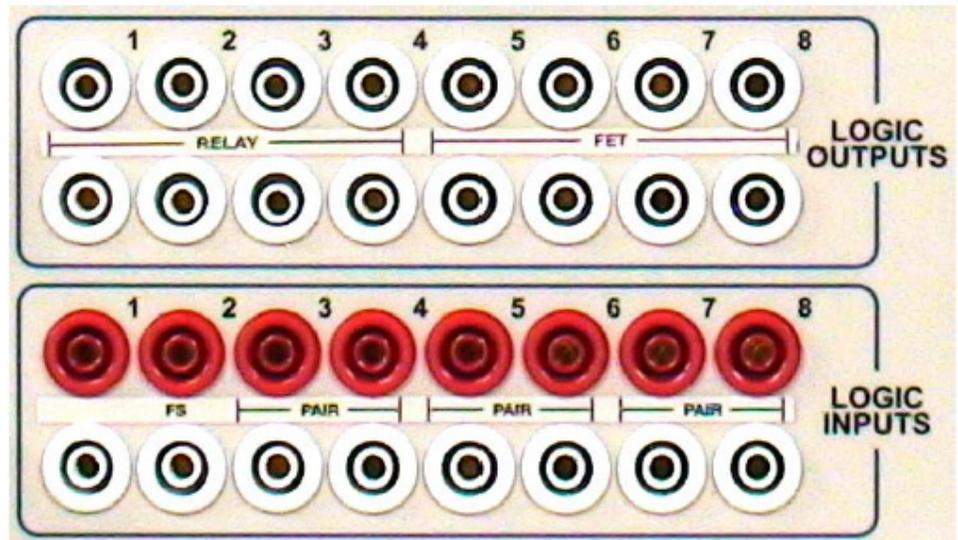
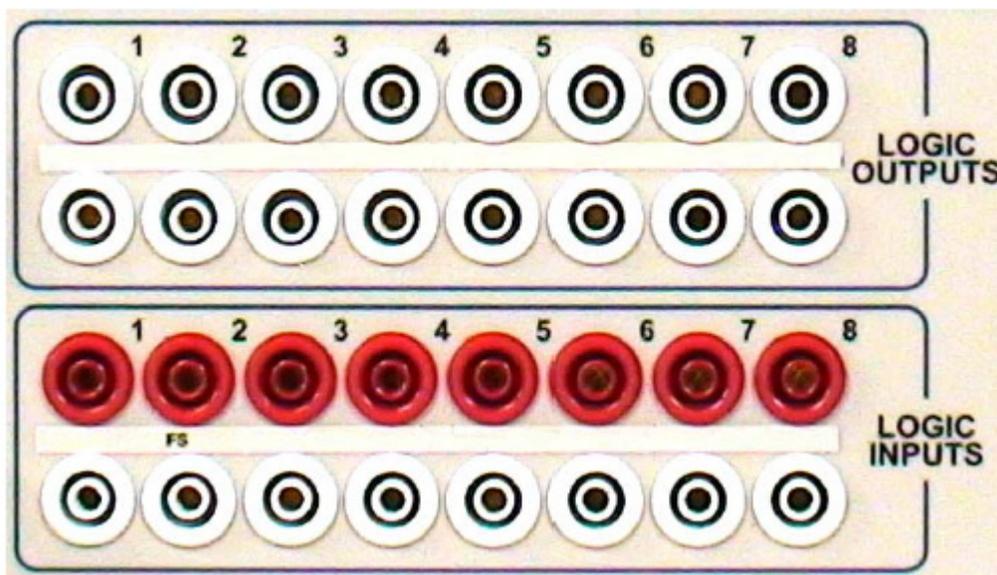


Figure 58 Logic I/O Section - Instrument with I/O 2 Board (Option 6844)



**NOTE:** For Option 6844, all of the Logic Outputs are FETs, and all of the Logic Inputs are Isolated. Input No. 2 provides the First Strike capability.



**Figure 59** Logic I/O Section, Instrument with I/O 5 Board (Option 6845)



**NOTE:** 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.

**Table 2 Logic Output Details**

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

## Logic Inputs

Logic inputs have two isolated inputs and six paired inputs isolated in three groups of two logic inputs.

**Table 3 Logic Input Details**

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

The following three figures 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 60 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 61 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 62 Input and Output Indicators for Six Current Sources**



**NOTE:** 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.



**NOTE:** 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, VAI1). See the ProTesT Macro Reference in the *ProTesT User Guide* (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.

## 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.

## 3. Setup & Configuration

### Getting Started

This topic describes how to set up and configure the F6150x and F6300. It also explains how to configure the voltage and current sources on the front panel. For specific F6350 configurations, also see “[Universal Low-Level Cable Descriptions](#)” on page 83.

The F6150/e/sv/a are controlled through one of the following:

- **F6 Control Panel** (a standalone application shipped with each F6000 instrument and also available under the tools menu of ProTesT)
- **Protection Suite Control panel** (See “Protection Suite User Guide”)
- **Protection Suite** (See “Protection Suite User Guide”)
- **ProTesT** (See “ProTesT User Guide”)
- **F6 Mobile Control Panel** (See [Chapter 11, “Mobile Control Panel Application.”](#))

The F6350 and F6350e are configured by the F6 Multiple Amplifier Configurator. They can then be operated as amplifiers, driven by Low-Level signals to control up to 12 Current and Voltage Sources.

The F6300 and F6300e can be configured by the F6 Multiple Amplifier Configurator to perform as amplifiers. In this mode, they can be driven by Low-Level signals to control 6 or 12 Current Sources.

The F6300 and F6300e can also be controlled by the F6 Control Panel, the Protection Suite Control Panel, ProTesT or Protection Suite. In this mode, they operate connected to an F6150/e/sv instrument.

### Launching F6ControlPanel

See “[Control Panels](#)” on page 18, and the *F6000 Control Panel User Guide* (72A-2419-01).

## Using F6000 Configuration

The F6000 Configuration window in ProTesT 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. There are similar configuration choices in Protection Suite. Also, Enhanced Rating (ER) current amplifiers are available in all F6xxe models, and ER amplifiers are standard on all SV instruments.

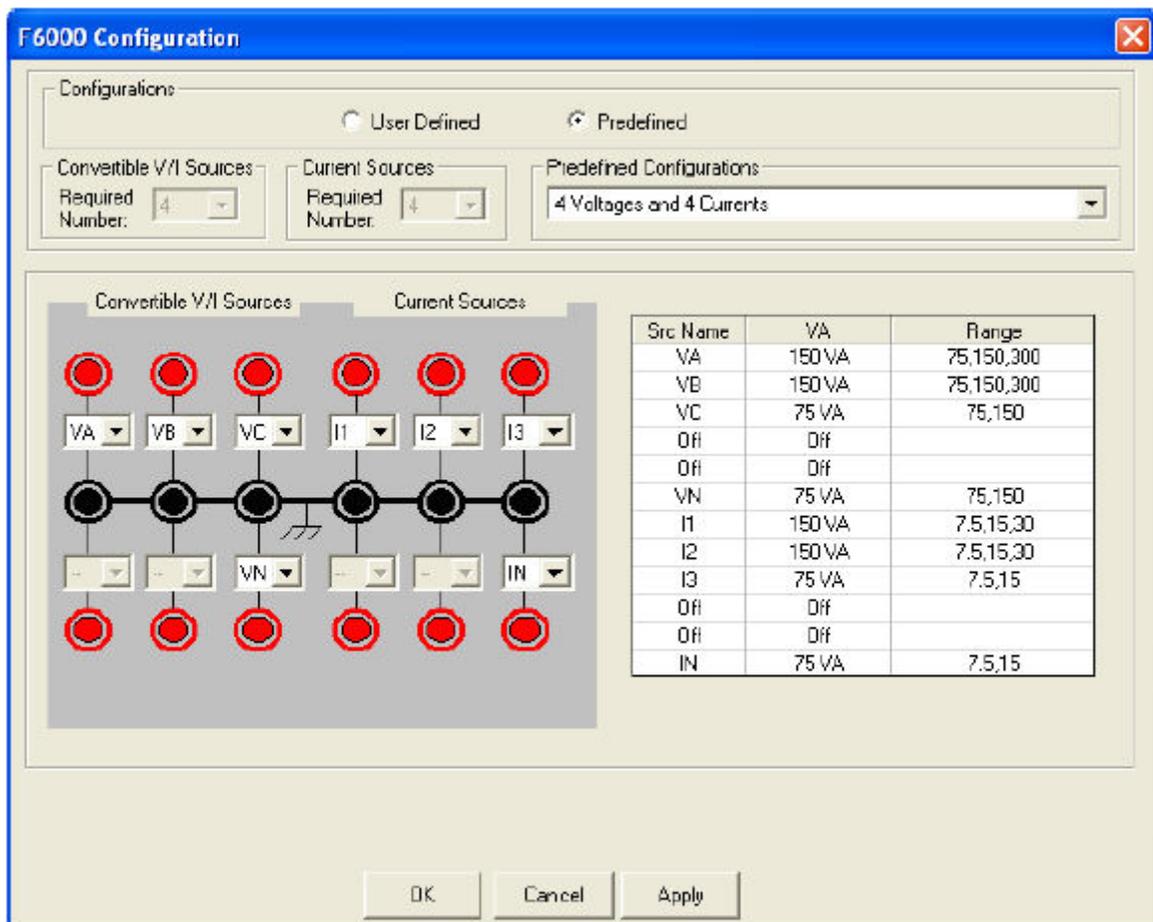


Figure 63 F6000 Configuration Dialog Box

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## 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 drop-down 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 drop-down menu.

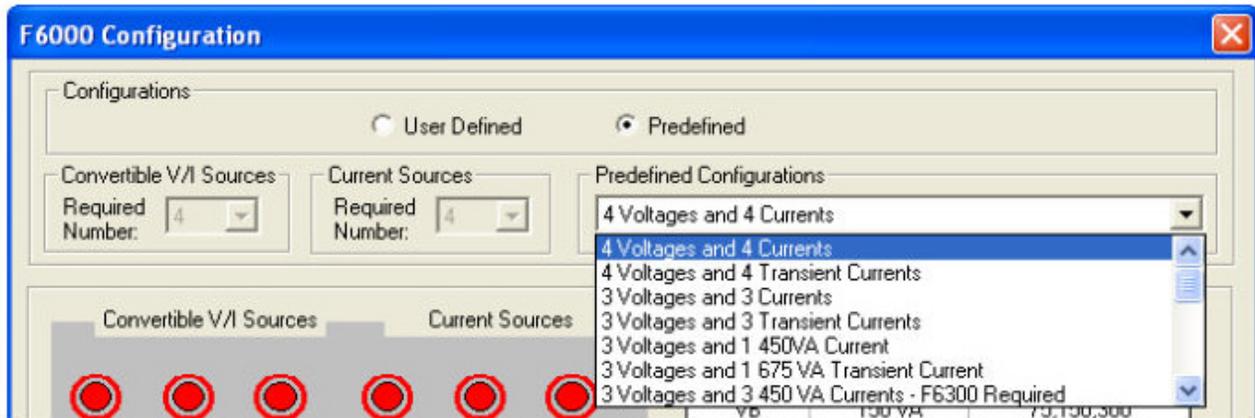
The current ranges for the 150 VA sources are 7.5, 15, and 30 A. The current ranges for the 75 VA sources are 7.5 and 15 A.

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.

## Pre-Defined Configurations

To use the pre-defined configurations:

1. Select **Tools -> F6000 Configuration**. The F6000 Configuration dialog box appears.
2. Click the Predefined option button (Figure 64 on page 74).



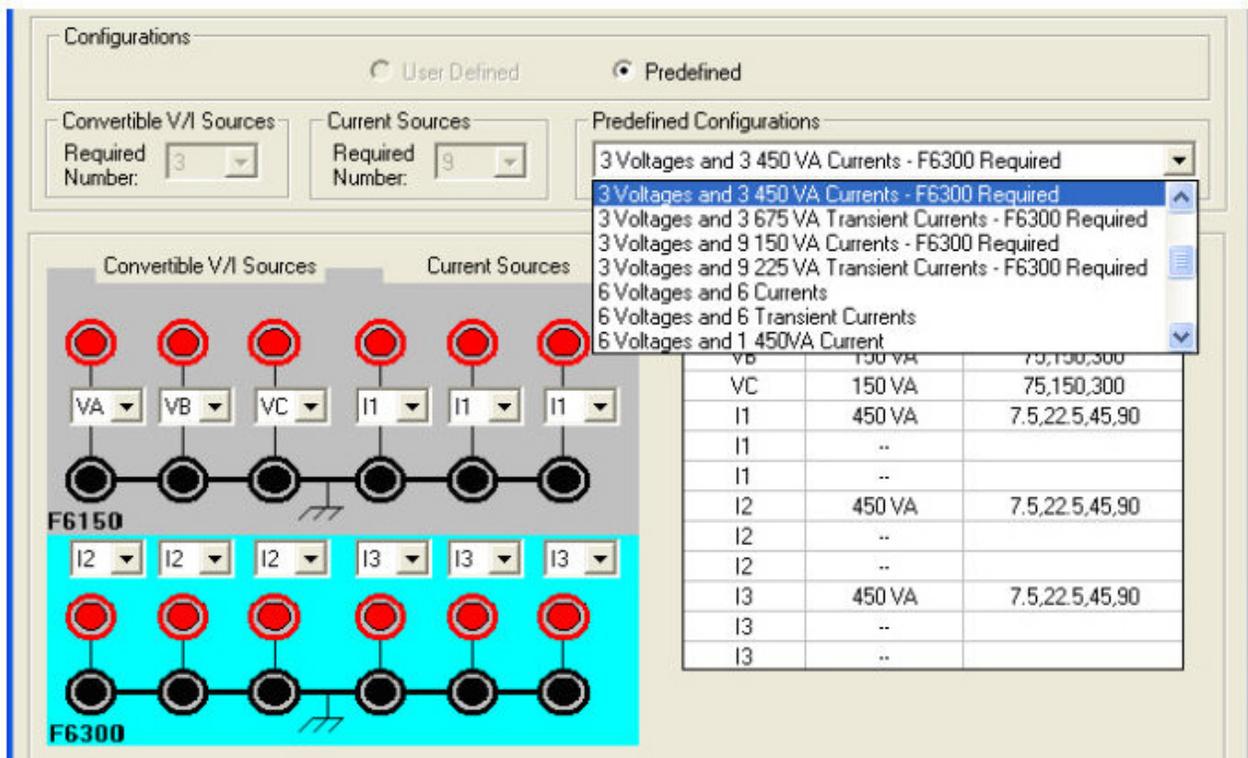
**Figure 64 Predefined Configurations**

3. Choose from one of 21 pre-defined 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 (below).

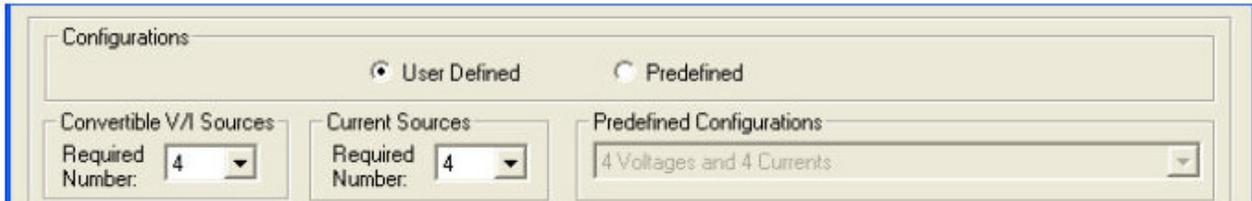


**Figure 65 F6000 Configuration Dialog Box with F6150/F6300 Configuration Selected**

## 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 66).



**Figure 66 User-Defined Configurations**

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.**

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.

## 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 4 on page 78](#).
- 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.



**WARNING!** 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 4 on page 78](#)).
- 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:

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

where S 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.**

The following four tables show range settings and compliance voltages for all common source configurations.

**Table 4 Maximum Compliance Voltage for Low-Current Source Combinations**

Current Range	75 VA Source	150VA Source	300VA Source	450VA Sources
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	--
3.0 A	--	--	--	150 V
4.0 A	--	--	75 V	--
6.0 A	--	--	--	75 V

**Table 5 Maximum Compliance Voltage for Low Transient Current Source Combinations**

Current Range	97.6 VA Source	195VA Source	390VA Source	585VA 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 6 Maximum Compliance Voltage for Current Source**

<b>Current Range</b>	<b>75 VA Source</b>	<b>150 VA Source</b>	<b>300 VA Source</b>	<b>450 VA Source</b>
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

**Combinations****Table 7 Maximum Compliance Voltage for Transient Current Source Combinations**

<b>Current Range</b>	<b>112.5 VA Source</b>	<b>225 VA Source</b>	<b>450 VA Source</b>	<b>675 VA Source</b>
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

**Table 8 Sampled Values Enhanced Ratings**

<b>Current Range</b>	<b>87.5 VA Source</b>	<b>131.25 VA Source</b>	<b>175 VA Source</b>	<b>262.5 VA Source</b>	<b>525 VA Source</b>	<b>787.5 VA</b>
8.75 A	10 V	15 V	20 V	30 V	60 V	90 V
17.5 A	5 V	7.5 V	10 V	15 V	30 V	45 V
26.25 A	--	5 V	6.67 V	10 V	20 V	30 V
35 A	--	3.75 V	5 V	7.5 V	15 V	22.5 V
52.5 A	--	--	--	5 V	10 V	15 V
105 A	--	--	--	--	5 V	7.5 V
210 A						3.75 V

## F6350 Source Configuration

The F6 Multiple Amplifier Configurator application allows users to configure and enable one or more of Doble’s F6350, F6350e, F6300 or F6300e instruments. It is intended to be used in conjunction with large power system simulator software to test complex protection systems. The application allows the user to specify a list of Doble instruments to be used in a test, along with their individual source and battery configurations, and then save the collection to be reused at a later time.

This software differs from other Doble software for the F-series of instruments in two important respects. First, it will work with up to 16 instruments concurrently. The other products control one instrument at a time. Second, it configures and enables the instruments and makes them available to the simulation software to control during the tests.

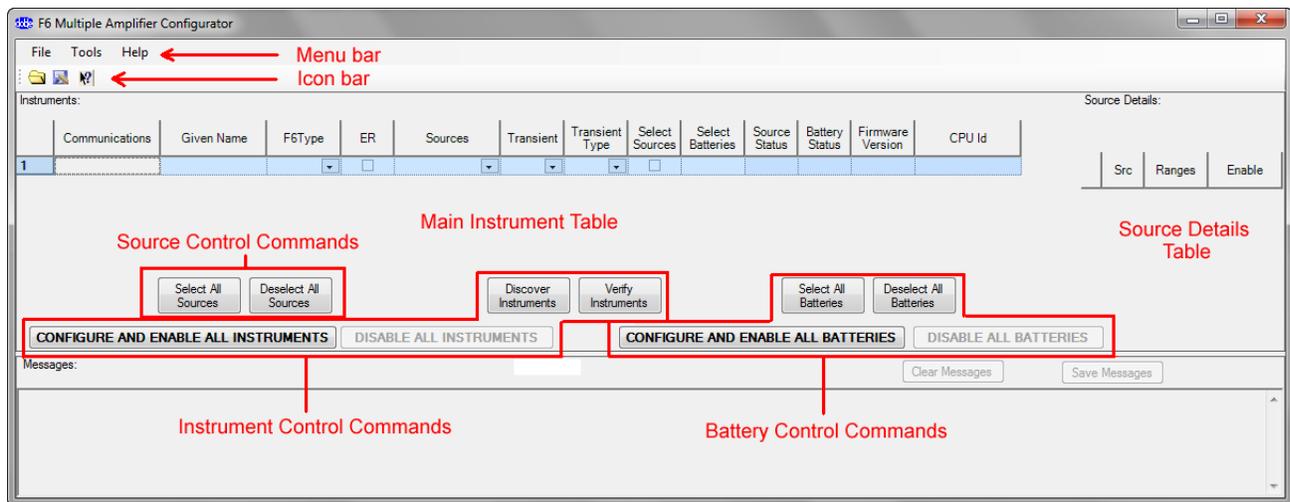
Once a collection of instruments is identified on the main screen, individual instruments can be configured. For each configured F6350, both individual sources as well as the battery level and on/off state can be set. For configured F6300e instruments, the battery can be configured, whereas with F6300s, only the individual sources can be set.

Given an instrument’s address, either a com port name or an Ethernet IP address, the application can automatically detect its type, i.e., F6350 or F6300, firmware version, and CPU ID, and whether the instrument has enhanced amplifiers. The CPU ID is used as the identifier for the instrument.

# F6 Multiple Amplifier Configurator

## Main Screen

The F6 Multiple Amplifier Configurator application will open up to an empty instrument list screen as shown in [Figure 67](#), below.



**Figure 67 Main Screen**

From the main screen, the user can begin to build an instrument list to be used in a test.

The screen is divided into a number of parts.

## Menu Bar and Icon Bar

The menu bar, at the very top has the following choices:

1. File allows the user to Save and Open established instrument lists and configurations (Sessions).
2. Tools Options command to specify the default directories for saving sessions, finding saved sessions, and creating log files.
3. Help Displays this file.

The Icon bar duplicates some of the more used commands from the menu bar and shows them with graphical icons to make their meaning clearer. Hovering the mouse cursor over an icon will display its text label.

## **Main Instrument Table**

This is where the instruments being configured are listed.

## **Source Details Table**

When the user selects an instrument and picks a source configuration in the instrument table, the details of the configuration appear here. Properties of individual sources can be edited.

## **Battery Configuration Table**

This is where the battery simulator voltage can be set for the F6300e and the F6350s.

## **Source control commands**

This group of command buttons is used to either select or de-select all the sources in the main instrument table. These are convenient shortcuts for selecting or de-selecting the source column in every row of the table.

## **Instrument control commands**

This group of commands is used in controlling the instruments. It includes Discover Instruments, Verify Instruments, Configure and Enable All Instruments, and Disable All Instruments.

## **Battery Control Commands**

This group includes the Select All Batteries and Deselect All batteries commands. These are convenient shortcuts for selecting or deselecting the battery column in every row of the table.

## Universal Low-Level Cable Descriptions

A cable (05B-0730-05) is available for injecting low-level signals into the low-level sources connector on the front of the F63xx instrument. This cable contains 12 twisted-pair leads that connect to the pins of the Low Level Sources connector. Each of these pins controls the output from one of the upper or lower channels of the amplifier, as shown in the channels columns of the table. An exception to this is noted below.

**Table 9 Universal Low-Level Cable Pinouts and Wire Colors for Sources with the F6 Multiple Amplifier Configurator**

Pin Number	F6350 -F6350e Channels	F6350 – F6350e Sources	F6300 Channels	F6300 Sources	F6300e Channels	F6300e Sources	Wire Color (Pos. First)
9	Amp4-Ch1	I1*	Not used		Amp4-Ch2	ID	White-Red
10	Amp5-Ch1	I2*	Not used		Amp5-Ch2	IE	Red-Green
11	Amp6-Ch1	I3*	Not used		Amp6-Ch2	IF	Orange-Red
2	Amp4-Ch2	I4	Amp4-Ch1	I4	Amp4-Ch1	I4	Brown-Black
3	Amp5-Ch2	I5*	Amp5-Ch1	I5	Amp5-Ch1	I5	Red-Black
4	Amp6-Ch2	I6	Amp6-Ch1	I6	Amp6-Ch1	I6	Orange-Black
12	Amp1-Ch1	VA or IA	Not used		Amp1-Ch2	IA	Yellow-Red
13	Amp2-Ch1	VB or IB	Not used		Amp2-Ch2	IB	White-Green
14	Amp3-Ch1	VC or IC	Not used		Amp3-Ch2	IC	Blue-Green
5	Amp1-Ch2	VR or IR	Amp1-Ch1	I1	Amp1-Ch1	I1	Yellow-Black
6	Amp2-Ch2	VS or IS	Amp2-Ch1	I2	Amp2-Ch1	I2	White-Black
7	Amp3-Ch2	VT or IT	Amp3-Ch1	I3	Amp3-Ch1	I3	Blue-Black

\* Where three currents are ganged together on the F6350, in the 3V 1(450VA) I configuration, for the 15A (or 17.5 Enhanced) range, it is necessary to inject the appropriate low-level signal into leads for Pin 3, in addition to Pins 9, 10, and 11. For Transients in the 30 (or 35) Amp range of the same 3V 1(450VA) I configuration, it is also necessary to inject a signal into the leads for Pin 3, as well as the expected Pins 9, 10, and 11.

## F6350 Cable Connections for Sources and System Configurations

This section describes how the Universal Low-Level Cable is used. For a given configuration, the appropriate voltage signal must be injected into the cable wire pair that connects to the appropriate pin.

### 3 V / 3 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
VC	14	Blue-Green
I1	9	White-Red
I2	10	Red-Green
I3	11	Orange-Red

### 2 V / 4 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
I1	9	White-Red
I2	10	Red-Green
I3	11	Orange-Red
I6	4	Orange-Black

### 3 V / 6 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
VC	14	Blue-Green
I1	9	White-Red
I2	10	Red-Green
I3	11	Orange-Red
I4	2	Brown-Black
I5	3	Red-Black
I6	4	Orange-Black

### 4 V / 3 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
VC	14	Blue-Green
VT	7	Blue-Black
I1	9	White-Red
I2	10	Red-Green
I3	11	Orange-Red

## 6 V /6 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
VC	14	Blue-Green
VR	5	Yellow-Black
VS	6	White-Black
VT	7	Blue-Black
I1	9	White-Red
I2	10	Red-Green
I3	11	Orange-Red
I4	2	Brown-Black
I5	3	Red-Black
I6	4	Orange-Black

## 3V/3 Low I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
VC	14	Blue-Green
IR	5	Yellow-Black
IS	6	White-Black
IT	7	Blue-Black

Build 19 of F6 Multiple Amplifier Configurator will label the currents IA, IB, IC, but pins 5, 6, and 7 still control these outputs.

## 6 Low I/6 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
IA	12	Yellow-Red
IB	13	White-Green
IC	14	Blue-Green
IR	5	Yellow-Black
IS	6	White-Black
IT	7	Blue-Black
I1	9	White-Red
I2	10	Red-Green
I3	11	Orange-Red
I4	2	Brown-Black
I5	3	Red-Black
I6	4	Orange-Black

## 3 V /1 Current @450 VA Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
VA	12	Yellow-Red
VB	13	White-Green
VC	14	Blue-Green
I1	9, 10, 11, and 3 (See Note on <a href="#">Table 9.</a> )	White-Red Red-Green Orange-Red

## F6300 Cable Connections for Sources and System Configurations

### 6 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
I1	5	Yellow-Black
I2	6	White-Black
I3	7	Blue-Black
I4	2	Brown-Black
I5	3	Red-Black
I6	4	Orange-Black

## 12 I Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
I1	5	Yellow-Black
I2	6	White-Black
I3	7	Blue-Black
I4	2	Brown-Black
I5	3	Red-Black
I6	4	Orange-Black
IA	12	Yellow-Red
IB	13	White-Green
IC	14	Blue-Green
ID	9	White-Red
IE	10	Red-Green
IF	11	Orange-Red

## 2 I Currents @450 VA Configuration

Source Names on VFD	Cable Pin Number	Cable Wire Colors (Pos. first)
I1 or I3	5, 6, 7	Yellow-Black White-Black Blue-Black
I2 or I4	2, 3, 4	Brown-Black Red-Black Orange-Black

## Low-Level Sources

The Low-Level Sources connector on any model of F6150 is used as an output connector to provide signals to an F6300, when they are used together. The low-level signals are generated by the CPU of the F6150, adjusted for the calibration of the F6300, and delivered by the DB-15 cable to the F6300.

When any F6300 or F6350 is used as a standalone amplifier, the Low-Level Sources connector serves as an input to receive low-level input signals that are to be amplified by the current amplifiers and the convertible amplifiers.

The following table describes the parameter ranges of the Low-Level Sources connector. The parameter values are approximate because each channel would have its own calibration when the F6xxx was used as a test instrument. The values below are the theoretical scale factors for an ideal instrument.

### Low-Level Source Parameter Ranges

**Table 10 Theoretical Low-Level Inputs for Amplifiers**

Model	Amplifier and Mode of Operation	Non-Transient Input Signal	T sources (Transient mode)
F6350 F6350e	Convertible amplifiers in Voltage Mode	6.698 V rms per source to produce full range (75, 150, 300 V rms)	No transient mode
F6350 F6350e	Convertible amplifiers in Current Mode	4.521 V rms per source to produce full range (0.5, 1.0 Amps rms)	6.782 V rms for 50% more (0.75, 1.5 Amps rms)
F6350 F6300	Non-Enhanced Current Amplifier	3.399 V rms per source to produce full range (7.5, 15, 30 Amps rms)	6.798 V rms for 100% more (15A in 15A Transient range, 30A, 60A)
F6350 F6350e F6300e	Enhanced Current Amp. (With 6005 - always on for FMAC)	3.5 V rms per source to produce full range (8.75, 17.5, 35 Amps rms)	7 V rms for 100% more (17.5 A in 17.5 Transient range, 35 or 70 A) Transient for 45 sec.
F6350 F6300 with FMAC2	Any amplifier with Enhanced Current Amps (which FMAC2 does not recognize)	3 V rms per source to produce displayed range of FMAC2 (7.5, 15, 30 Amps rms)	6 V rms for 100% more (15, 30, 60 Amps rms for 45 sec. Transient.)

## 4. Troubleshooting

### General Techniques

This topic 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/](http://www.doble.com/support/))

Email: [customerservice@doble.com](mailto:customerservice@doble.com)

Telephone: 617-926-4900

### F6150

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

- 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

- If preliminary external checks do not identify the problem, remove the cover (see [“Removing the Cover” on page 134](#)) and check the LED status of internal components for proper operation (see [“LED Status Indicators” on page 95](#)).

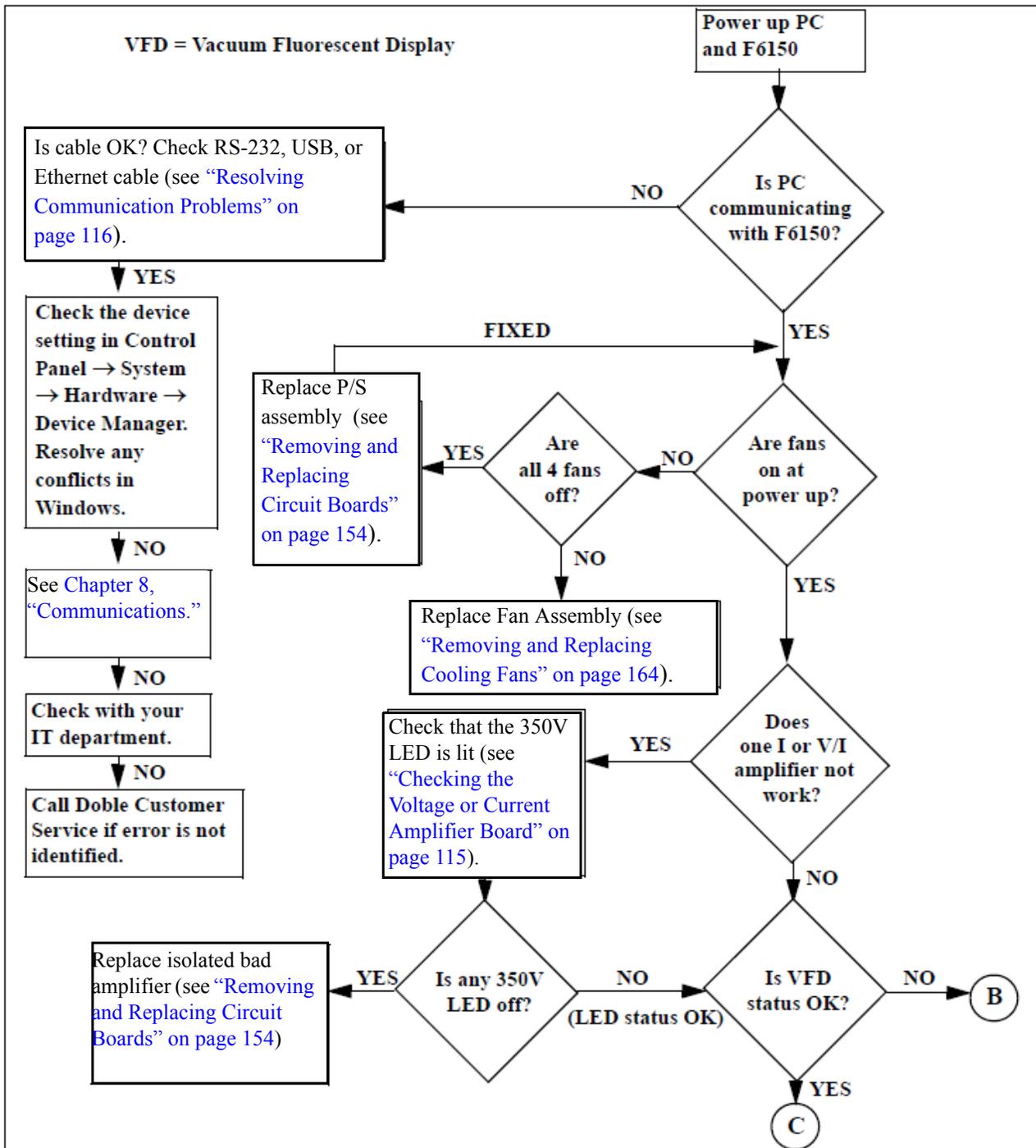


**NOTE:** Many of the major problems encountered in the F6150 can be corrected by replacing a board in the unit. See [“Removing and Replacing Communications Board” on page 147](#) and [“Removing and Replacing Circuit Boards” on page 154](#) for how to remove and replace a defective board.

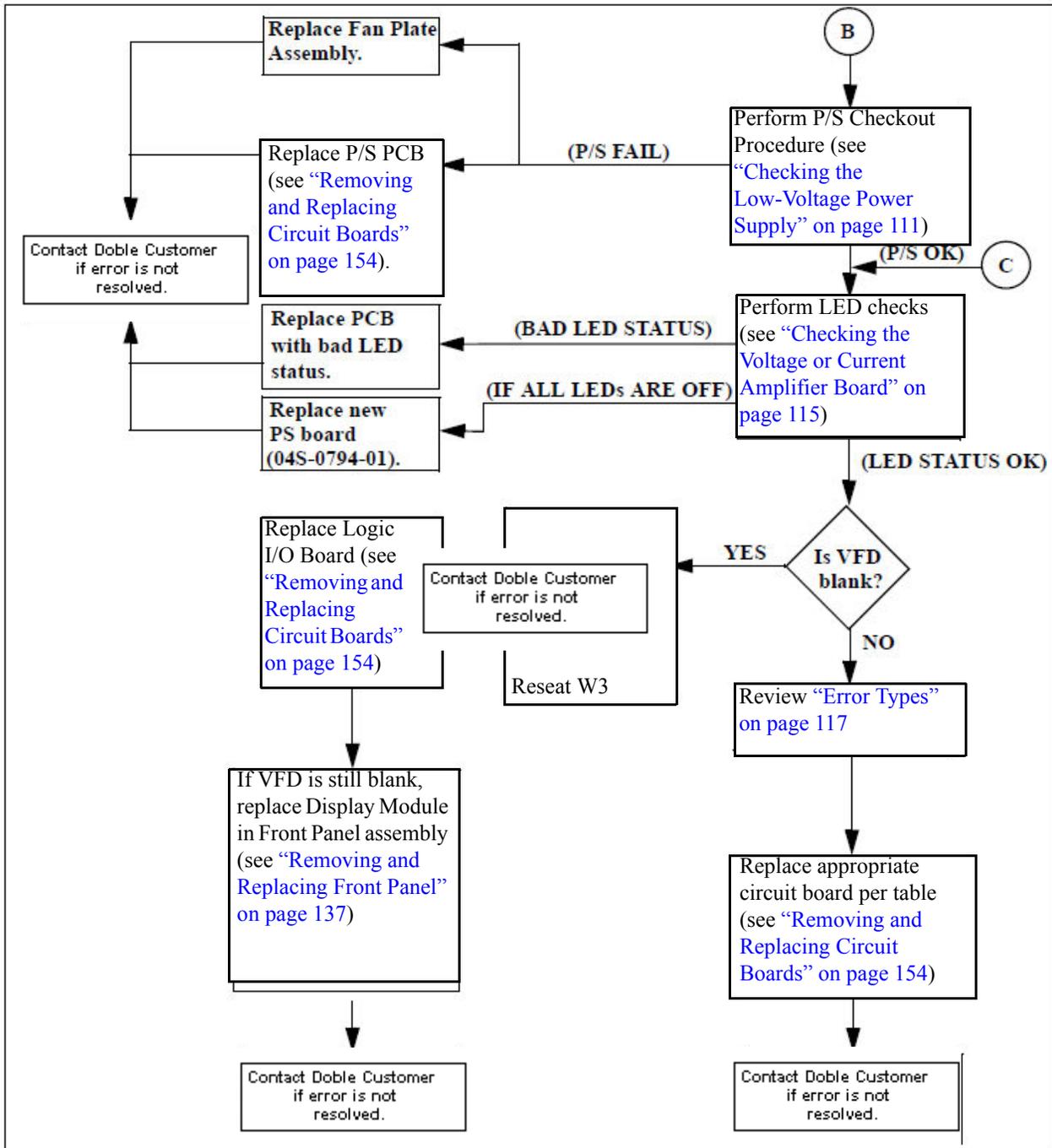
## Troubleshooting Flowcharts

The following are diagnostic flowcharts to help identify and isolate problems in F6150 operation.

**Table 11 Troubleshooting Flowchart 1**



**Table 12 Troubleshooting Flowchart 2**



## LED Status Indicators

The following circuit boards have status LEDs:

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



**WARNING:** 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 CPU 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 has twelve LEDs and one push button, located at the top of the board.

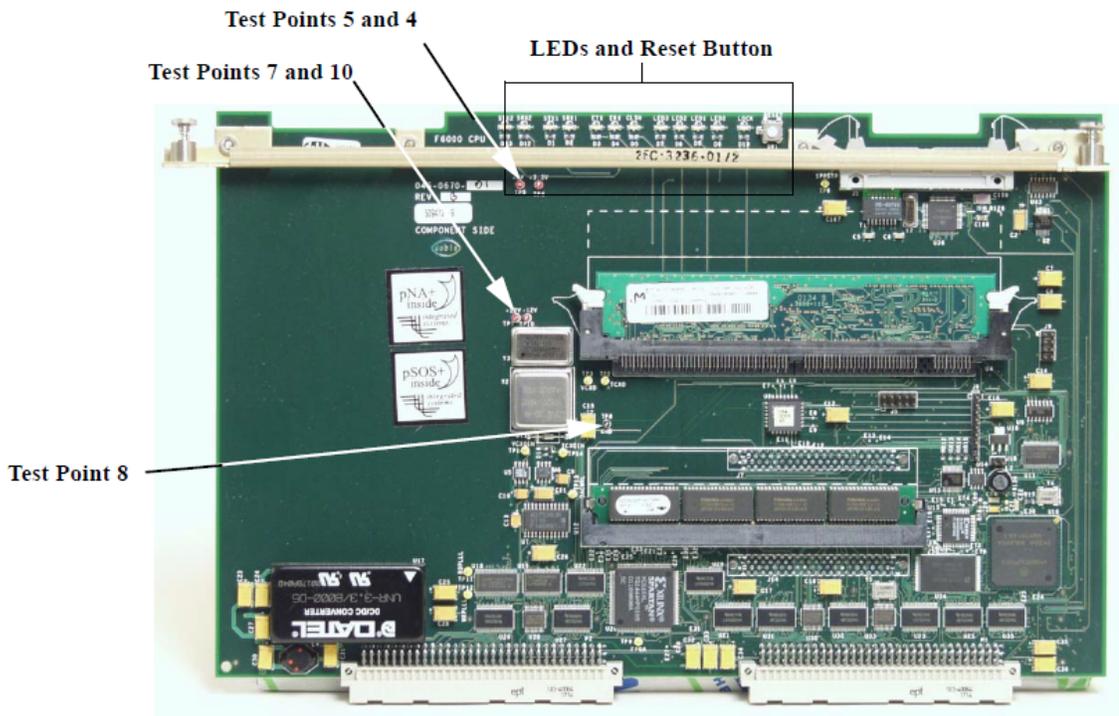


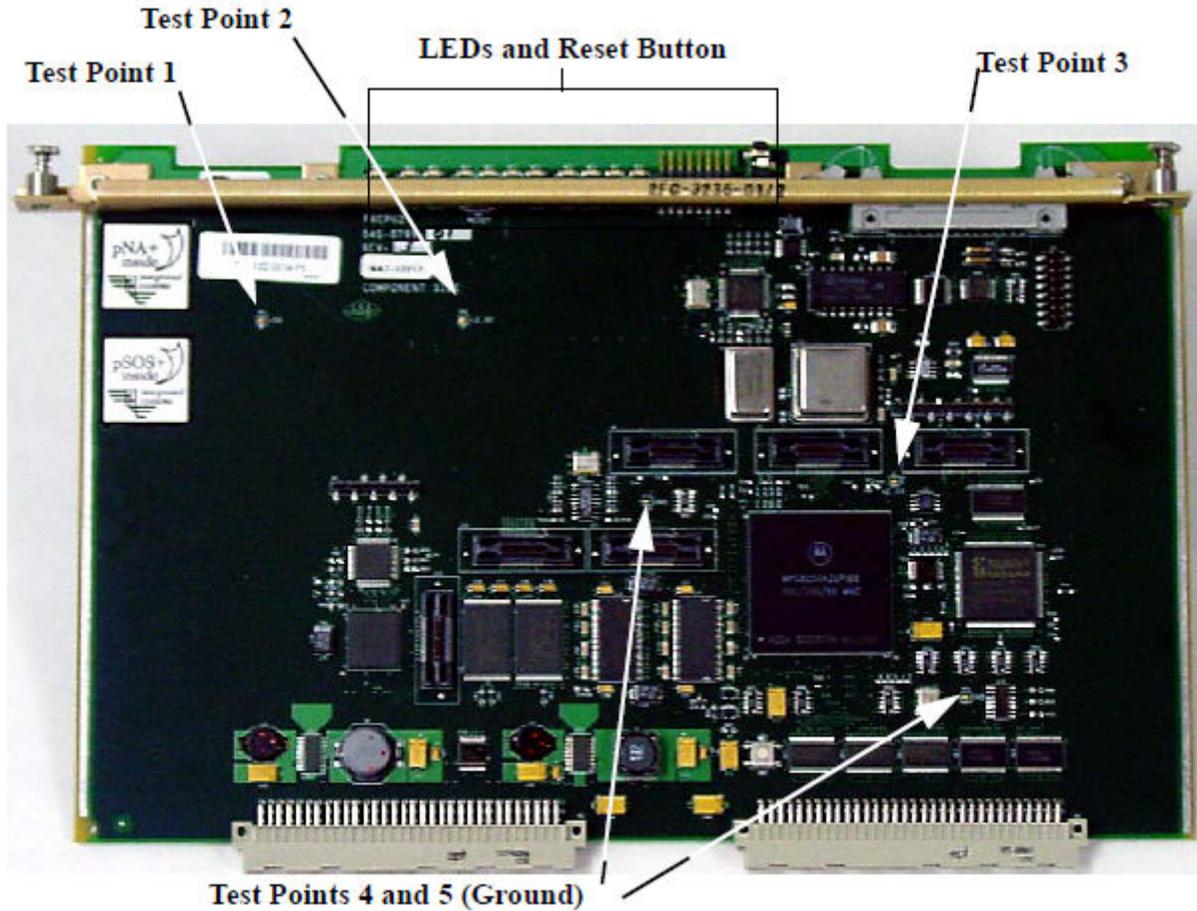
Figure 68 Slot 3 - CPU1 Board

## 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 received active.
STX1	D1	RS-232 serial port transmit active. Blinks red during RS-232 communication with the controlling PC.
SRX1	D2	RS-232 serial port receive active. Blinks red during RS-232 communication with the controlling PC.
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	D7	Ethernet collision. Blinks red during power-up and when no Ethernet cable is attached.
LED3	D8	General-purpose LEDs for CPU/RAM status and power-on self test.
LED2	D9	
LED1	D6	
LOCK	D10	

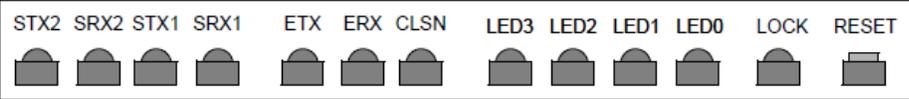
### CPU2 Versions 1 and 2

The CPU2 circuit board has nineteen LEDs in two rows at the top of the board.



**Figure 69 Slot 3 - CPU2 Board**

## 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 received active.
STX1	D2	RS-232 serial port transmit active. Blinks red during RS-232 communication with the controlling PC.
SRX1	D3	RS-232 serial port receive active. Blinks red during RS-232 communication with the controlling PC.
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.

### CPU3 (sv)

The CPU3 (sv) circuit board has LEDs in two rows at the top of the main board.



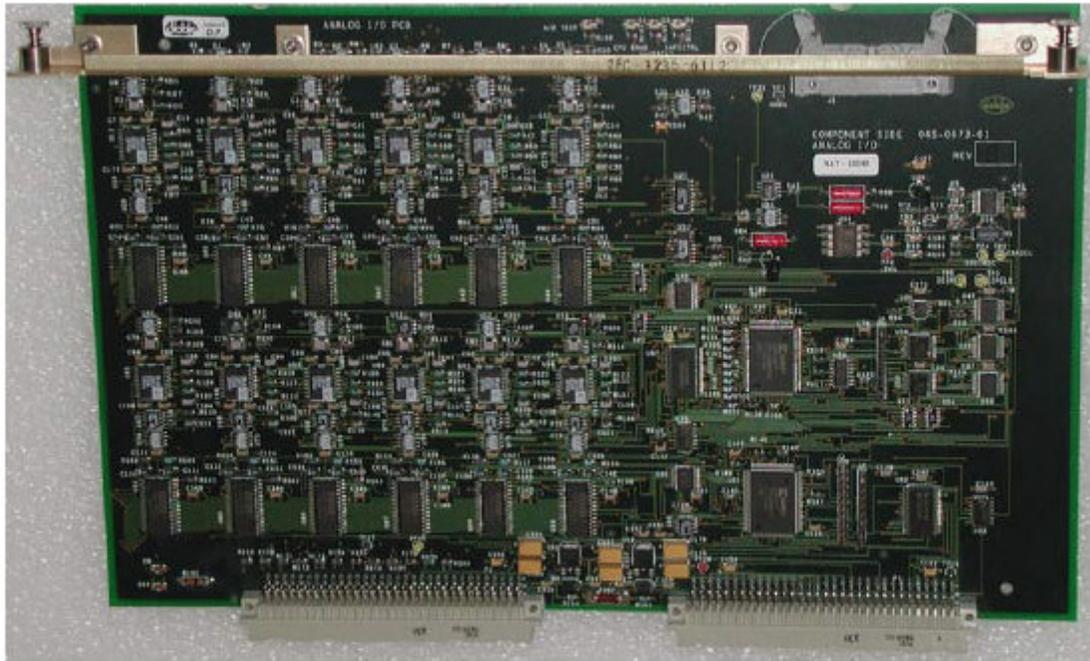
**Table 13 CPU3 (sv) LEDs**

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 received active.
STX1	D2	RS-232 serial port transmit active. Blinks red during RS-232 communication with the controlling PC.
SRX1	D3	RS-232 serial port receive active. Blinks red during RS-232 communication with the controlling PC.
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.

<b>Code</b>	<b>LED No.</b>	<b>Indication</b>
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.
for internal Doble testing	D16	This LED should always be on.
	D22	This LED should always be on.
	D44	This LED should always be on.

## Analog I/O Circuit Board

The Analog I/O circuit board is installed in slot 4 and has four LEDs. When the F6150 is powered but idle, all LEDs should be off. The table identifies the Analog I/O board LEDs.



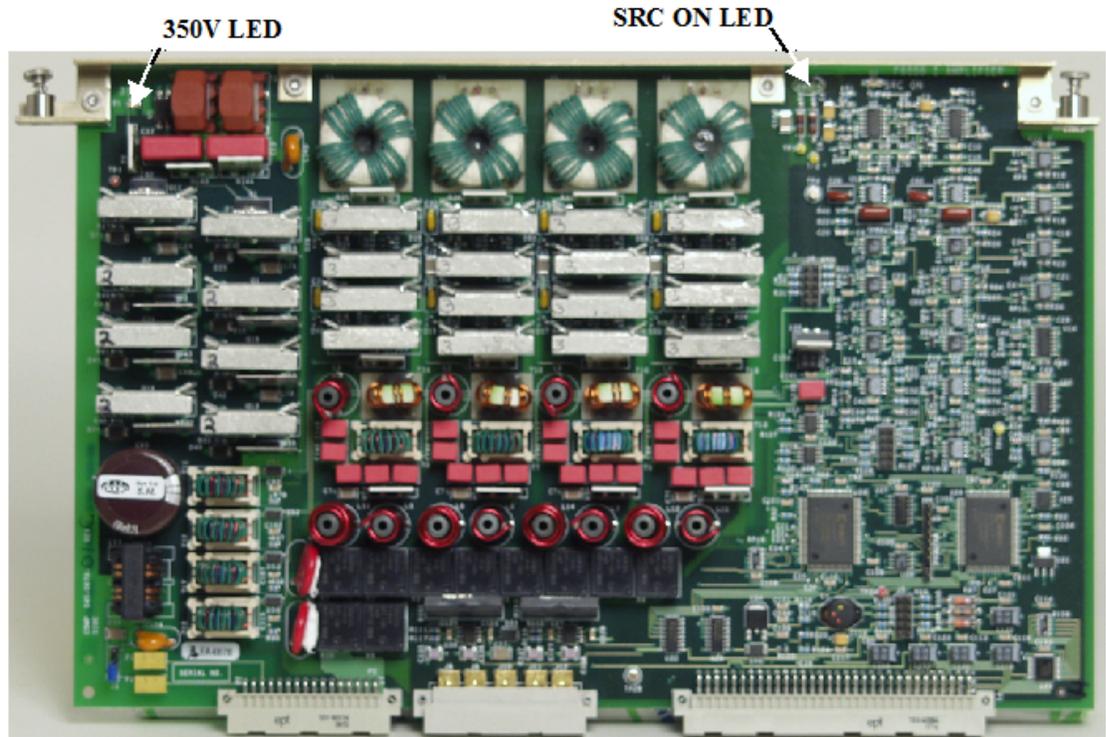
**Figure 70 Slot 4 - Analog I/O Board**

**Table 14 Analog I/O Board LEDs**

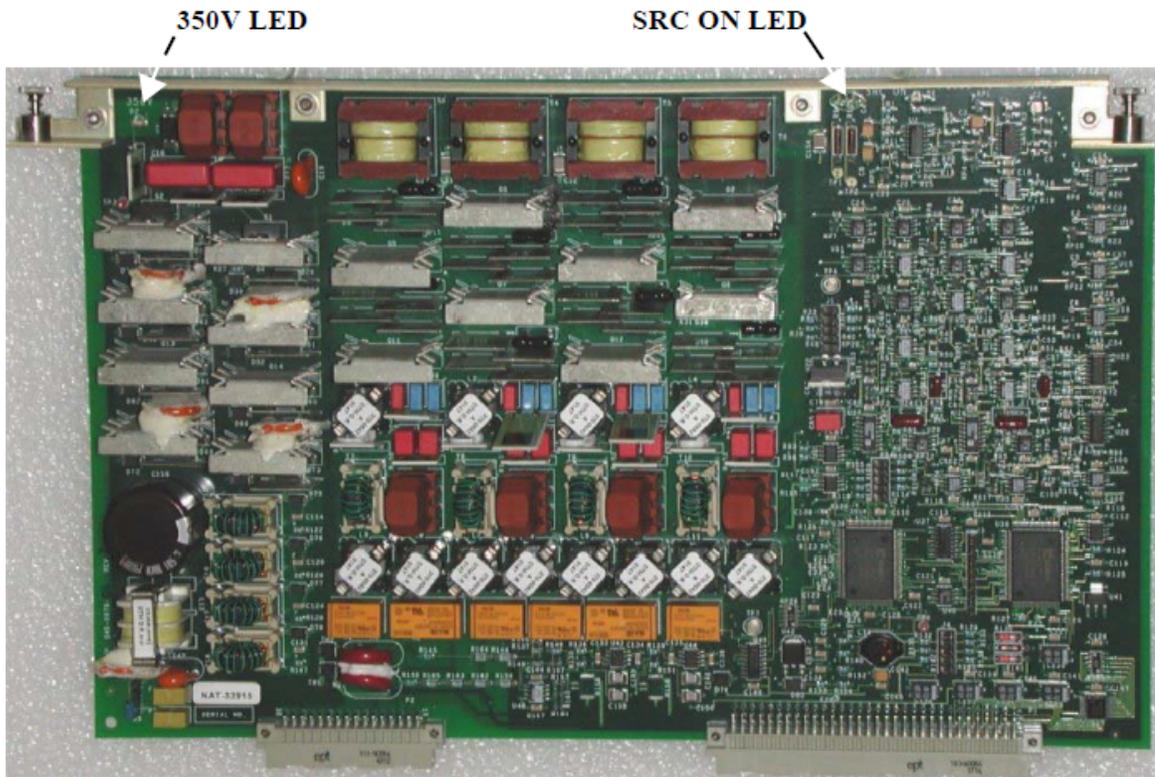
Code	LED No.	Indication
A/D Test	D1	Illuminates red during power-up only, then off. This LED is for Doble use only. If the LED illuminates steady red, the PCB may be installed in an incorrect slot.
CPU ENAB	D2	Illuminates green during power-up only, then off.
SAFESTAT	D3	Should never illuminate green 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 in slots 5–7 and three voltage/current Convertible Amplifier boards in slots 8–10.



**Figure 71 Slots 5, 6, and 7 - Current Amplifier Boards**



**Figure 72 Slots 8, 9, and 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:

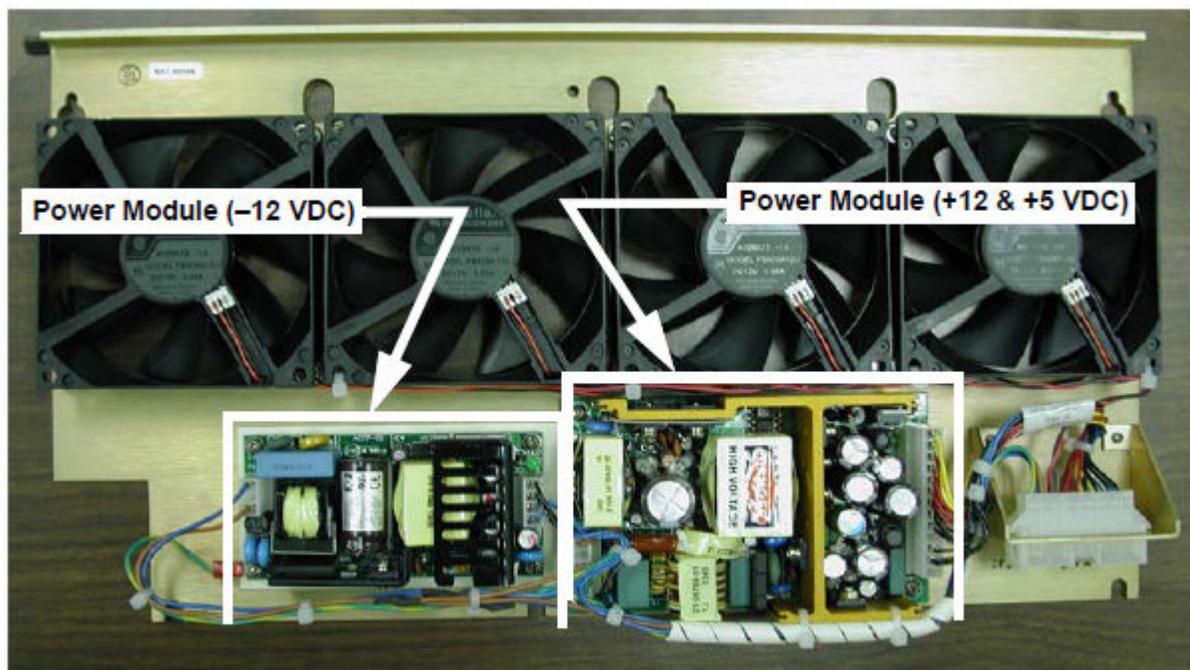
- 350V. Illuminates steady green after the power-up diagnostics pass, indicating a healthy status. This LED is located on the left side of the board, close to the top edge, as viewed from the front. If all six 350V LEDs are off, check the power supply (see [“Component Checkout Procedures” on page 111](#)).
- 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 [“Voltage and Current Amplifier Circuit Boards” on page 103](#)

## 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.

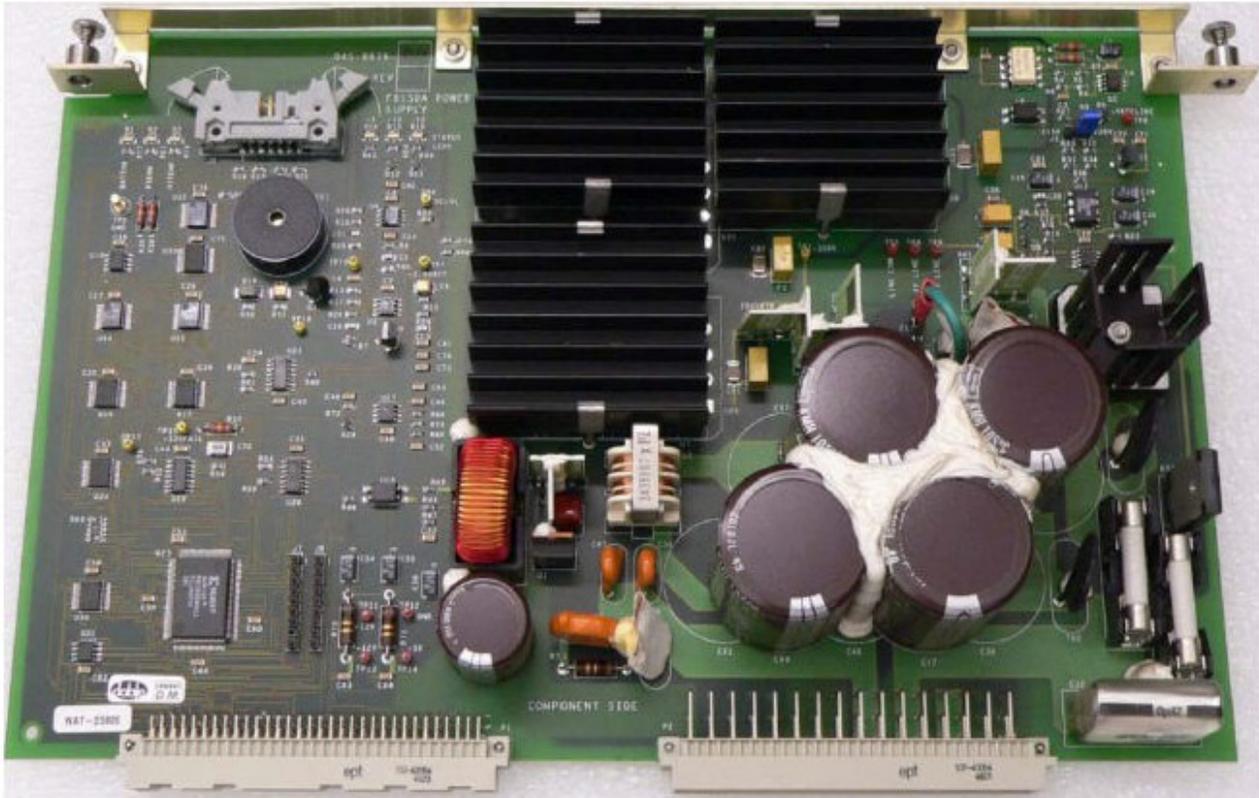
On CPU1 instruments, the low-voltage supply is on the high-voltage supply circuit board.

On CPU2 and CPU3 (sv) instruments, the low-voltage supply is at the bottom of the fan plate assembly.



*Figure 73 Fan Assembly with Integral Power Supply*

## Type 1



**Figure 74 Slot 11 - Power Supply (Type 1)**

Type 1 (earlier) power supplies (Figure 4-8) were configured for either 115 or 230 V 50/60 Hz. These models [P/N 04S-0676-01 (120V) or P/N 04S-0676-02 (220V)] have three LEDs (D1, D2, and D3) visible from the rear of the chassis (see [Table 15 on page 107](#)).

**Table 15 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.

This board supports the high/low voltage requirements and the Fixed Output Battery Simulator functions (see table further below).

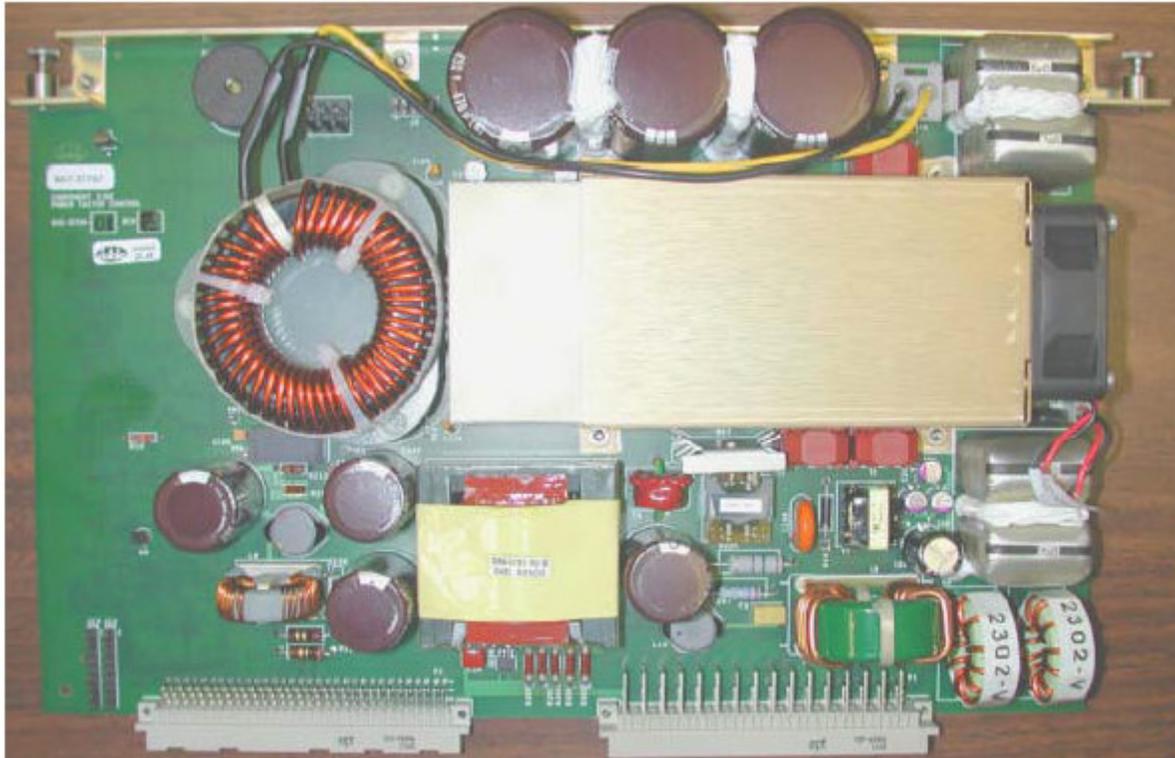
### Fuses

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.

## Type 2



**Figure 75 Slot 11 – Power Supply with Variable Output Battery Simulator (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 (P/N 04S-0794-01) has six LEDs (D20, D21, D22, D23, D4, and D25) visible from the rear of the chassis (see table). This board supports the high-voltage requirements and the Variable Output Battery Simulator functions (see table on next page).

**Table 16 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.

### Fuses

Type 2 power supply boards do not contain fuses for AC mains input. They have a 3 A fuse (P/N 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.

## Battery Simulator

The following table shows the battery simulator alternatives:

**Table 17 Battery Simulator Alternatives**

Board Part Number	Location	Option No. on VFDisplay	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

#### CPU 1

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 the table below, on the CPU1 circuit board in slot 3.

**Table 18 CPU 1 Power Supply Test Points**

Test Point	Value
4	+3.3 VDC $\pm$ 0.1 V
5	+5 VDC $\pm$ 0.1 V
7	+12 VDC $\pm$ 0.1 V
10	-12 VDC $\pm$ 0.1 V

If any voltages are not present, replace the Power Supply circuit board in slot 11 (see [Chapter 5, “Field Replacement Procedures.”](#)).

#### CPU 2 / CPU3 (sv)

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 19 on page 112](#), on the CPU2 circuit board in slot 3.

**Table 19 CPU 2 Power Supply Test Points**

Test Point	Value
1	+5 VDC $\pm$ 0.1 V
2	+3.3 VDC $\pm$ 0.1 V
3	+2 VDC $\pm$ 0.1 V

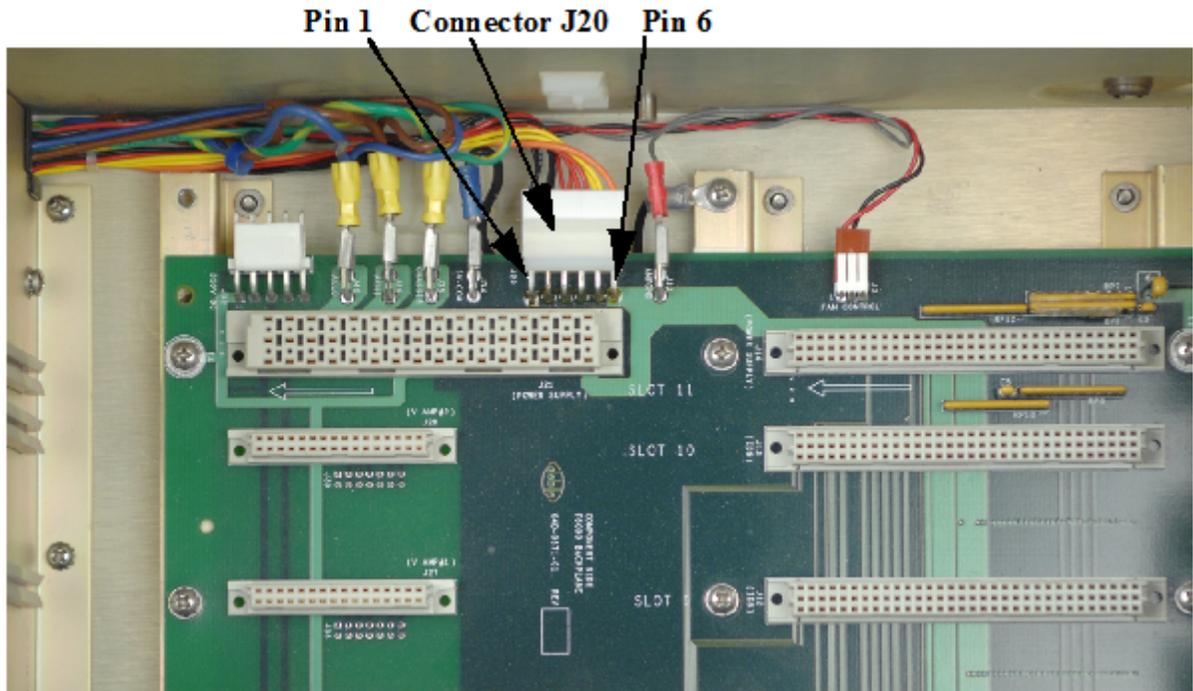
5. Measure the voltages in the following table, on pins 3 and 4 and on pins 5 and 6 of connector J20, a 6-pin Molex connector at the rear of the backplane.

**Table 20 Connector J20 Test Points**

Pin	Wire Color	Value
1	Black	Ground
2	Black	Ground
3	Red	+5 VDC $\pm$ 0.1 V
4	Red	+5 VDC $\pm$ 0.1 V
5	Yellow	+12 VDC $\pm$ 0.1 V
6	Blue	-12 VDC $\pm$ 0.1 V

6. Pin 1 is at the left side of the connector, looking down from the front.

If any voltages are not present, replace the fan plate assembly (see [Chapter 5, “Field Replacement Procedures.”](#)).



**Figure 76 Connector J20 Test Points at Rear of Backplane (Top View)**

## 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 (P/N 04D-0598-01). See [“Removing and Replacing Battery Simulator” on page 160.](#)

## Variable Output Battery Simulator (VOBS) - Standalone

Instruments with a standalone VOBS (P/N 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 [“F6150 with Variable Output Battery Simulator” on page 160](#)).
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 [“Field Replacement Procedures” on page 131](#)).
  - 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 (P/N 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 [“Removing and Replacing Battery Simulator” on page 160](#)).

## 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”](#), above).
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 page 154](#)).

## 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 page 154](#)).

## 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 over-temperature condition occurs.



**CAUTION: 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 Cover” on page 134](#)).
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 (P/N 04S-0676-01 or P/N 04S-0676-02).
  - If the L1 inductor has not broken loose, replace the fan (see [“Removing and Replacing Cooling Fans” on page 164](#)).

There are two styles of cooling fan assemblies. Some instruments have a fan assembly with an integrated power supply (P/N 03D-1587-01). See [“Removing and Replacing Cooling Fans” on page 164](#), for removal instructions.

Equipment with the older style fan assembly (without an integrated power supply) uses a different removal procedure (see [“Removing and Replacing Cooling Fans” on page 164](#)).

## 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.

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 [“Field Replacement Procedures” on page 131](#), 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.



**CAUTION: 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).**

The following table describes hardware errors and possible solutions.

**Table 21 Hardware Errors**

Error Message	Description	Action
Cal A/D hardware failure	The analog- to-digital converter calibration hardware failed.	Replace the analog I/O board. (Refer to <a href="#">Chapter 5, “Field Replacement Procedures.”</a> , when replacing boards.)
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 <a href="#">“Checking the Low-Voltage Power Supply” on page 111</a> ). <ul style="list-style-type: none"> <li>• If the voltages are not correct, replace the Power Supply board.</li> <li>• If the voltages are correct, replace the Analog I/O board.</li> </ul>
Analog I/O –5V out of range	The instrument reads out of range.	Check the power supply with a voltmeter (see <a href="#">“Checking the Low-Voltage Power Supply” on page 111</a> ). <ul style="list-style-type: none"> <li>• If the voltages are not correct, replace the Power Supply board.</li> <li>• If the voltages are correct, replace the Analog I/O board.</li> </ul>

Error Message	Description	Action
Analog I/O +5V out of range	The instrument reads out of range.	Check the power supply with a voltmeter (see <a href="#">“Checking the Low-Voltage Power Supply” on page 111</a> ). <ul style="list-style-type: none"> <li>If the voltages are not correct, replace the Power Supply board.</li> <li>If the voltages are correct, replace the Analog I/O board.</li> </ul>
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.
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 <a href="#">“Checking the Low-Voltage Power Supply” on page 111</a> ). Replace the board if necessary.
Bad/Blank CPU EEPROM	The CPU board is bad or the EEPROM has no data.	Replace the CPU board.
Metering option required	The F6800 transducer interface option is required.	Get new Key Code from Customer Service.

<b>Error Message</b>	<b>Description</b>	<b>Action</b>
Missing analog input measurement board	Hardware is missing or not communicating properly with the CPU.	If missing, get new hardware. If defective, replace.
GOOSE option required	The F6860 UCA GOOSE option is required.	Get GOOSE option from Customer Service.
Comtrade Clipping	The Comtrade file being played back as a transient contains values that are outside the range of the source and the waveform is clipped.	You are exceeding ranges. Get back into specified ranges.
L/R Clipping	The decaying exponential term resulted in values outside the range of the source and the waveform is clipped.	You are exceeding ranges. Get back into specified ranges.
F6816 Logic output overload	There is an overcurrent on a logic output in the F6816 external logic I/O board.	Check connections.
Lost communication with F6816	Communication is lost with the F6816 external logic I/O board.	Check communication cable between F6150 and F6816.
BUS Timeout	The F6150 microprocessor had a bus timeout.	Check with Customer Service.

## 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.

The following table defines common source errors:

**Table 22 Common Source Errors**

<b>Error</b>	<b>Description</b>	<b>Action</b>
Transient over 1.5 seconds	Hardware disables the source.	Turn off the source.
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

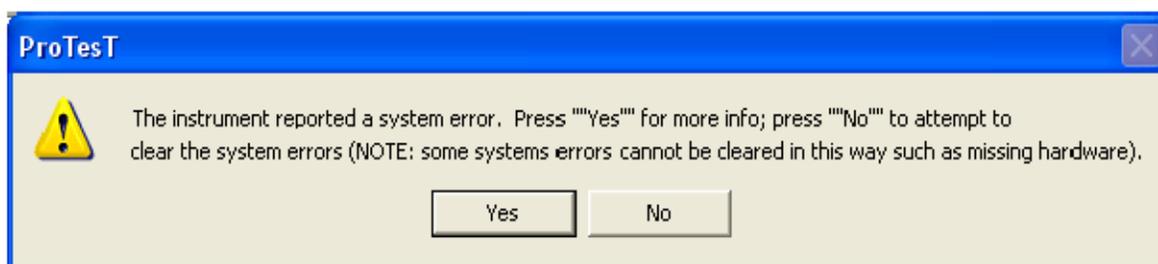
System errors display in F6ControlPanel. A system error occurs when an instrument component controlled by F6ControlPanel functions improperly. For example, if a current amplifier overheats, F6ControlPanel shows a system error message.

System errors display in a dialog box. This is the first message that appears:



**Figure 77 System Error Message**

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



**Figure 78 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).



**CAUTION: 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.**

When replacing any boards, use the following table to diagnose and correct the error. See [“Field Replacement Procedures” on page 131](#).

**Table 23 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. Another common cause for this error is that the instrument is too cold. Starting in firmware 5.3.0, F6150 displays system errors on the VFD. The application software reports either the original "voltage monitor..." or a new message. The F6150 VFD shows "Instrument is below specified operating temperature".	Reduce the input line voltage or replace the power supply (old type). If due to a cold instrument, allow time for the instrument to warm up.
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 <a href="#">Chapter 5, "Field Replacement Procedures."</a> ).
+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.

Error	Description	Action
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 <a href="#">Chapter 5, "Field Replacement Procedures."</a> when replacing this board).
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.
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. This is reported by the application software (Protection Suite, ProTest, etc.). Starting in firmware 5.3.0, the F6150 displays system errors on the VFD. The error displayed on F6150 is "Battery simulator turned off.". Battery simulator turned on, but status shows it is off.	Verify the status of the amplifier circuit boards. Toggle battery simulator enable. If condition persists, contact Doble customer service.
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.

Error	Description	Action
Missing analog I/O board	Hardware is missing or not communicating properly with the CPU. May be seen with old firmware.	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. May be seen with old firmware.	Check the communication cable. If OK, replace the Battery Simulator board (P/N 04D-0598-01).
Control Panel Mode	Option F6909 required.	Contact Doble Customer Service.
Macro Mode	Option F6910 required.	Contact Doble Customer Service.
No convertible sources	Option F6810 required.	Contact Doble Customer Service.
Instrument is below specified operating temperature.		Allow time to warm up.
Either unknown message, or, unknown message sequence received.	Application software or communication issue.	
Battery simulator turned off.	Duplicate of 3-second system error.	
Option F6860 required for GOOSE I/O.		Contact Doble to purchase the F6860 option.
Option F6800 required for metering.		Contact Doble to purchase the F6800 option.
Protocol revision 0 not supported.	Application software is using unsupported protocol.	
Comtrade data exceeds peak value supported.	Application software attempted to exceed capabilities of amplifier.	Check range to insure transient can be played back.
Test parameters caused current source to clip because of L/R exponential term.	Current source range is not sufficient to run test.	Increase the current source range or decrease the test amplitude.
Test parameters require analog input measurement board.		Contact Doble to purchase the analog input measurement board.

Error	Description	Action
F6816 detected over current condition on a logic output.		Check wiring to F6816.
Communication lost with F6816.		Check Ethernet connection to F6816.
Backplane bus timeout. Please power cycle the instrument.		If condition persists, contact Doble customer support.
Unsupported configuration of amplifiers	Hardware configuration is inconsistent with instrument model and / or purchased keys.	Insure configuration is valid.
Detailed configuration invalid.	A valid basic configuration message must come before receiving a detailed configuration message.	Insure application software is using a source configuration consistent with the instrument hardware configuration.
Front panel configuration invalid.	A valid basic configuration message must come before receiving a front panel configuration message.	Ensure application software is using a source configuration consistent with the instrument hardware configuration.
Inconsistent setting of F6300 IP / Network mask / source mask.	F6300 IP address is required when configuring F6300 sources. F6150 must have 3 voltage and 3 current amplifiers when configuring F6300 sources. Application software must send a new basic configuration message, before sending the front panel configuration message, when reconfiguring sources with a F6300.	Ensure you entered F6300 IP address. Insure F6150 has 3 voltage and 3 current amplifiers. Re-start the application software to insure it sends both a basic configuration and a front panel configuration.
F6300 can not be used in low level mode	F6150 must use it's amplifiers when using F6300 amplifiers.	Configure application to use both F6150 and F6300 amplifiers.
F6300 Did not respond, check cables and IP address / Netmask configuration.	F6150 attempted to forward a configuration message to the F6300 but F6300 did not reply.	Ensure you entered correct F6300 IP address. Insure F6150 and F6300 have the same network mask. Check Ethernet cables.

Error	Description	Action
F6300 Configuration error, may need to check low level sources cable to F6300.	The F6150 attempted to send a signal to the F6300 and the F6300 did not see the signal.	Check the low level sources cable to the F6300. Insure it is connected to the low level sources port on both ends. It is also possible for this to occur if the application software miss-configures the F6150 / F6300. If the low level source cable is properly connected then verify the configuration and re-start the application in necessary.
Waveform transmit under run.	The output signal to either the power amplifiers, or sampled value generator, was interrupted.	Either there is a CPU utilization issue or a hardware issue. If situation persists, you could try modifying the test to reduce CPU load (e.g. reduce number of timers, reduce number of sources) and re-test. If situation persists, contact Doble customer support.
Waveform transmit out of synchronization	The output signal to either the power amplifiers, or sampled value generator, was interrupted.	Either there is a CPU utilization issue or a hardware issue. If situation persists, you could try modifying the test to reduce CPU load (e.g. reduce number of timers, reduce number of sources) and re-test. If situation persists, contact Doble customer support.
Out of Buffers	System ran out of communication buffers.	Power cycle the instrument to recover the buffers. If situation persists, contact Doble customer support.

**Table 24 Power On Self Test Errors**

<b>Error</b>	<b>Description</b>	<b>Action</b>
Missing/bad (I AMP#0) SLOT 5	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (I AMP#1) SLOT 6	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (I AMP#2) SLOT 7	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (V AMP#0) SLOT 8	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (V AMP#1) SLOT 9	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (V AMP#2) SLOT 10	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (I AMP#3) SLOT 8	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (I AMP#4) SLOT 9	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad (I AMP#5) SLOT 10	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad HVPS	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.

**Table 24 Power On Self Test Errors**

<b>Error</b>	<b>Description</b>	<b>Action</b>
Bad/Blank CPU EEPROM	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Cal A/D Hardware failure	A serial ADC on the analog I/O board failed to complete a conversion. The serial ADC is used to verify operation of the analog I/O board. It is also used to do a self-calibration. If it fails then calibration constants are replaced with EEPROM values (from board calibration).	If condition persists, contact Doble customer support.
Analog I/O -5V out of range	This is a power on self-test of the analog I/O board.	If condition persists, contact Doble customer support.
Analog GND sense Failed	This is a power on self-test of the analog I/O board.	If condition persists, contact Doble customer support.
Analog I/O +5V out of range	This is a power on self-test of the analog I/O board.	If condition persists, contact Doble customer support.
DAC Calibration out of limits	This can occur either at power on or when sources are configured. When a source configuration is received the instrument does a self-calibration for DC offset of the analog I/O board. If the calculated offset is out of range then this message is displayed. In this case the calculated offset values are replaced with EEPROM values (from board was calibrated).	If condition persists, contact Doble customer support.
DAC Calibration Hardware failure	A serial ADC on the analog I/O board failed to complete a conversion. The serial ADC is used to verify operation of the analog I/O board. It is also used to do a self-calibration. If it fails then calibration constants are replaced with EEPROM values (from board calibration).	If condition persists, contact Doble customer support.
Positive DAC readback failure.	This is a power on self-test of the analog I/O board.	If condition persists, contact Doble customer support.

**Table 24 Power On Self Test Errors**

<b>Error</b>	<b>Description</b>	<b>Action</b>
Negative DAC readback failure.	This is a power on self-test of the analog I/O board.	If condition persists, contact Doble customer support.
Invalid amplifier configuration %dV,%dI	F6150 with less than 3 current amplifiers must have current amplifiers installed front to back. F6150 with less than 3 voltage amplifiers must have voltage amplifiers installed front to back. F6300 must have 6 current amplifiers. F6350 must have 3 current and 3 voltage amplifiers.	Ensure amplifier configuration is valid.
Invalid option keys for %dV,%dI amplifiers	Amplifier count exceeds limit set by option keys. Keys limit amplifier configuration as follows: F6020 2 Voltage amplifiers, F6010 1 Voltage amplifier, F6003 0 Voltage amplifiers, F6002 2 Current amplifiers, F6001 1 Current amplifiers, F6003 0 Current amplifiers.	Either remove amplifiers to achieve a valid configuration or contact Doble to purchase appropriate key configuration.
Invalid standard amplifiers in F6150sv	F6150sv must have enhanced rating current amplifiers.	Insure instrument has enhanced rating current amplifiers.
Invalid standard amplifiers in F6350	F6350 with CPU3 must have enhanced rating current amplifiers.	Insure instrument has enhanced rating current amplifiers.
Invalid image for CPU2	The image in FLASH is made for a CPU3.	Download a valid CPU2 image into FLASH and power cycle.
Invalid image for CPU3	The image in FLASH is made for a CPU2.	Download a valid CPU3 image into FLASH and power cycle.
Missing/bad Logic IO board	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Missing/bad Analog IO board	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.

**Table 24 Power On Self Test Errors**

<b>Error</b>	<b>Description</b>	<b>Action</b>
Missing/bad AIM board	A required board either does not respond or has an EEPROM checksum error.	Re-seat the board. If condition persists, contact Doble customer support.
Metering A/D Hardware failure	A serial ADC on the logic I/O board failed to complete a conversion.	If condition persists, contact Doble customer support.

## 5. Field Replacement Procedures

This set of topics 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 and F63xx 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 or F63xx, read and follow the following warnings.



**WARNING:** 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.



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

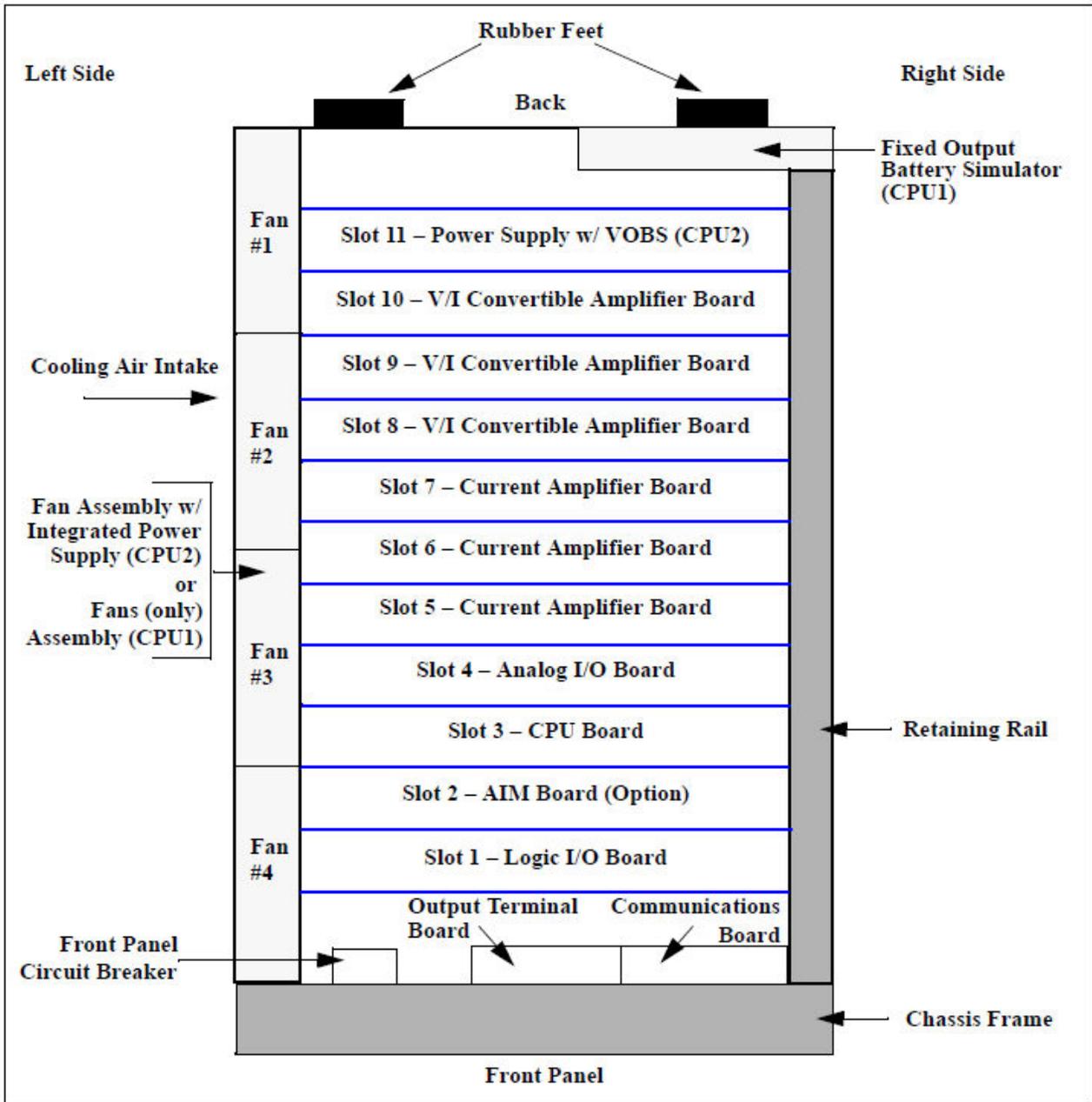


**WARNING:** The F6150 contains electrostatic-sensitive components. Practice safe handling methods to protect components against electrostatic discharge.



**WARNING:** 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 79 Top View of F6150 Component Orientation - CPU1, CPU2/CPU3(sv)**

Except for W16, all cables in the F6150 (see following table) connect to the communications board or the output terminal board on the front panel.

**Table 25 Cable Connections**

<b>Cable</b>	<b>Connects from</b>	<b>Connects to</b>
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 section.

### Removing the Cover

Remove the cover to access the replaceable components. To remove the instrument's cover:

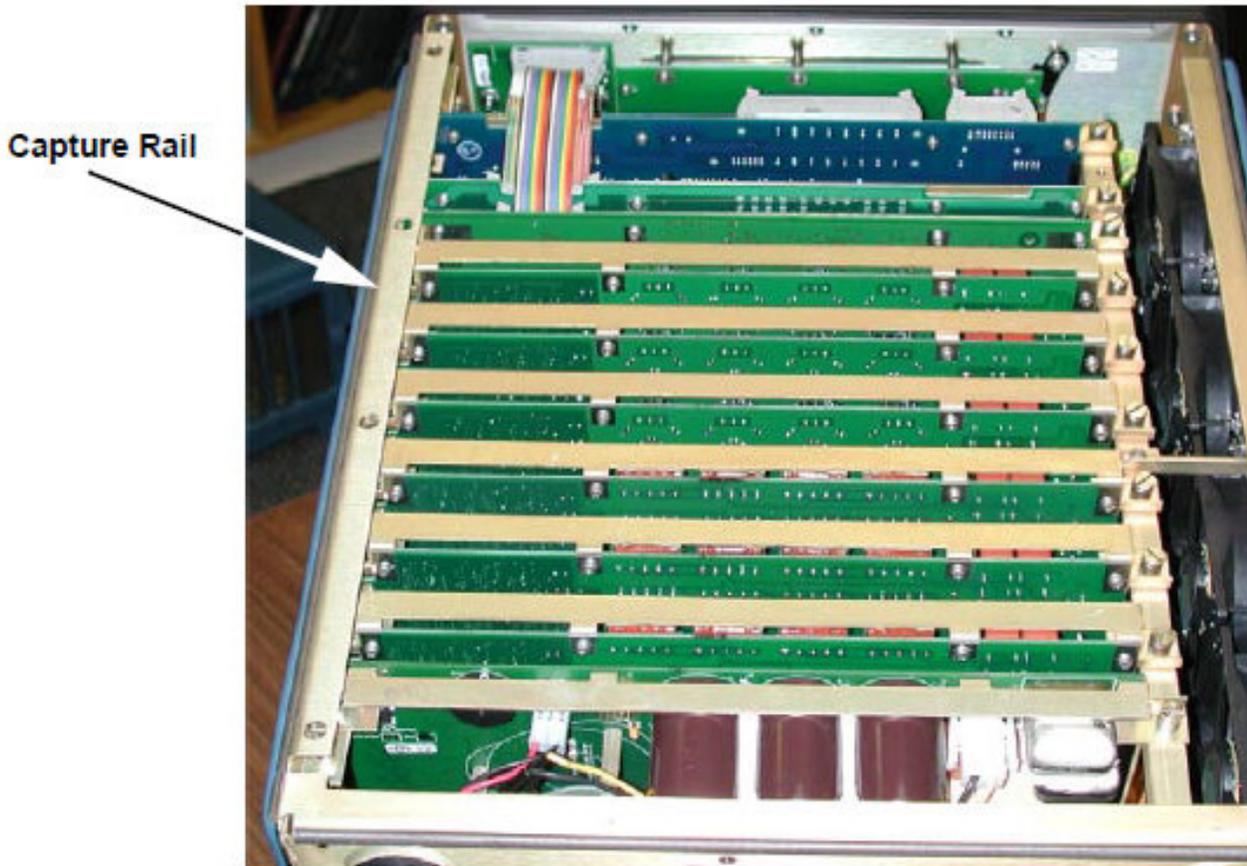
1. Power the instrument off.
2. Remove the power cord.
3. Use a flat-head screwdriver to remove the top two rubber feet from the back of the instrument.
4. Remove the cover to expose the circuit boards and other components inside the instrument.
5. On the side of the capture rail, remove the screw at 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 80 Rubber Feet at the Back of the Instrument**



**Figure 81 Internal Components and Capture Rail**

## Power Up and Perform a Visual Check

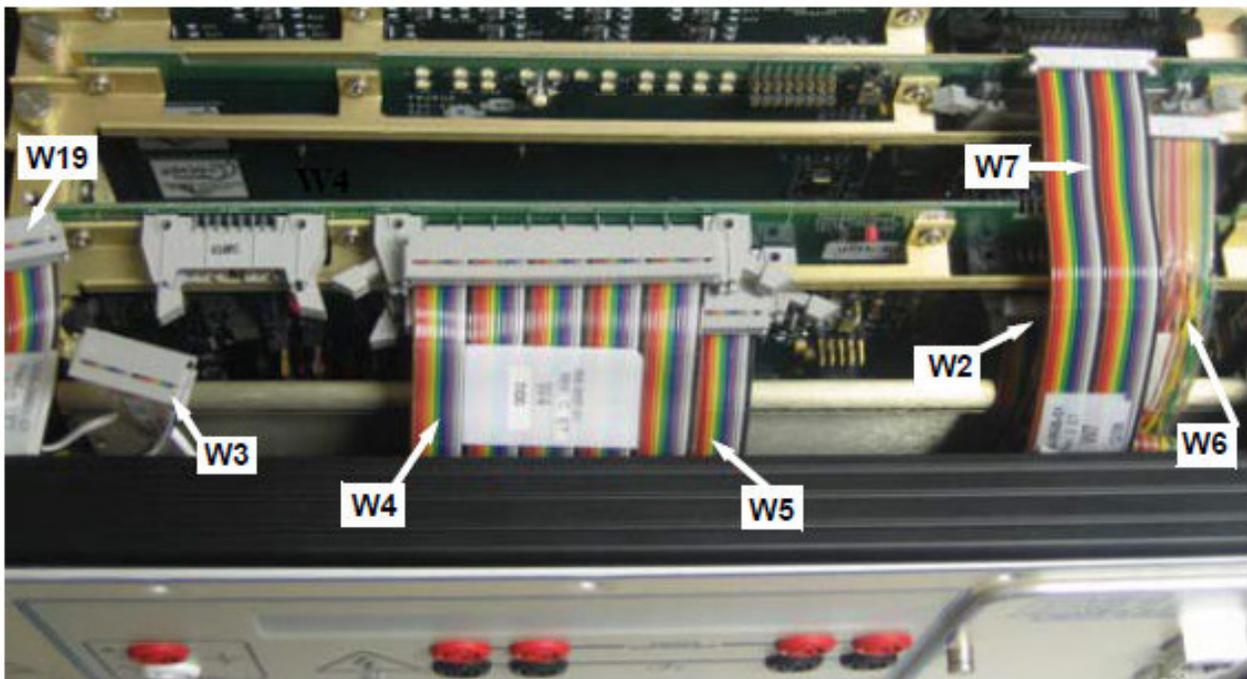
For the initial power-up and visual check:

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 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.
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.
4. If your instrument is equipped with a W19 ribbon cable, disconnect that as well.

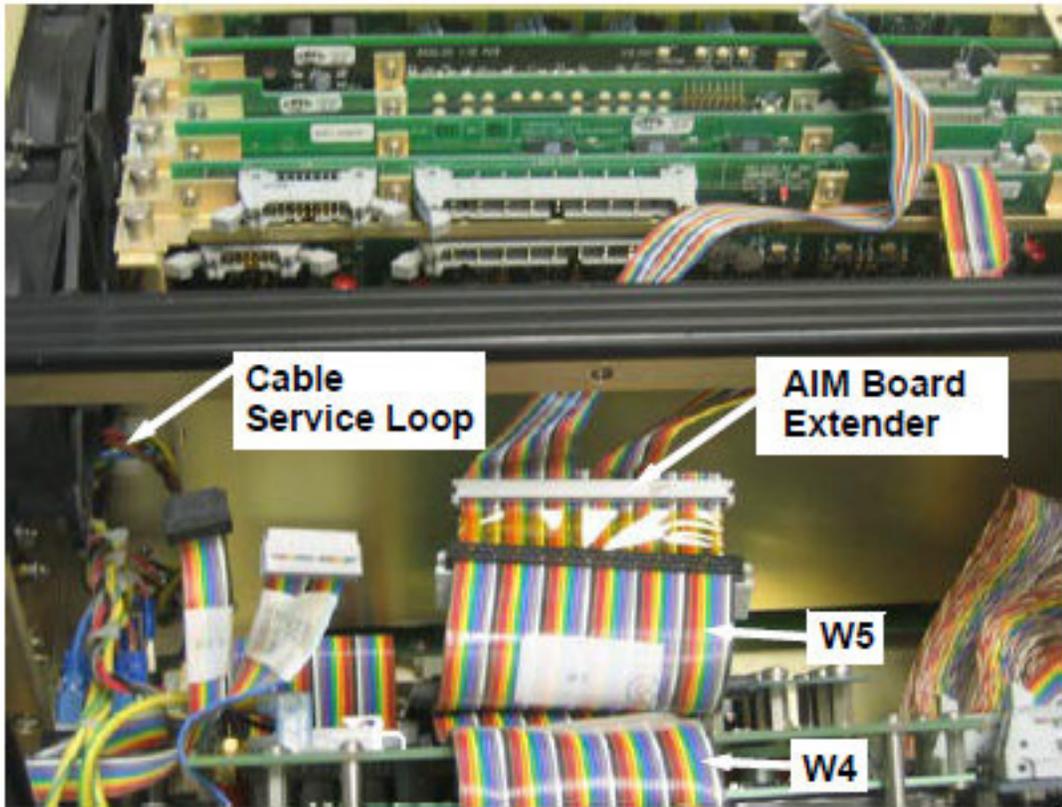


**Figure 82 Ribbon Cables**

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



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



**Figure 83 W5 Connector Plugged into AIM Board Extender**

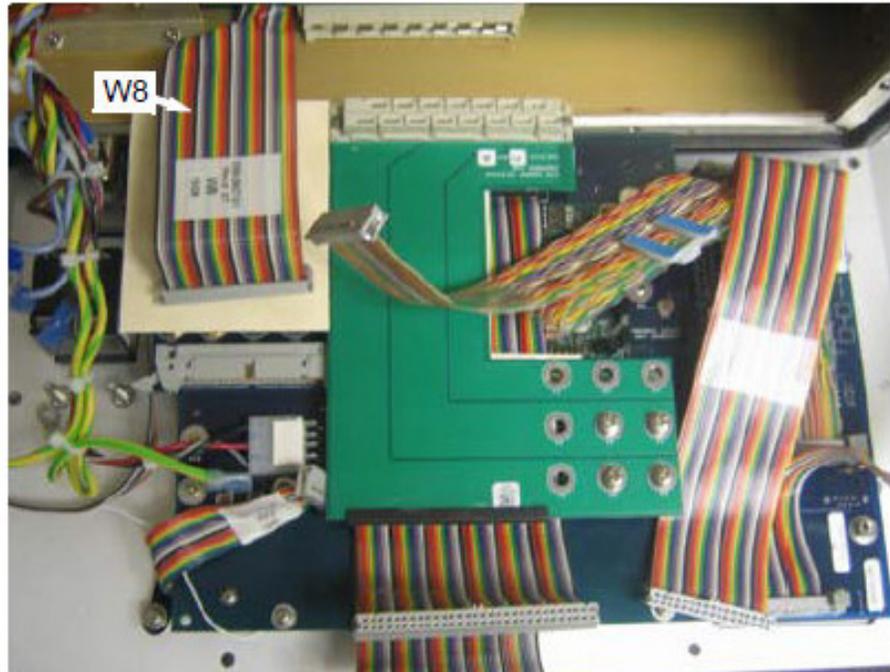
5. Remove the 12 hex-head retaining screws from around the edge of the front panel.
6. Gently pry the front panel away from the unit, starting at the top and working down the left and right hand sides until the connector at the bottom disengages.



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

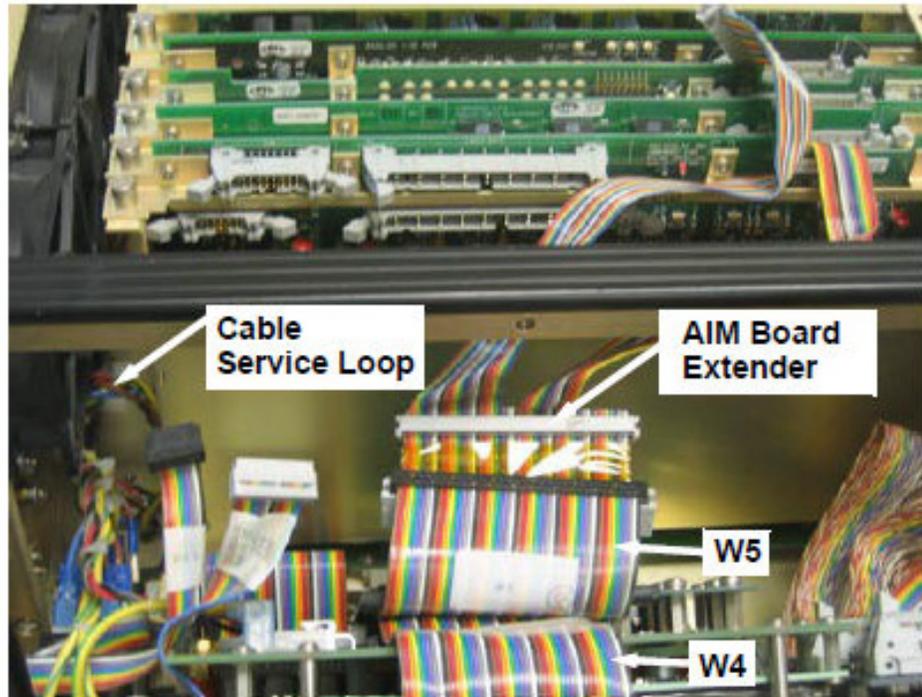
7. After the connector has disengaged, gently pull the top of the front panel forward to an angle of about 30 degrees. This will allow access to the wiring connecting the front panel to the main chassis.

8. Disconnect the W8 connector from the back of the printed circuit board (see below).



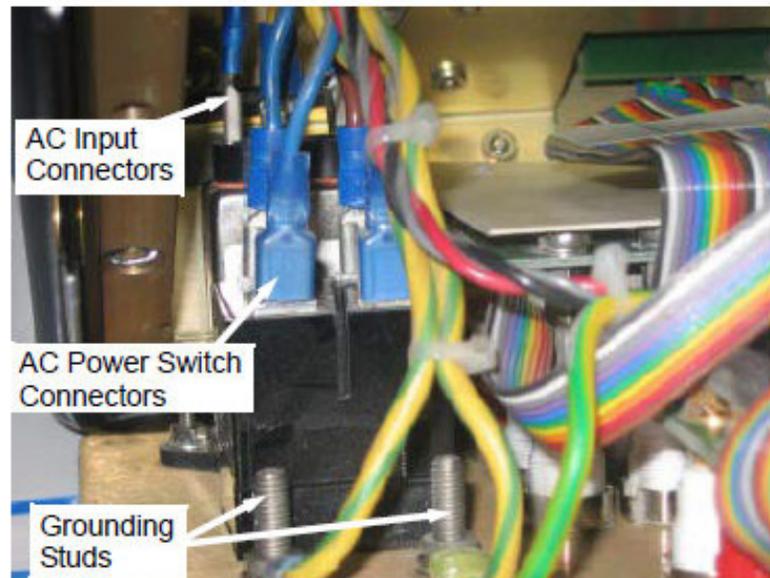
**Figure 84 W8 Connector and Front Panel Components (Rear View)**

9. Pull the cable service loop carefully forward from the opening at the left side of the chassis.



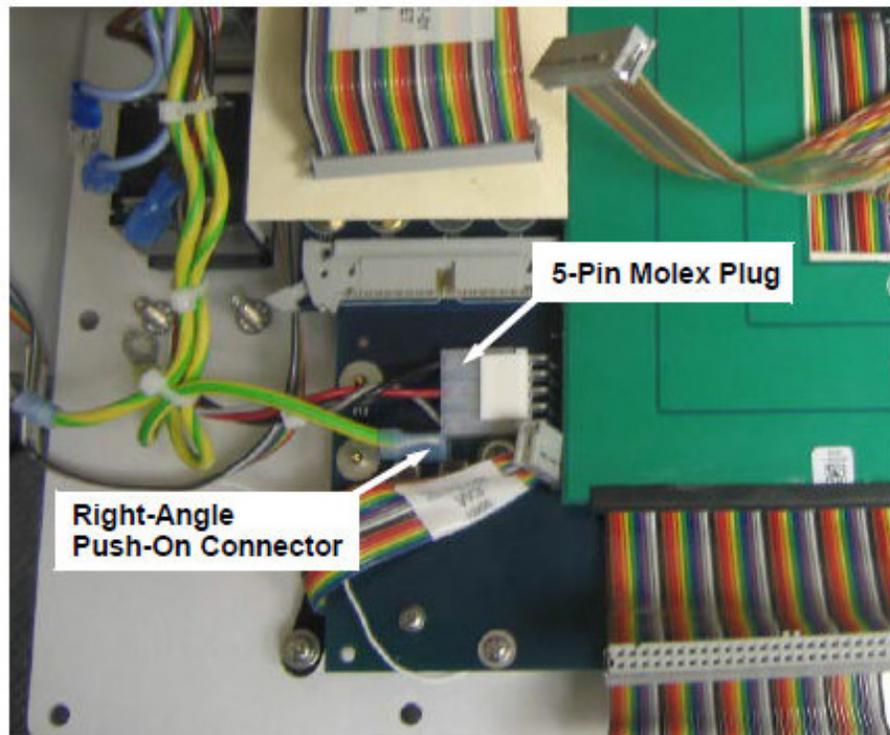
**Figure 85 W5 Connector Plugged into AIM Board Extender**

10. Place the front panel flat face down on a protective surface in front of the instrument.
11. With a 5/16" open-end wrench or nut driver, remove the nuts from the two studs that retain the green/yellow ground wires on the left above the AC power switch (Figure 85). Remove the wires from the studs.



**Figure 86 Rear of Front Panel - Yellow/Green Ground Wires and AC Connectors**

12. Remove the two brown and two blue wires with push-on connectors from the AC power switch (see above).
13. 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 86).
14. Remove the green/yellow wire with a right-angle push-on connector from the left side of the printed circuit board (Figure 87 on page 142).



**Figure 87 Rear of Front Panel - Green/Yellow Ground Wire and 5-Pin Molex Plug**

15. Remove the five-pin Molex plug from the left side of the printed circuit board (see [Figure 87](#)).

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

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## Front Panel Replacement

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.

1. 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 figures earlier in this topic, as needed.
2. Attach the shortest green/yellow wire with a push-on connector to the center terminal of the AC input connector.
3. Attach the short blue wire with a push-on connector to the left terminal of the AC input connector.
4. Attach the short brown wire with a push-on connector to the right terminal on the AC input connector.
5. Attach the medium-length blue wire with a push-on connector to the left bottom terminal of the AC power switch.
6. Attach the medium-length brown wire with a push-on connector to the right bottom terminal of the AC power switch.
7. Attach the long blue wire with a push-on connector to the top left terminal of the AC power switch.
8. Attach the long brown wire with a push-on connector to the top right terminal of the AC power switch.
9. Attach the long green/yellow wire with a blue connector sleeve to the left stud of the front panel.
10. Attach the long green/yellow wire with a yellow connector sleeve to the right stud of the front panel.
11. Assemble the previously removed nuts and lock washers to the front panel grounding studs and tighten securely.
12. Attach the long green/yellow wire with a right-angle push-on connector to the blade terminal on the printed circuit board.
13. Snap the five-pin Molex plug into the five-pin connector on the printed circuit board.
14. 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.

15. Reconnect ribbon cable W8.
16. Thread the other ribbon cables between the card cage and the top rail.
17. Fold ribbon cables W4 and W5 (the large cables in the center of the front panel) back over the top rail.
18. 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.
19. Carefully align the two connectors. Make sure the bottom of the front panel is inside the bottom rail.
20. Press lightly on the bottom center of the front panel to mate the two connectors.
21. 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 (see [Figure 88](#)).



**Figure 88 Routing of W6 and W7 Ribbon Cables**



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



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

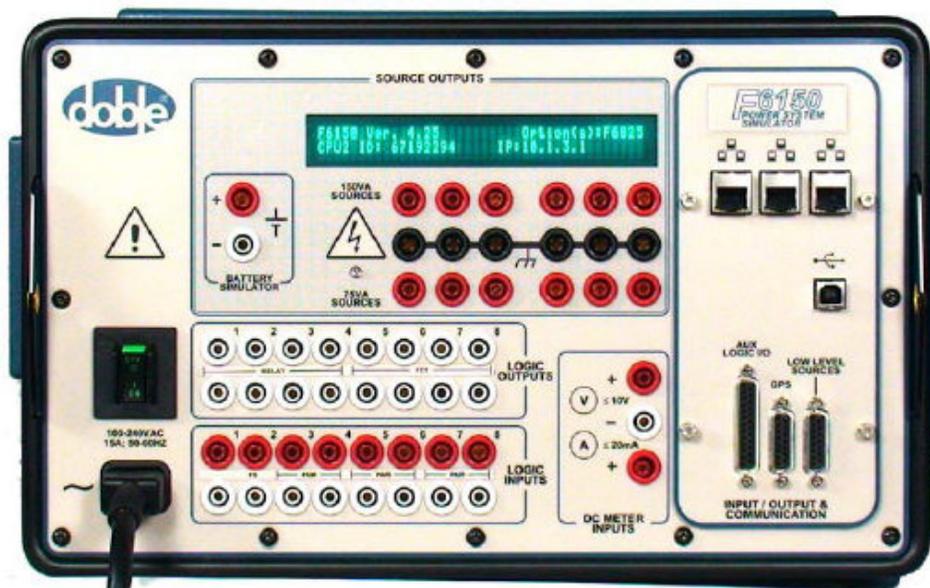
22. Turn the instrument on and verify that it powers up correctly. If it does, proceed to the next step. If the instrument is not functioning properly, review the preceding steps and attempt to remedy the problem.
23. Reinstall the front panel retaining screws.



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

24. Install the cover.
25. Reinstall the two rubber feet at the top rear of the instrument housing.

The front panel replacement procedure is complete (below).



**Figure 89 Completed Installation**

## Removing and Replacing Communications Board

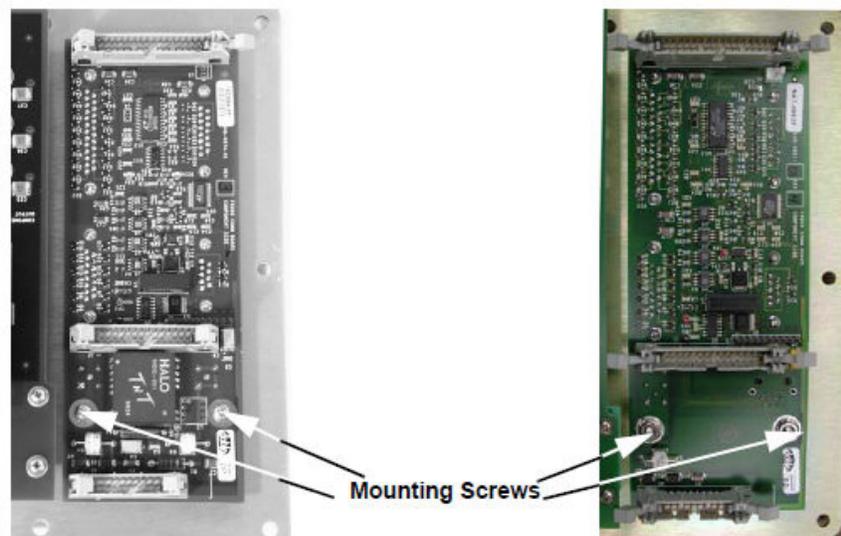
The communications board supports the input and output terminals on the right side of the front panel.

### CPU1 and CPU2 Version 1 Instruments

<b>!</b>	<b>NOTE: Upgrading the communications board on a CPU1 instrument also requires upgrading the CPU1 board to a CPU3 board.</b>
----------	--

#### Removal

1. Follow Steps 1–8 in [“Removing and Replacing Front Panel”](#) on page 137.
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 (see below).
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).
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 90 Communications Boards Ready for Removal (CPU1 and CPU2 Version 1)**

## 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 (see above).
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.
5. Be sure the connector at the bottom of the front panel mates properly with the connector on the motherboard.
6. Secure the front panel to the instrument chassis with the 12 hex-head screws.
7. Reconnect the W2, W3, W4, W5, W6, and W7 ribbon cables.
8. Replace the instrument cover.

## CPU2 Version 2 Instruments

### Removal

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

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 (see [Figure 91 on page 149](#)).
3. Withdraw the board from the opening far enough to disconnect the three ribbon cable connectors.

4. Remove the board.



**Figure 91 Removing the Communications Board (CPU2 Version2)**

### 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 91](#)).
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.

## F6150 CPU Wi-Fi Communications Board Installation

This section shows how to install the Wi-Fi comm board in instruments that have a CPU2 processor. The Wi-Fi board is necessary to use the Mobile Control Panel application.

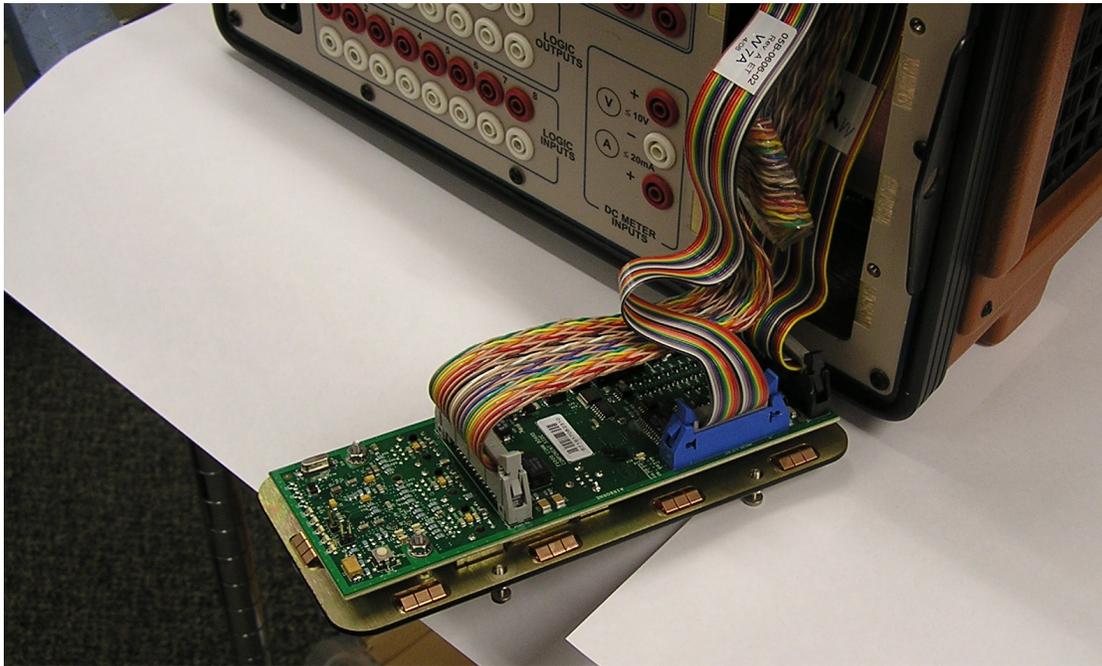
### Step 1: Remove Communications Board

1. Remove the four screws that hold the communications board in the front panel.



**Figure 92 Remove These Four Screws**

2. Pull the communications board partly out of the front panel and disconnect the three ribbon cables from the rear of the board. Mark the cables so that you can re-install them in the correct positions on the new board.

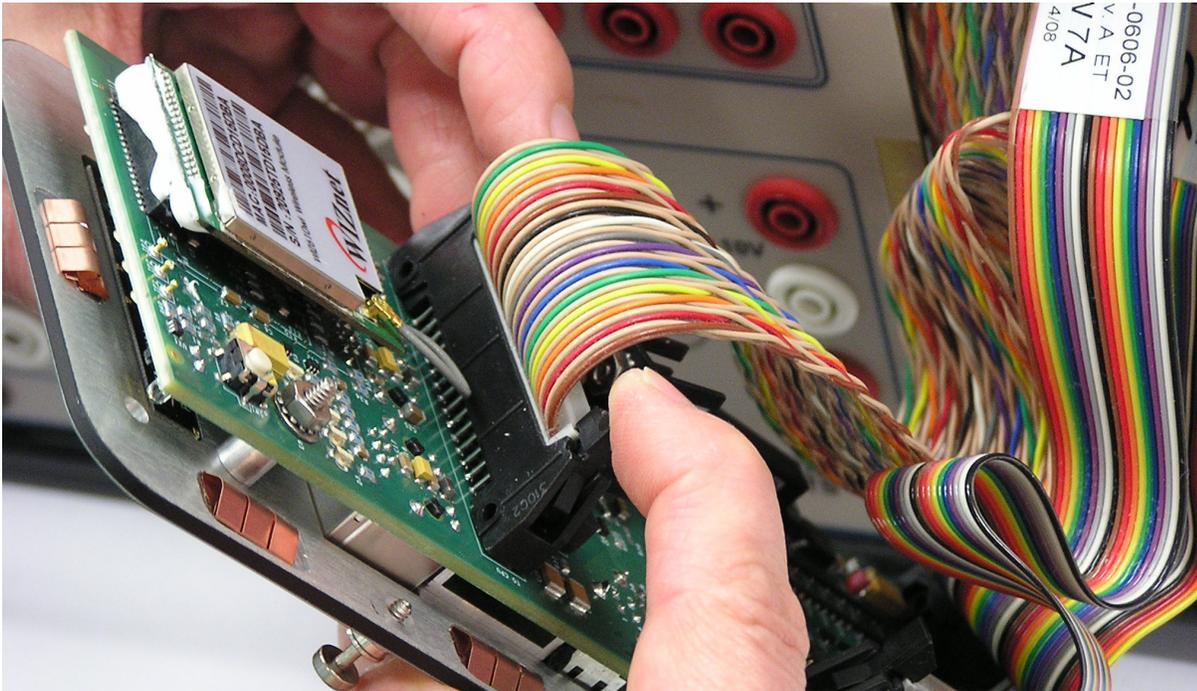


**Figure 93 Disconnect Three Cables**

3. Remove the comm board from the instrument.

## Step 2: Place New Module

1. Connect the three ribbon cables to the same positions on the rear of the new comm board. Press each connector down until the levers lock.



**Figure 94 Connect Cables to Wi-Fi Comm Board**

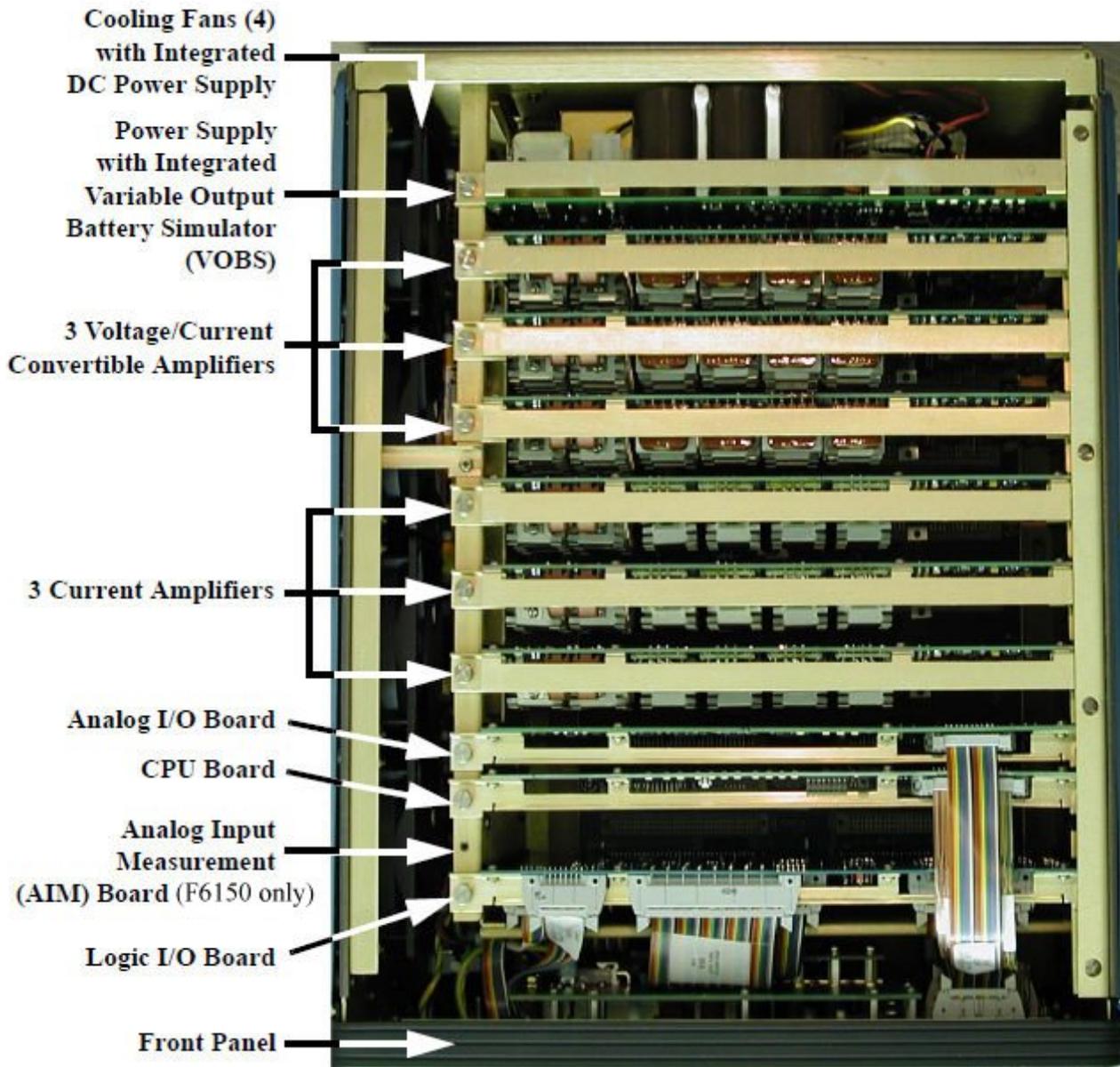
2. Place the new communications board in the front panel.
3. Seat the comm board.
4. Re-install the four screws.



5. Install firmware V. 4.3.1.

## 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. The figure below shows circuit boards in the F6150. The F6300 adds three current amplifiers (for a total of six), instead of three voltage amplifiers.



**Figure 95 Component Locations**



**CAUTION:** 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.

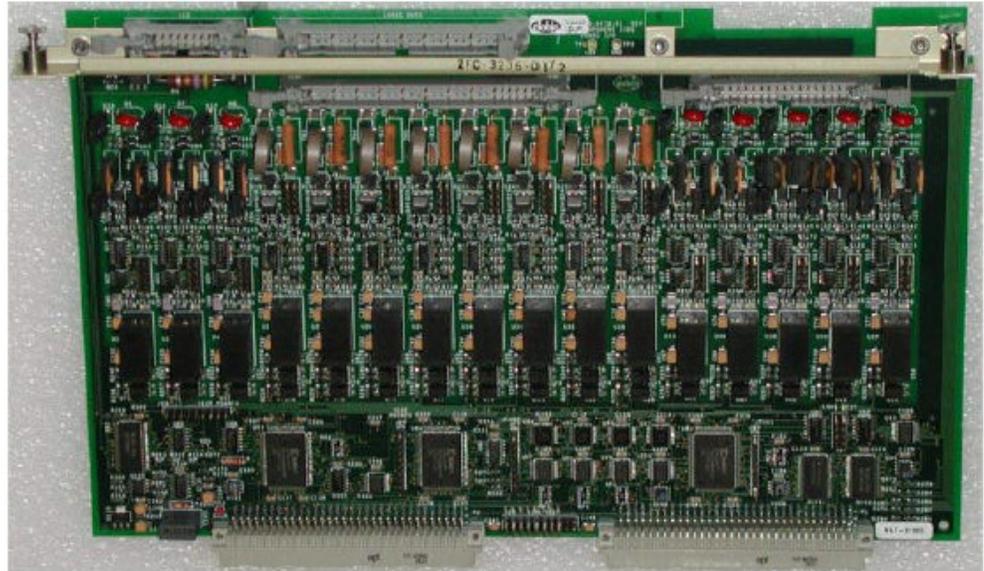
## Installation

1. Place the new board firmly in the slot and make sure it is squarely seated.
2. Reattach ribbon cables if necessary. Use the table below to verify the placement of all cables.

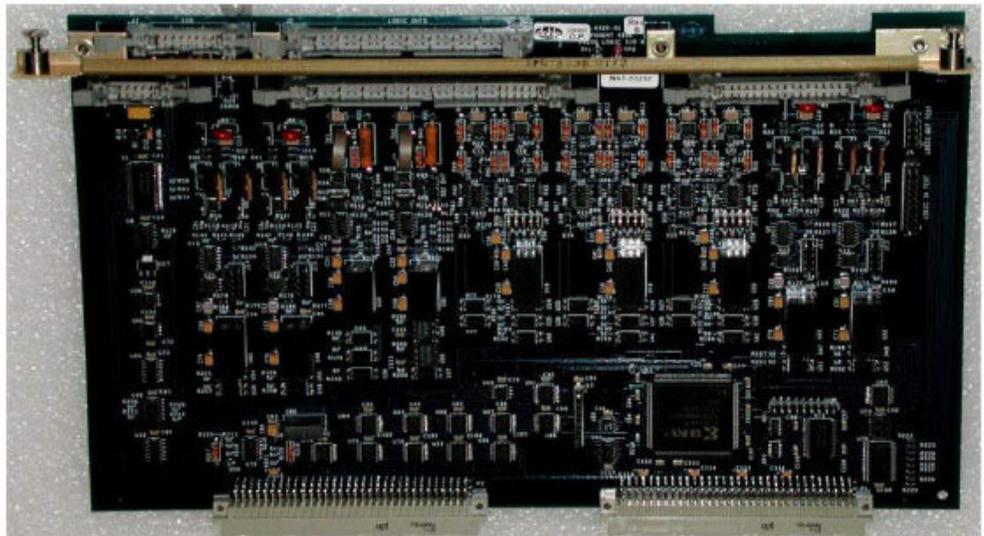
**Table 26 Cable Connections**

<b>Cable</b>	<b>Connects from</b>	<b>Connects to</b>
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

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.

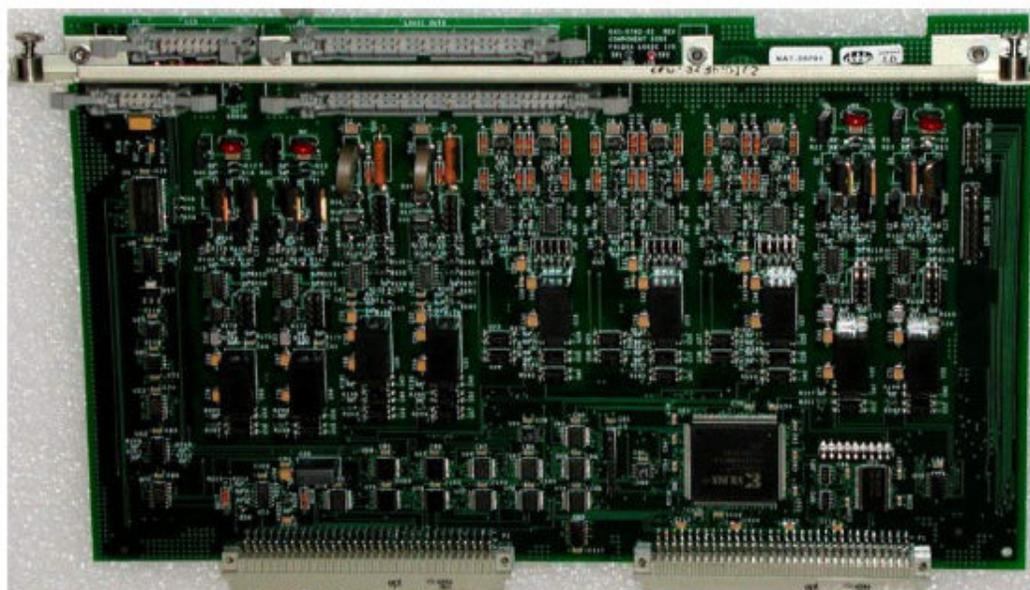


*Slot 1 – Logic I/O Board Type 1*

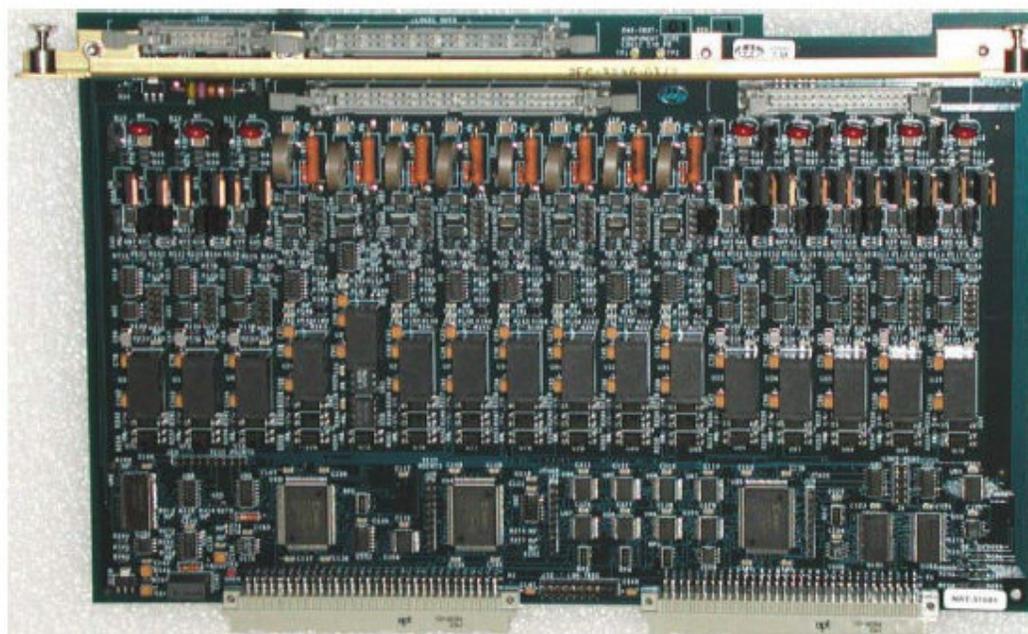


*Slot 1 – Logic I/O Board Type 2*

**Figure 96 Logic I/O Board Types**

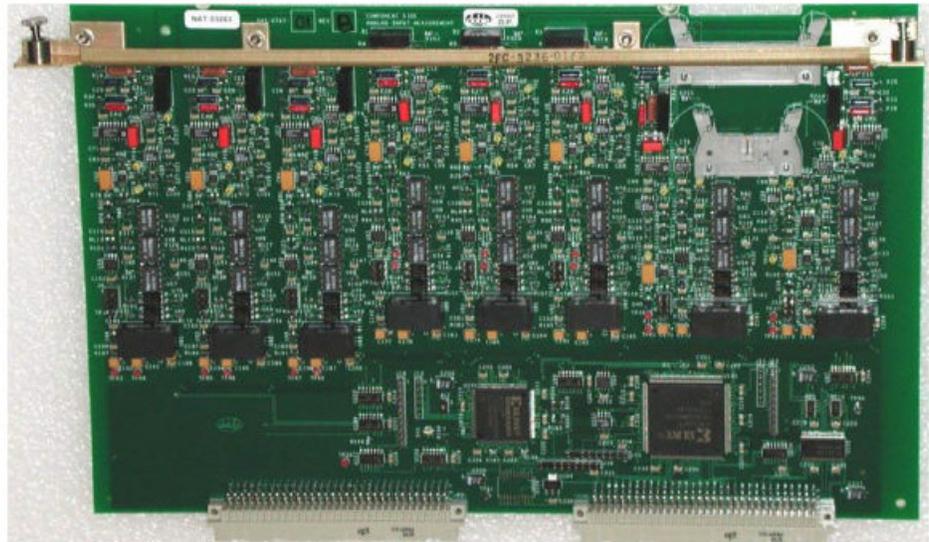


*Slot 1 – Logic I/O Board Type 4*



*Slot 1 – Logic I/O Board Type 5*

**Figure 97 Logic I/O Board Types, continued**



**Figure 98 Slot 2 - Analog Input Measurement (AIM) Board**



**NOTE:** The AIM board is an option for the CPU2- and CPU3-based instruments. Slot 2 is a spare (vacant) for CPU1-based instruments.

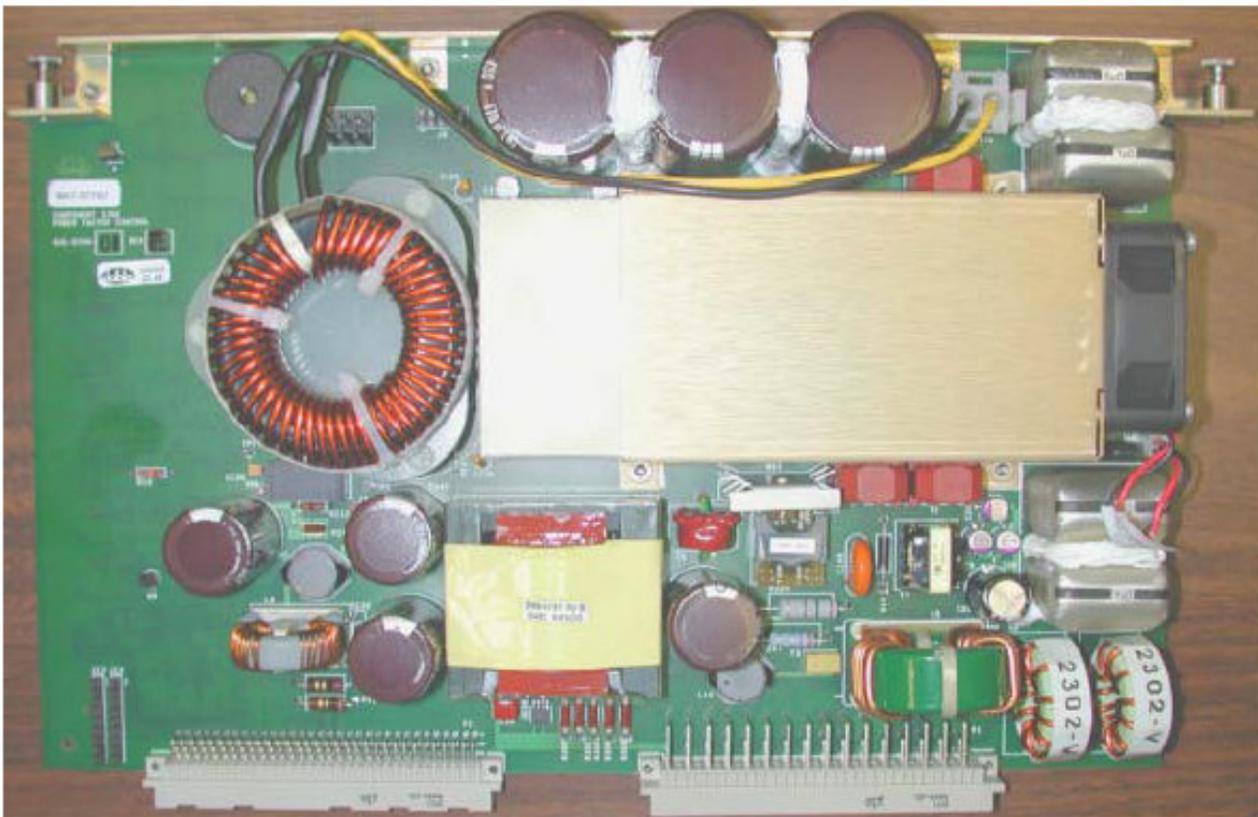
For photos of the remaining circuit boards, see [“Troubleshooting” on page 91](#).

## Removing and Replacing Battery Simulator

### F6150 with Variable Output Battery Simulator

The F6150sv instruments have a battery simulator that is integrated with the power supply board.

CPU2 Version 1 F6150 instruments can use a power supply board (04S-0794-01) that has an integrated VOBS. This board is located in slot 11 (Figure 99). If the board is diagnosed as defective, remove it in the same manner as the other circuit boards.



**Figure 99 Slot 11 - Power Supply with Variable Output Battery Simulator (Type 2)**



**NOTE:** 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 100).

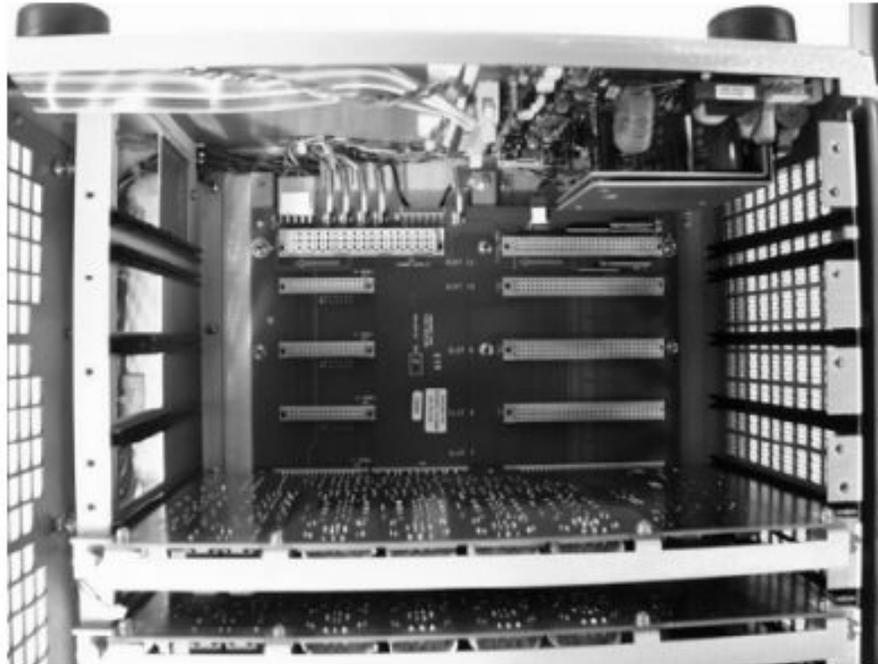


**Figure 100 Fixed Output Battery Simulator Mounted at the Back of the Instrument**

### 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

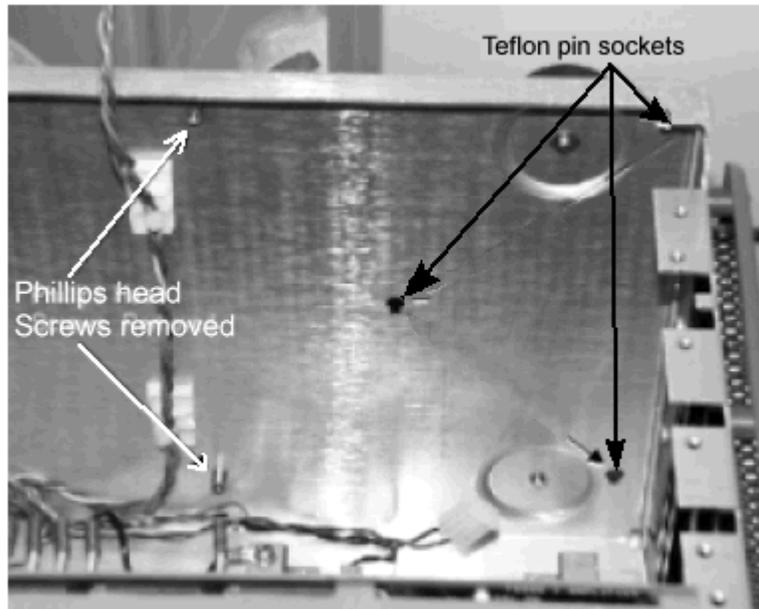


**Figure 101 Remove Power Supply and Voltage Amplifiers to Access Battery Simulator**



**CAUTION:** 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 (see [Figure 102](#)).



*Back Panel after Removal of Battery Simulator*

**Figure 102 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 102](#)). 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. The figure above 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.



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

## Removing and Replacing 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 (see [Figure 103 on page 165](#)).

6. Remove the three Phillips-head screws above the fans from the instrument chassis.



**Figure 103 Side View of Instrument Before Removal of Cooling Fans**

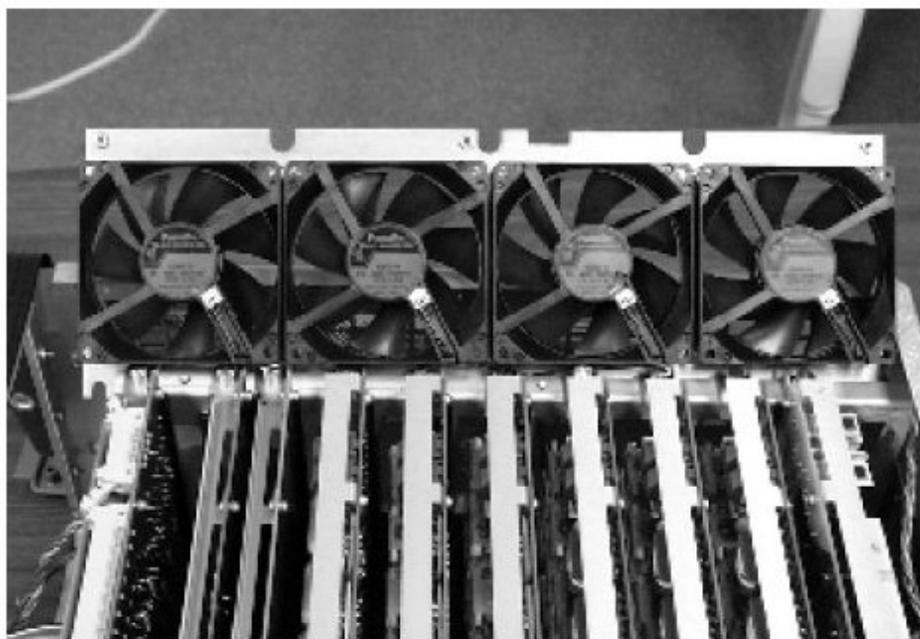
7. Remove the two Phillips-head screws that hold the top retaining bracket in place ([Figure 104 on page 166](#)).

<b>!</b>	<b>NOTE:</b> The two screws that secure the retaining bracket are different lengths. The outer screw is 1/4-inch; the inner screw is 3/8-inch. When replacing the bracket during reassembly, replace each screw in its original position.
----------	---



**Figure 104 Retaining Bracket for Cooling Fans**

8. Pull the fan assembly up out of the instrument until all four wire connectors are exposed ([Figure 105](#)).



**Figure 105 Cooling Fans with Wires Connected**

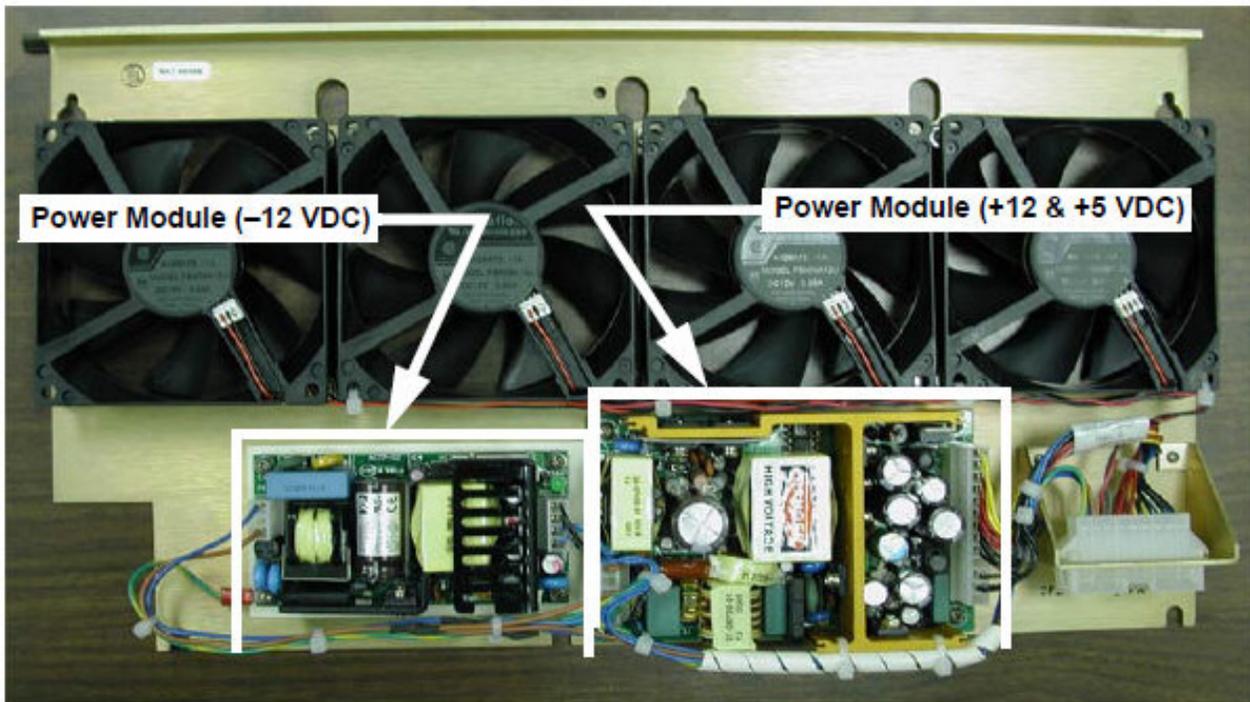
9. Disconnect the wire from each of the four fans.
10. Pull the fan assembly the rest of the way out of the instrument.
11. Use an open-ended wrench to remove the four hex nuts that secure the fan to be replaced.
12. Pull the defective fan off its supporting plate.

### **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 106 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.

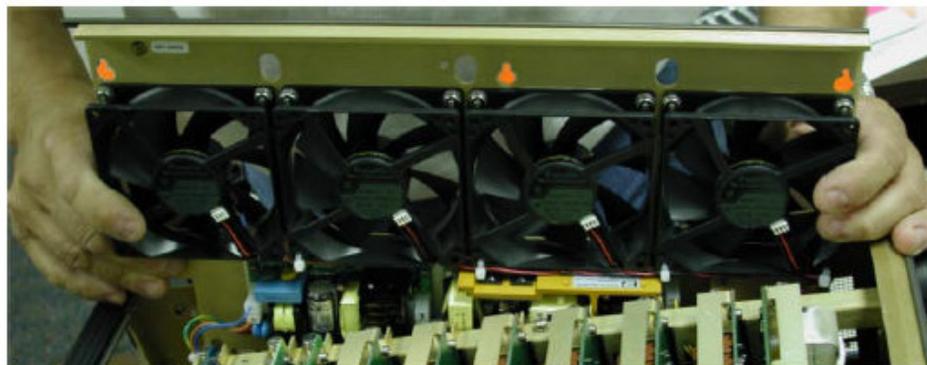


**Figure 107 Retaining Bracket for Cooling Fans**



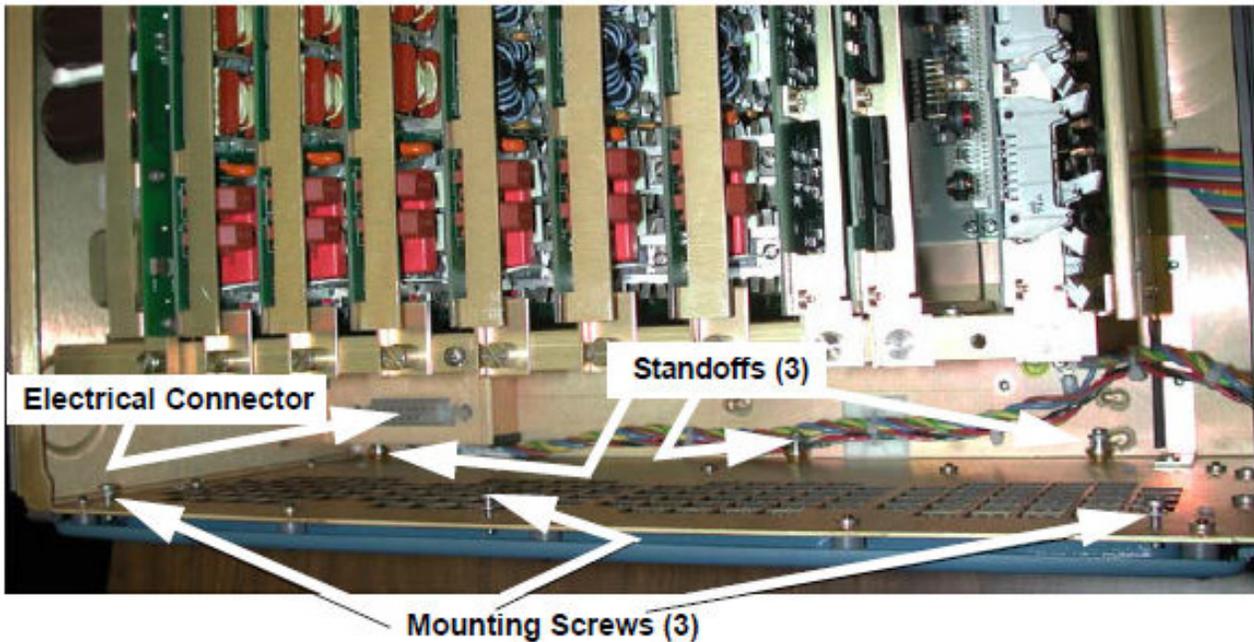
**NOTE:** The two screws that secure the retaining bracket are different lengths. The outer screw is 1/4-inch; the inner screw is 3/8-inch. When replacing the bracket during reassembly, replace each screw in its original position.

5. Loosen the Phillips-head screws that secure each end of the assembly. These screws fit inside oblong holes on the assembly rail ([Figure 108](#)).



**Figure 108 Screw Holes on Fan Assemble Rail**

6. Slide the board upward, tilt it forward, and pull it up and out of the chassis.
7. Make sure that you do not snag or nick any wires on the assembly.
8. Study the instrument chassis with the fan assembly removed (Figure 109). Before replacing the fan assembly, locate the electrical connector, three standoffs, and three mounting screws.



**Figure 109 Instrument Chassis with Fan Assembly Removed**

### Installation

1. Make sure 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.
4. If the replacement is successful, the status indicator lights are green and the error message on the front panel is cleared.
5. Repeat the test sequence that led to the error.
6. Check the instrument's front panel for error messages.
7. Check F6ControlPanel for source errors.

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## 6. Safety & Maintenance

### Rules for Safe Operation

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

- Do not use the F6150 or F63xx 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.



**WARNING:** The F6150 and F63xx contain 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 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 and F63xx are intended for per technical specifications.

## Use of Ground Adapter

Your instrument comes with a ground adapter that protects it. The ground adapter is to be used in environments where a neutral ground is suspect or non-existent through the power cord. It is included in the cable bag, and is shown in [Figure 110](#).



**Figure 110 Ground Adapter**

To properly use the ground adapter, plug it into the AC power connector on the instrument, then plug the power cord into the adapter, as shown in [Figure 111 on page 175](#). Connect the ring lug on the connector to a good electrical ground.



**Figure 111**

## Cleaning the Unit

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 Department at 617-926-4900 or send e-mail to [customerservice@doble.com](mailto: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 ([Table 11 on page 93](#) and [Table 12 on page 94](#)) to identify and isolate problems.
- Perform the “[Component Checkout Procedures](#)” on [page 111](#) 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 bootstrap.
- 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 Unit

If troubleshooting checks and replacing defective parts in the field fail to correct a problem, the F6150 or F63xx 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 unit 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



**CAUTION:** Doble Engineering Company 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 Company, freight prepaid, unless other arrangements have been authorized in advance by Doble customer service.

The shipping address is:

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

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## 7. Firmware

### Flash Loader

This information applies to both the F6150 series and the F63xx units.

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

- **F6000 Flash Loader:** Installs revised firmware.
- **F6000 Key Code Update:** Installs F6 options
- Protection Suite

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

<b>!</b>	<b>NOTE: When the F6 powers up, the current firmware revision number and the options installed appear in the display on the instrument's front panel.</b>
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Operation of the F6 requires the correct firmware version:

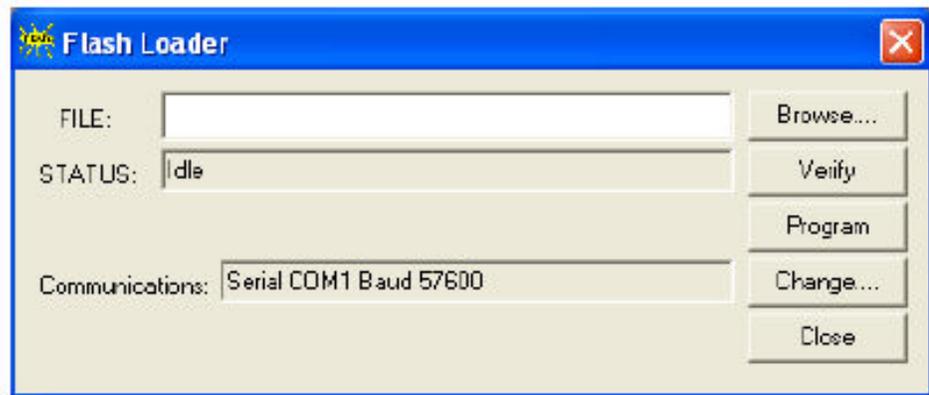
- 2.11 (or higher) for CPU1 instruments
- 4.11 (or higher) for CPU2 instruments
- 5.0 (or higher) for CPU3 instruments (F6150, F6150e, F6150sv)
- 5.3 or higher for F6350e instruments

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

The F6300 requires a firmware package file (\*.pkg). This file must contain F6300 in its name.

The F6350 requires a firmware package file (\*.pkg). This file must contain F6350 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 112 on page 180](#)).



**Figure 112 Flash Loader Dialog Box**

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.

	<p><b>NOTE:</b> 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.</p>
---	---

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](http://www.doble.com/support/download_fseries.html)) and is loaded from your computer using a USB, RS-232 (CPU1 and CPU2 Version 1) serial connection, or LAN.

	<b>NOTE:</b> Check the 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 **Protection Suite** or **F6ControlPanel** and make sure that the communications are set up correctly.
2. 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.
3. Select **Tools** -> **F6000 Flash Loader**.
4. 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.
5. 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.
6. Click **Program** to update the firmware with the selected package file.

	<b>CAUTION:</b> 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.

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

<b>!</b>	<b>NOTE:</b> 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 113).



**Figure 113 Set Communications Parameters Dialog Box**

2. Select the correct setting from each of the drop-down menus:
  - To change the serial COM port, select a different port from the PORT drop-down 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 (below).



**Figure 114 Set Communications Parameters Dialog Box**

- b. 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 115 Saving Settings**

- b. Click **Yes**. You are returned to the initial dialog box.
4. Click **Program** to update the firmware with the selected package file.

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 displays a message with waiting in it. The recovery procedure depends on the type of instrument involved.



**NOTE:** 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 and CPU3 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 is displayed, ending with a prompt.
6. At the prompt, type f6xs and press **Enter**.
7. Shut down HyperTerminal or use the disconnect on the toolbar.
8. Run Flash Loader and reload the firmware.



**NOTE:** If the boot loader is defective, the CPU board or the entire unit must be returned to Doble.



**NOTE:** If the boot loader is defective, the CPU board or the entire unit must be returned to Doble.

## Key Code Update

This information applies to both the F6150 series and the F63xx units.

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.

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.

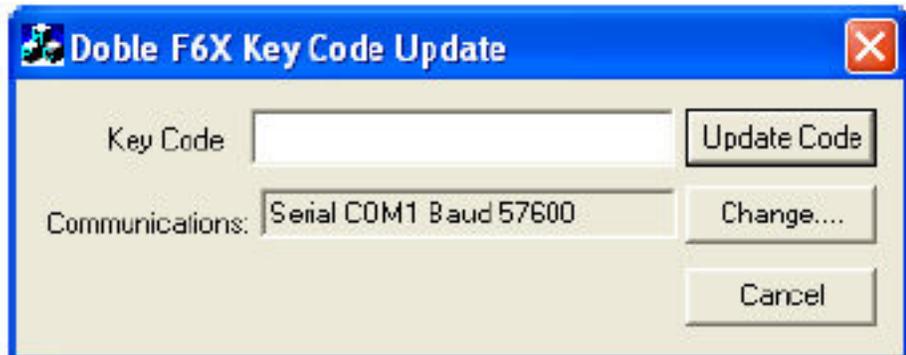


**NOTE:** The Key Code utility is required only when options are to be installed in the field. All options ordered with the unit are installed before delivery.

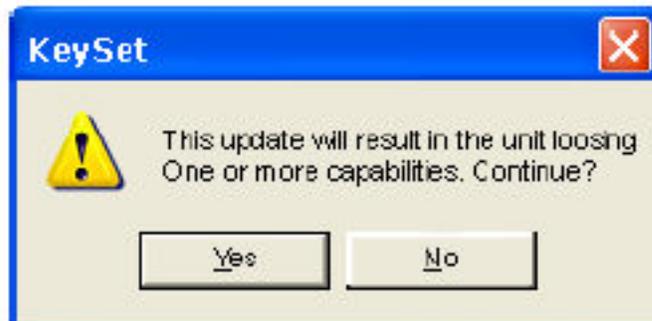
To update F6150 options:

1. Select **Tools -> F6000 Key Code**.

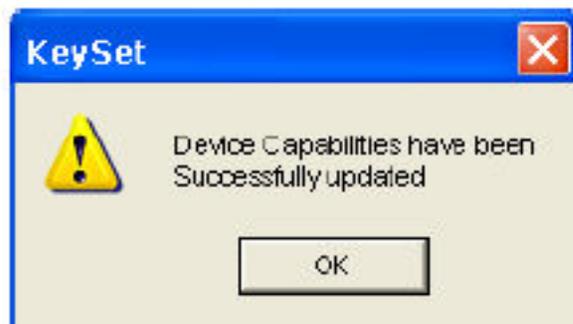
The Key Code Update dialog box appears:



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



- a. Click **Yes**. A message appears, indicating a successful update:



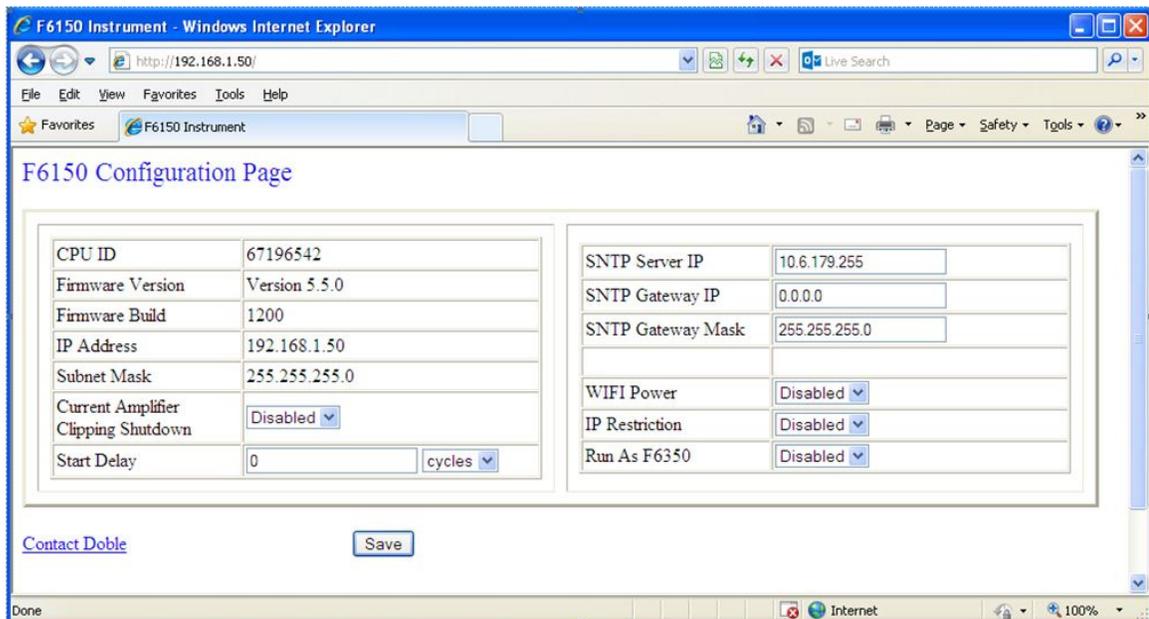
- b. Click **OK**.
  - If the code you entered was incorrect, an error message appears:



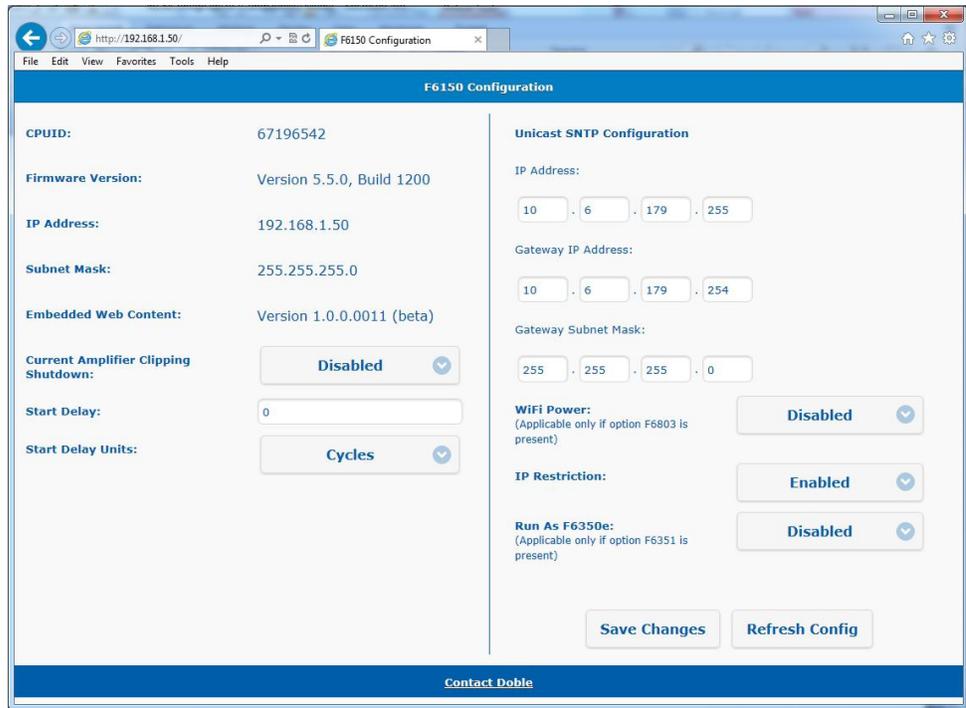
- a. Click **OK**
  - b. Return to **step 2**.
4. If necessary, click **Change** to enter new communications parameters. (See “[Communications Parameters](#)” on page 182, for the procedure.)

## Setting the F6150 Start Delay & Current Amplifier Clipping Shutdown

1. Go to your web browser.
2. Type in the IP address of your instrument. The “F6150 Configuration Page” will appear ([Figure 27](#)).



**Figure 27 F6150 Configuration Page**



**Figure 116 F6150 Configuration Page through Mobile Control Panel**

In “Start Delay”, adjust the number, select either cycles, ms or the default from the drop-down list, then Save the changes. See [Table 28 on page 189](#).

!	<p><b>The Current Amplifiers normally shut down if waveform clipping is detected (setting is Enabled). In units with enhanced current amplifiers, you can change the "Current Amplifier Clipping Shutdown" setting to Disable the amplifier shutdown.</b></p> <p><b>Remember to Save Changes!</b></p>
---	---

## Firmware Compatibility Matrices for End-to-End Testing

This is the recommended firmware for compatibility.

**Table 28 Recommended Firmware Compatibility Matrix**

CPU1 <sup>a</sup>	CPU2	CPU3	Time Diff in Default State	Comments
FW V2.23	FW V4.30.1 or greater	FW V5.3 or greater	0 ms	There is a 2 cycle delay in the Configuration Screen seen on the web browser, to adjust to F6350 instruments. Adjust timing, as needed, for non-Doble instruments.

- a. All versions of firmware are available on the web site. Although there is a V2.5, use V2.2.3, when running end-to-end testing.

**Table 29 Firmware Compatibility Matrix**

End 1	End 2	Time Diff in Default State	Comments and Recommended Adjustment/Action
CPU2 FW 4.29.3	CPU1 FW 2.22 and 2.23	0 ms	With a default setting of 2 cy at End 1 both test sets will start after 2 cy delay. FW2.22 has a fixed delay of 2 cy. FW 4.29.3 is left at 2 Cycle default delay
CPU2 FW 4.29.3	CPU1 FW 2.25	-1000 ms	Flash CPU1 with FW ver. 2.22 or 2.23 and leave the 2 cy default on FW 4.29.3
CPU2 FW 4.27	CPU1 FW 2.22 and 2.23	0 ms	No change required - Both Ends start after 2 cycle delay
CPU2 FW 4.27	CPU1 FW 2.25	-1000 ms	Flash CPU1 with FW ver. 2.22 or 2.23. No adjustment available in FW Ver 2.27 or 2.25
CPU2 FW 4.29.3	CPU1 FW 4.27	0 ms	With a default setting of 2 cy on 4.29.3 and a fixed delay on 2 cy on FW 4.27 both Ends will start with a delay of 2 cy.
CPU1 FW 2.22 or 2.23	CPU1 FW 2.25	-1000 ms	Flash CPU1 at End 2 with FW ver. 2.22 or 2.23. This will result in both units starting after 2 cycle delay
CPU2 FW 4.29.3	F2253 FW 4.15, 4.18, 4.19	0 ms	With a default setting of 2 cy on 4.29.3 both Ends will start after 2 cy delay

End 1	End 2	Time Diff in Default State	Comments and Recommended Adjustment/Action
CPU2 FW 4.27	F2253 FW 4.15, 4.18, 4.19	0 ms	No change required
CPU1 FW 2.22, 2.23	F2253 FW 4.15, 4.18, 4.19	0 ms	No change required
CPU1 FW 2.25	F2253 FW 4.15, 4.18, 4.19	-1000 ms	Flash CPU1 with FW version 2.22 or 2.23
<b>CPU2 FW 4.29.3</b>	<b>CPU2 FW 4.28.2</b>	-1000 ms	With both 4.29.3 and 4.28.2 set at 0 sec the difference will be -1 sec Solution 1 flash FW 4.29.3 at End 2
<b>CPU2 FW 4.28.2</b>	CPU2 FW 4.27	-1000 ms	Flash End 1 FW with fw ver. 4.29.3 and set delay at 2 cycles
<b>CPU2 FW 4.28.2</b>	CPU1 FW 2.25	0 ms	Both Ends start 1 sec before the GO AT Time. Flash 4.29.3 at End 1 and leave delay at 2 cy Flash FW 2.22 or 2.23 at End 2. Both Ends will start with a 2 cycle delay.
<b>CPU2 FW 4.28.2</b>	CPU1 FW 2.22, 2.23	-1000 ms	Flash FW at End 1 to 4.29.3 and leave default delay of 2 cycles

**Red Colored entries** indicate adjustable delay settings available via web browser.

**Red Colored FW** is set with default (2 Cycle) to arrive at the quantities in the Time Difference Column.

## 8. Communications

### Connecting the Control PC

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.



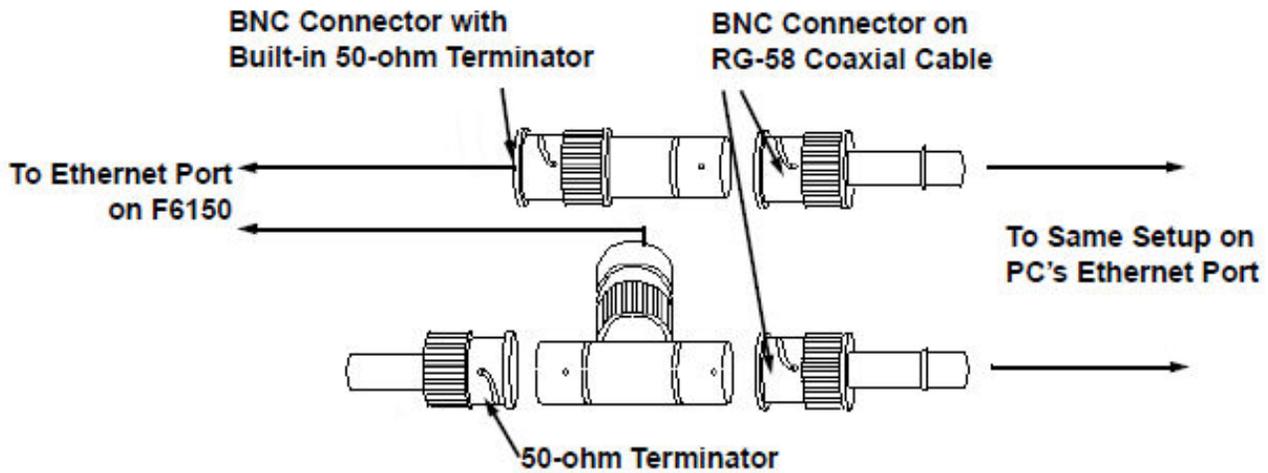
**NOTE:** One PC can control multiple F6150 instruments through an Ethernet connection, to execute end-to-end protection scheme tests under laboratory conditions. Controlling multiple F6150s, using one PC, eliminates the need for GPS synchronization.

### 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.

The following figure shows 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 117 Alternate 50-Ohm Terminator CPU1 Connections for Coaxial Cable**

## CPU2 and CPU3 (sv) Instruments

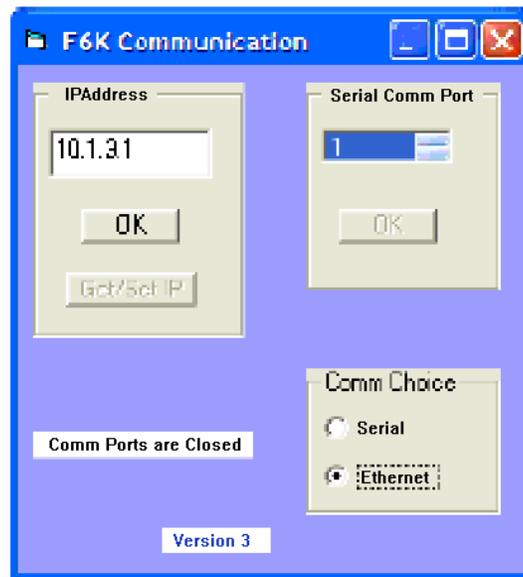
If connecting to the F6150 directly from a PC, plug the crossover adapter (P/N 401-0303) supplied with the instrument into the Ethernet connector on the F6150 and then use the supplied standard Ethernet cable between the adapter and the PC.

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.

## F6350 Communications

[Figure 118 on page 193](#) shows the options that are available for setting up the communication between the Control Panel user interface and the F6350.

You can select either serial or Ethernet communication along with related communication port and IP address of F6350.



**Figure 118 Communications Options**

## Configuring the Control PC

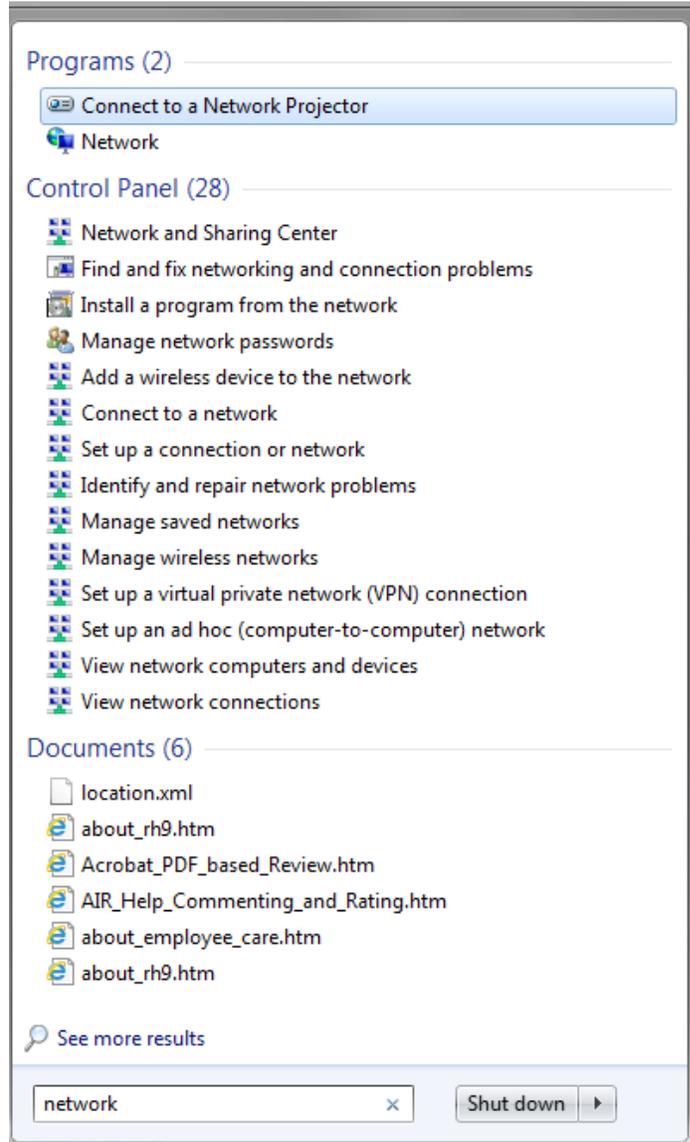
If the control PC is configured for Ethernet communications, it can communicate with the F6150 or F63xx on a private network using the UDP/IP protocol. When it initiates two-way communication, the PC sends its IP address to the instrument. Both the F6 unit and the PC must have an IP address assigned.

**One PC can control multiple F6 instruments via an Ethernet connection, to execute end-to-end protection scheme tests under laboratory conditions. Controlling multiple F6 units using one PC eliminates the need for GPS synchronization.**

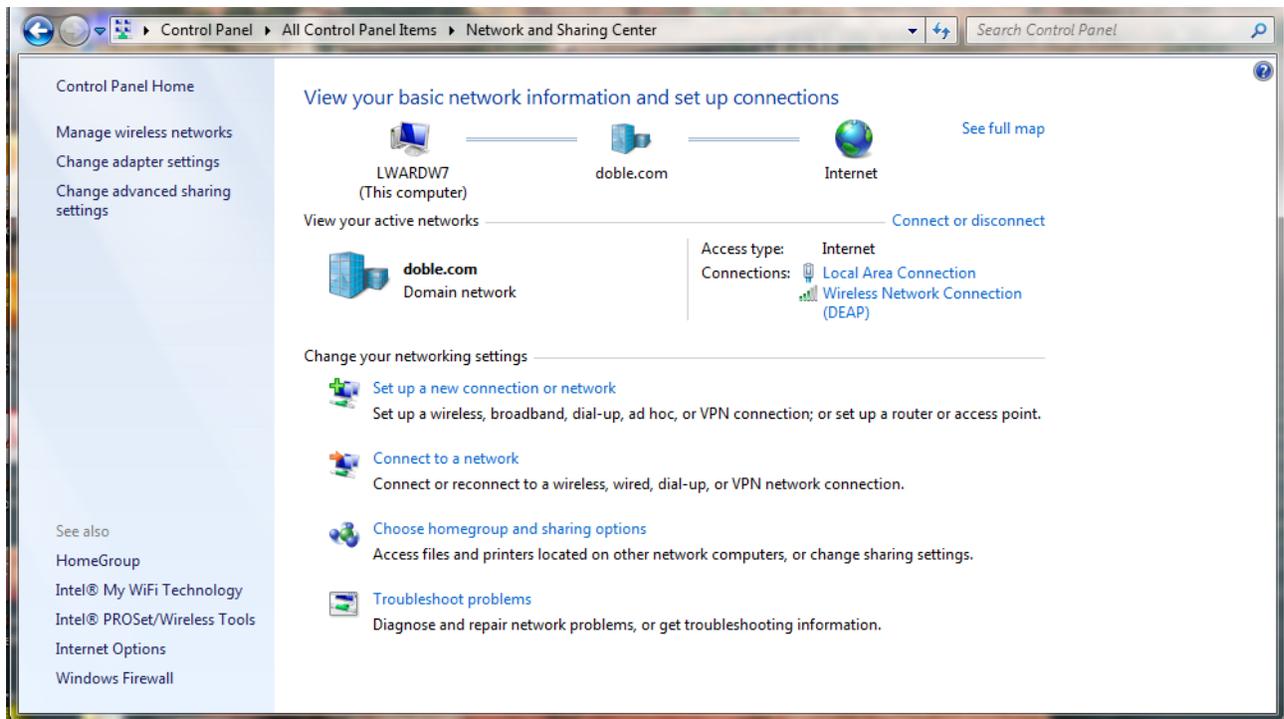
## Establishing the IP Address

To configure Windows 7 for communication with the F6 unit on a private network:

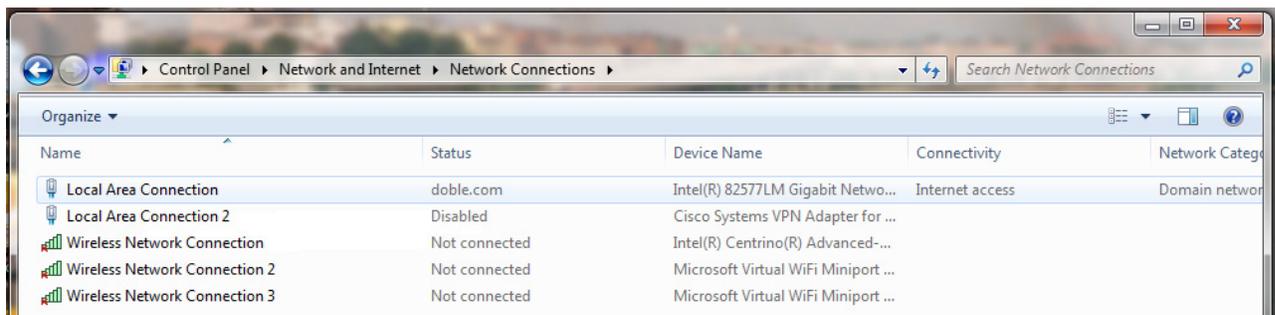
1. Click the **Start** button, and type “network” in the space.



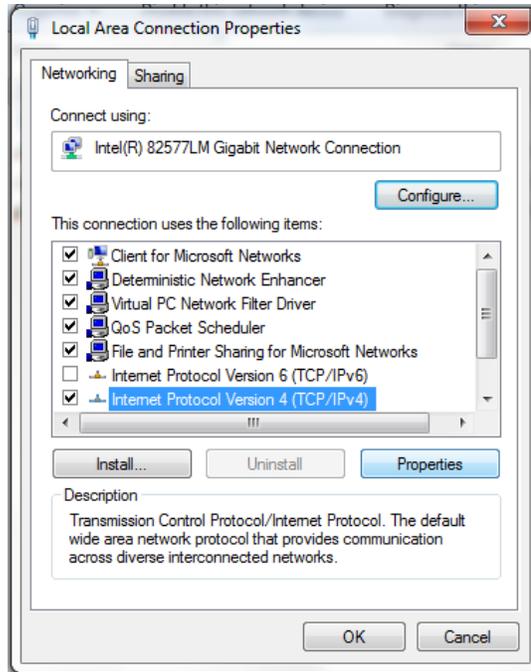
2. Under Control Panel section, click **Network and Sharing Center**.



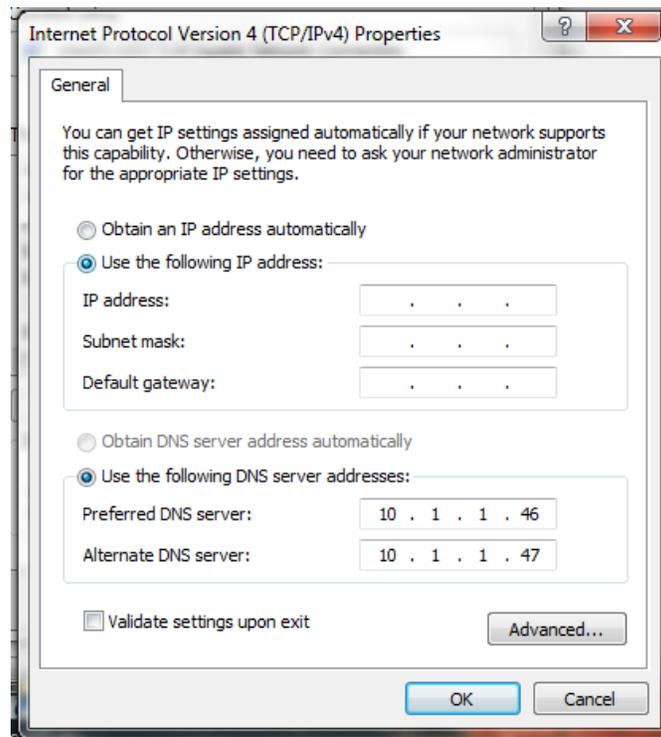
3. In the left column, click **Change Adapter Settings**.



4. Choose the Network Interface Card that you are using, right-click on it, and choose **Properties**.



5. Select **Internet Protocol Version 4 (TCP/IPv4)**.
6. Click **Properties**.



7. Click the radio button for **Use the following IP address:**, then enter the desired IP address.
8. Click **OK**.
9. Click **OK** again.

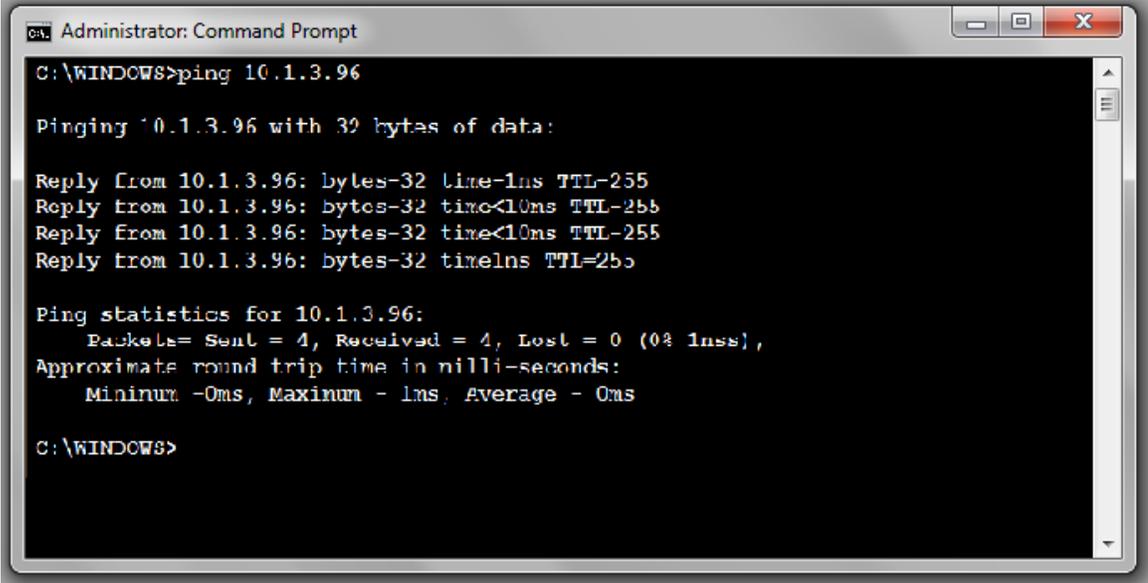
**Note:** For systems using **Windows 98**, restart the computer for these changes to take effect. For systems using **Windows XP**, **Vista**, or **Windows 7**, you do not need to restart.

## Pinging 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, Vista, or Windows 7, 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 or F63xx.

If the Ethernet connection is working, four replies from the F6 unit appear (below).



```
Administrator: Command Prompt
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>
```

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

## Configuring F6ControlPanel

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 page 71.

1. In the F6 Instrument section, click the **Ethernet** option button.
2. Enter the **IP address** of the F6 unit. The IP address appears in the front panel display when the instrument is turned on and the firmware loads.
3. Click **OK**.
4. Click the menu bar icon for the appropriate virtual device. The device opens and provides manual control of the instrument.



**NOTE:** 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 Network Settings

To restore your PC's original network settings:

1. Follow step 1 through step 4 in “Establishing the IP Address”, above.
2. Restore the original settings that you copied down in step 4.
3. Click OK, then click OK again.

For systems using **Windows 98**, restart the computer for these changes to take effect. For systems using **Windows XP, Vista, or Windows 7**, you do not need to restart.

## Setting the F6000 IP Address

This information applies to both the F6150 series and the F63xx units.

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:



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 page 182, for the procedure.)
4. Click **Set**.
5. To enable the new IP address, power the unit off and then back on.

## Setting Up your GPS Equipment

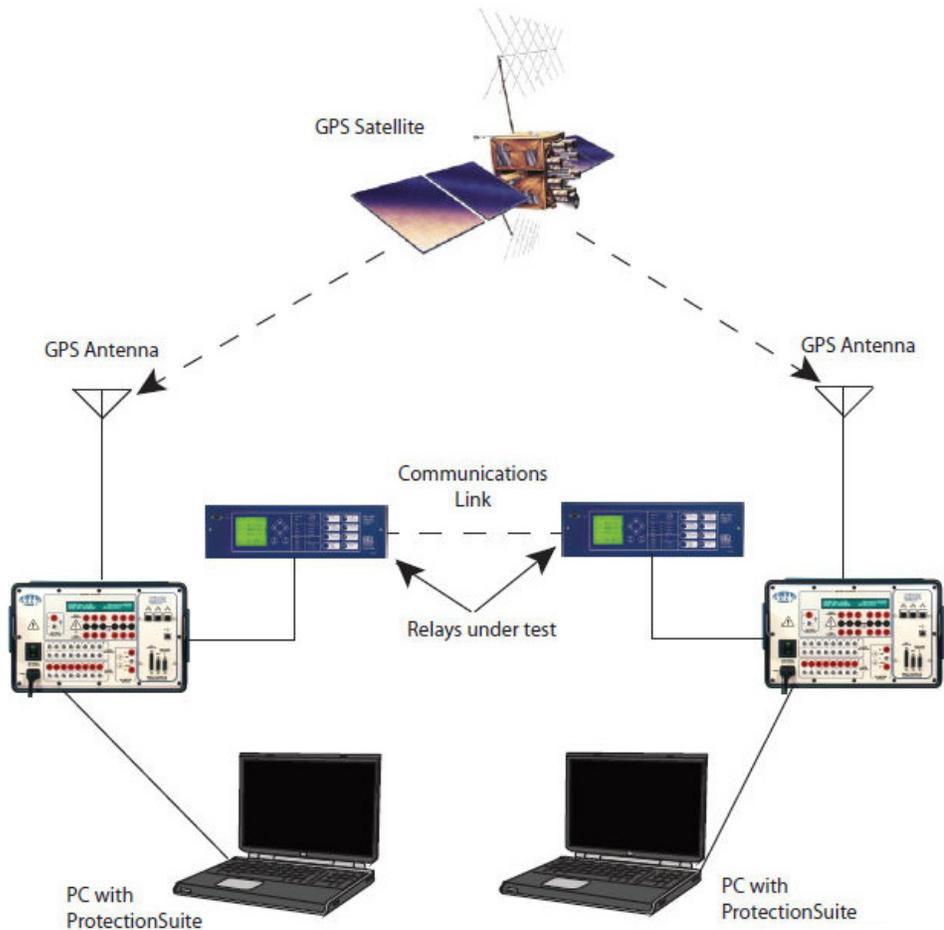
GPS, or Global Positioning System, has many uses in the world, including the broadcast of standard time signals.

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. The following figure gives an overview of the components required to conduct an end-to-end test using GPS synchronization, and demonstrates end-to-end testing:



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.

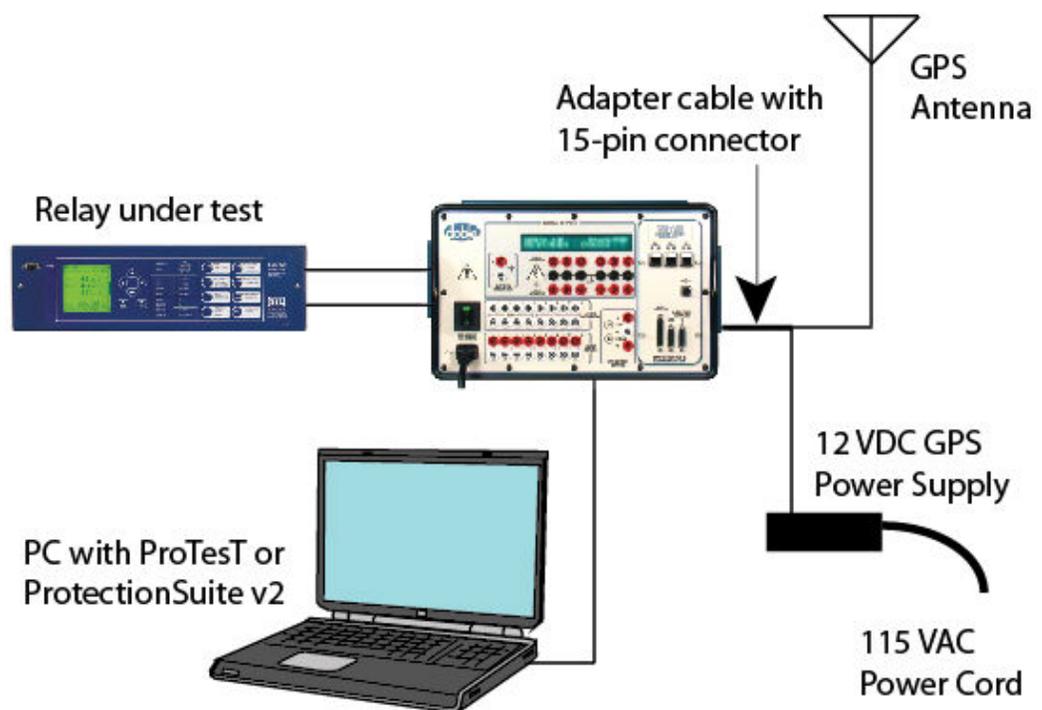
The GPS antenna comes with the following components:

- 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

To set up GPS synchronization:

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. The following figure shows the equipment required for the test:



**Figure 119 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.

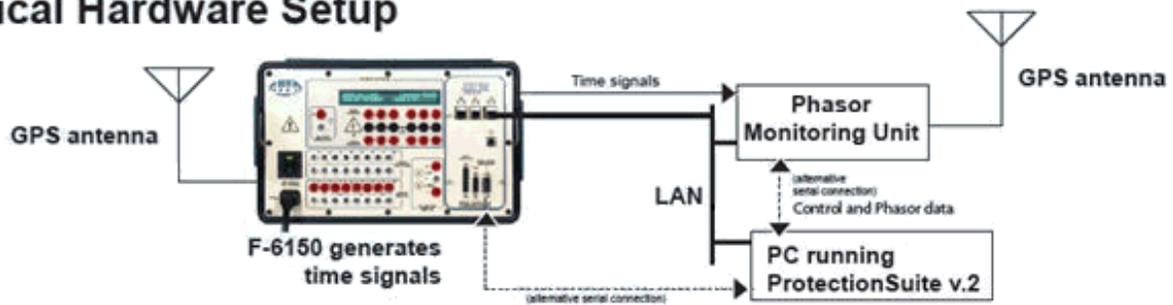
When the system is ready, “GPS 6 Sats” appears, followed by the time in Universal Time Coordinates; for example, “GPS 17:04:26 UTC”. This message indicates that the components are connected correctly and that the instrument is synchronized to the GPS clock.

## PMU Testing

Before running a PMU test, you need to set up the hardware, as well as configure the software.

To set up the hardware, refer to the following diagram:

### Typical Hardware Setup



**Figure 120 Typical Hardware Setup**

The PC, PMU, and F6150 must each have unique IP addresses.

The purpose of each connection is:

**ProtectionSuite to F6150** - Waveform definitions and start time

**ProtectionSuite to PMU** - Request configuration, start transmission

**F6150 to PMU** - Generated waveforms

**PMU to ProtectionSuite** - Configure response, phasor data stream

## Conducting the Synchronization Test

Protection Suite and ProTesT include the control software needed for end-to-end testing with GPS synchronization for the F6150. (This information does not apply to the F6300 or F6350.)

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.

## Wi-Fi

F6150sv instruments now feature Wi-Fi capabilities. The Wi-Fi 802.11 (B+G) module allows communications with your PC's Wi-Fi card.



This section covers connecting with the Wi-Fi module and configuring it.



**On the S6150e and F6150sv, Wi-Fi is optional.**

## Range

The range of operation is approximately 30 to 80 feet (9 to 24 meters), but will vary with the environment. The antenna is internal.

## Connecting

For your PC to be able to communicate with the instrument, you must have both the instrument and the Wi-Fi equipped PC powered up.

Connecting to the instrument is easy. Once the instrument is configured for Wi-Fi, your PC will see it as a potential wireless connection. The instrument name will appear as the instrument type, followed by the serial number. In the following example, the instrument is an F6150sv, and the serial number is "0312048xx", so the wireless name ("ssid") of the instrument is "f6150sv0312048xx".



1. Select the instrument name, and click **Connect**.

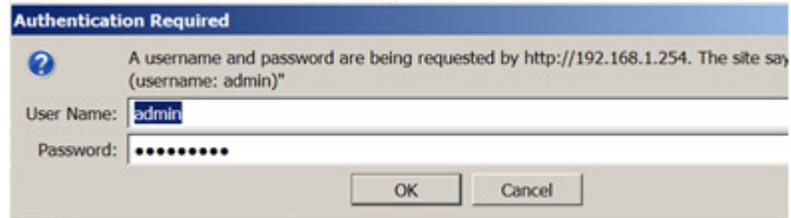


A window will appear, asking for a user name and password.

2. Use the default user name of “admin” and a password that consists of the name “Doble”, followed by the last four numbers of your instrument serial number.

For example, if your instrument serial number ends in “4889”, your password would be “Doble4889”.

This is the default password.



## Configuring

To make changes to the IP address of the module, or to configure the module, you will first need to connect. Go to your browser and type in the IP address for the Wi-Fi module. When prompted, use the user name of “admin” and the default password of “admin”.

The System Status window will appear, as shown in [Figure 121 on page 209](#).

**System Status**

System	
Uptime:	2 min, 36 secs
Firmware Version:	WLANAP_v1.2.3
Firmware Date:	2011/12/15 16:50:19

LAN Configuration	
MAC Address:	00:08:DC:D0:AE:33
IP Address:	192.168.1.254
Network Mask:	255.255.255.0
Default Gateway:	0.0.0.0
DHCP Server:	ON
DHCP Start IP Address:	192.168.1.201
DHCP Finish IP Address:	192.168.1.253

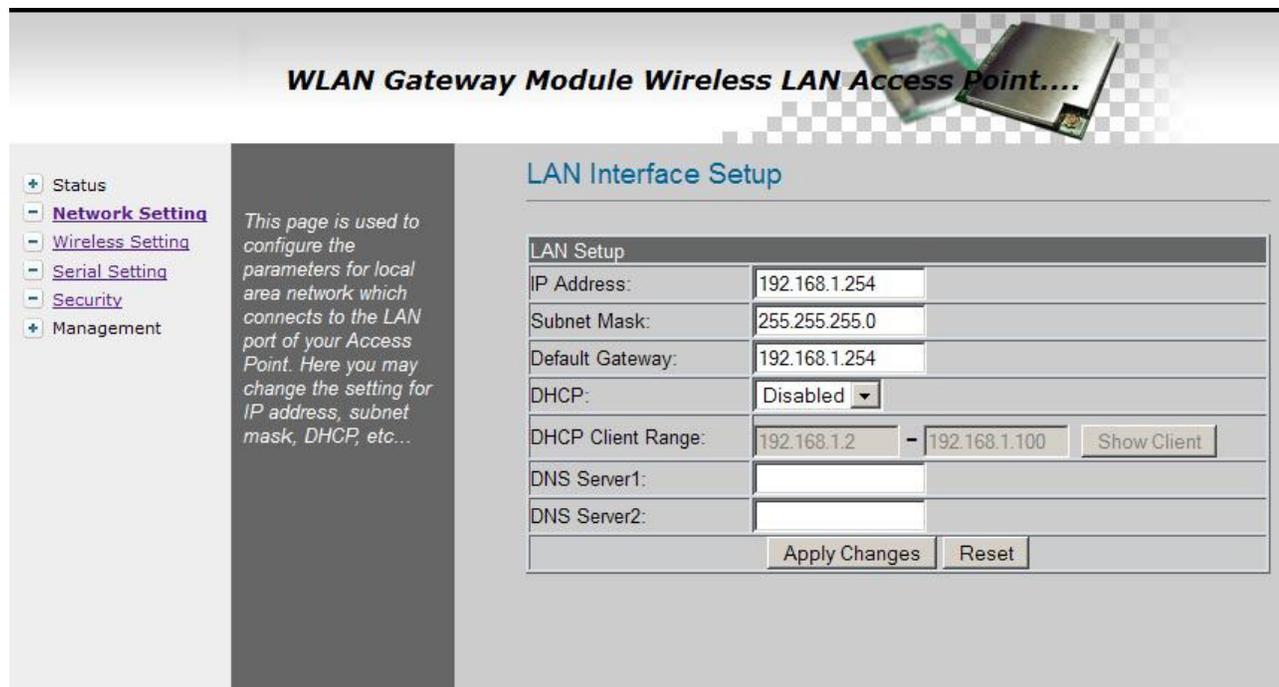
WLAN Configuration	
MAC Address:	00:08:DC:D0:AE:32
SSID:	F61505Vwifi1
Channel:	1

Serial Configuration	
Status:	Enable
Protocol:	TCP
Mode:	Client
Server IP(or Domain):	255.255.255.123
Port:	5000
TCP Reconnect Time:	0 seconds
Baudrate:	38400 bps
Databits:	8 bits
Parity:	None
Stopbits:	1 stopbits
FlowControl:	None
Time:	0 Mill-Seconds
Size:	0 Bytes
Char:	00
Inactivity Time:	0 Seconds

**Figure 121 System Status Window**

On the System Status window, note the choices on the left side. These will be used for configuring and setting security for your module.

Click **Network Setting**. The LAN Interface Setup window will appear (Figure 122).



**Figure 122 LAN Interface Setup**

This window allows you to change these parameters:

- IP address of instrument
- Default gateway
- DHCP client range

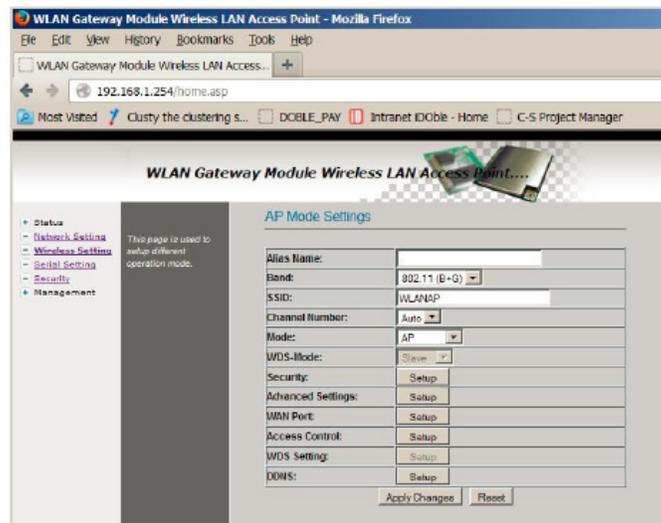
**Note:** If you change the IP address of the instrument, you also need to change the IP address of the PC's CPU, as they must be on the same subnet.

After making changes, click **Apply Changes** for them to take effect.

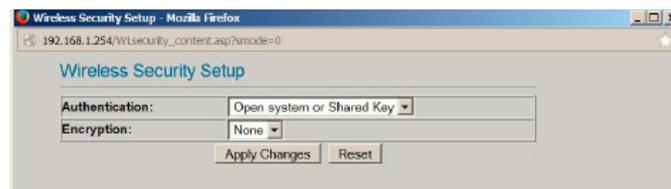
## Security

To prevent unauthorized use of the wireless router that could compromise control of the F6 instrument:

1. On the AP Mode Settings window (Figure 123), next to **Security**, click **SETUP**.



**Figure 123 AP Mode Settings Window**



**Figure 124 Security Window**

2. When the Wireless Security Setup window (Figure 124) appears, select Authentication as **WP2A-PSK**.
3. Set Encryption as **AES**.
4. Click **Apply Changes**.

!	<p><b>NOTE:</b> F6150 now requires AUTHENTICATION with WPA2-PSK and AES security encryption and the default Wi-Fi login password for the user's instrument is factory assigned to be "Doblexxxx" where "xxxx" are the last four digits of the serial number.</p>
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## 9. Specifications

### Sources

<b>!</b>	<b>NOTE:</b> Specifications are subject to change without notice.
----------	---

### 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

The following table shows source configurations for convertible sources.

**Table 30:**

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

The following table shows ranges and resolution for convertible sources.

**Table 31:**

<b>Source (VA)</b>				
	<b>75</b>	<b>150</b>	<b>300</b>	<b>450</b>
AC Voltage	75, 150 V RMS (0.01 V)	75, 150 V RMS (0.01 V)		
DC Voltage	106, 212 V DC (0.01 V)	106, 212 V (0.01 V), 300 V DC (0.1 V)		
<b>AC Current</b>				
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)
<b>DC Current</b>				
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

The following table shows source configuration for current sources.

**Table 32:**

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

The following table shows ranges and resolution for current sources.

**Table 33:**

Source (VA)				
	75	150	300	450
<b>AC Current</b>				
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)
<b>DC Current</b>				
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)

### Enhanced Ratings (Standard on the F6150sv, optional on the F6150e)

Ranges AC	Ranges DC	Power
6x8.75, 17.5 (35) A rms (L-N)	6x5.83, 11.6 (23.3)A dc	6x87.5VA/87.5; (6x131.25VA/131.25 W) <sup>*1</sup>
3x8.75, 17.5, 35 (70)A rms (L-N)	3x5.83, 11.6, 23.3 (46.6) A dc	3x262.5VA/ 262.5 W 3x175VA/175W; (3x262.5VA/262.5 W) <sup>*1</sup>
1x8.75, 17.5, 26.25, 52.5, 105 (210) A rms (L-N) S1 S2 S3	1x5.83, 11.6, 17.5, 35, 70 (140) A dc S1 S2 S3	1x525VA / 525 W; (1x787.5VA/787.5 W) <sup>*1</sup>

\*1 Maximum power delivered at high source range

*Specifications Subject to Change*

## General Specifications

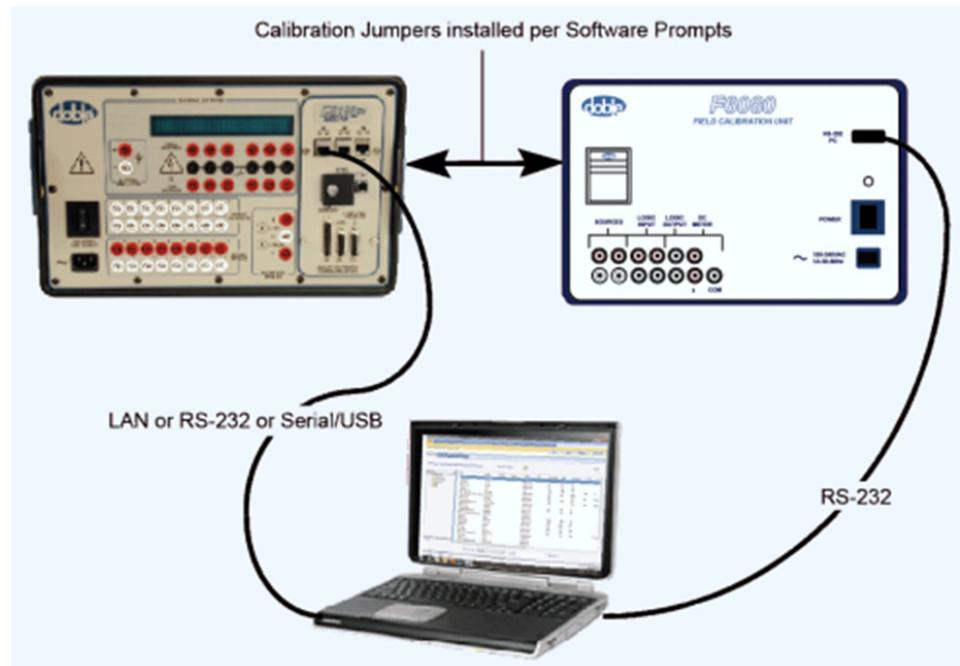
For general specification on the F6 hardware, please refer to the Doble web site.

For further assistance with Doble protection products and software, please email [fserieshelp@doble.com](mailto:fserieshelp@doble.com) or contact your Doble representative.

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## 10. Calibration Using F6080

The F6080 is a field calibration unit for the F6050.



**Figure 125**

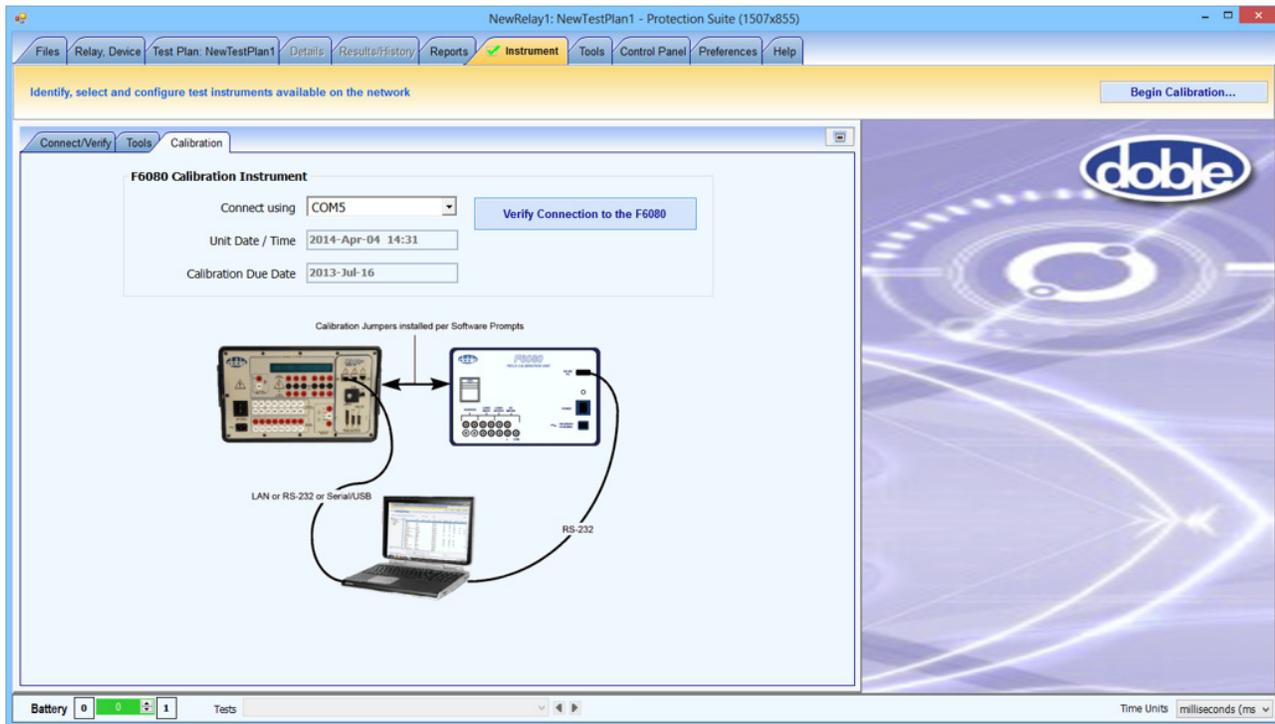
Calibration is done through the Protection Suite Instrument and Calibration tabs, as shown in [Figure 126](#).

### Calibrating All Amplifiers

The full calibration process requires testing and reading current values, calibration, instrument reboot, then retesting and reading values. With the latest instrument firmware, reboot of instrument after calibration is done automatically, further reducing manual intervention.

Previous versions of calibration software required 54 cable swaps with a 2.5 hours commitment. Currently, with Protection Suite, only 18 cable swaps are required, taking about 1.25 hours.

To save even more time and reduce errors, use the “Only Calibrate if Out of Spec” check box.



**Figure 126 Calibration in Protection Suite**

The calibration sequence is implemented as a wizard that reads some basic information from the unit. The wizard confirms the connection to both the F6080 and the instrument.

Click **Begin Calibration...** to start the procedure.

The screenshot shows the 'Doble F6150 Calibration Wizard' window. The title bar reads 'F6150 Calibration Wizard'. The main window has a header with the 'doble' logo and the title 'Doble F6150 Calibration'. Below the header is a section titled 'Calibration Session' with a light orange background. Inside this section, there are three input fields: 'Customer' with the value 'Doble', 'Tested By' with the value 'RLaChance', and 'Calibration Results File' with the value 'CalibrationResults.xls' and a browse button '...'. At the bottom right of the window, there are 'Next >>' and 'Cancel' buttons.

**Figure 127**

When prompted (Figure 127), enter basic information about this calibration session.

Click “...” to select a previous calibration session document.

The screenshot shows the 'Doble F6150 Calibration Wizard' window with the title bar 'F6150 Calibration Wizard - CalibrationResults.xls'. The main window has a header with the 'doble' logo and the title 'Doble F6150 Calibration'. Below the header is a section titled 'F6080 Details' with a light orange background. It contains three input fields: 'Line Frequency' with radio buttons for '50 Hz' and '60 Hz' (60 Hz is selected), 'Battery Status' with the value 'OK - 2014-Apr-04 14:39:59' and a 'Check Battery...' button, and 'Unit Date / Time' with the value '2014-Apr-04 14:35' and a 'Set Date/Time...' button. Below this is a section titled 'F6150 Details' with a light orange background. It contains two input fields: 'Serial Number' with the value '021400008' and a 'Set Serial Number...' button, and 'Last Calibration Date' with the value '2014-Jan-29 10:32' and a checked checkbox 'Serial Number Matches Case'. At the bottom right of the window, there are '<< Back', 'Next >>', and 'Cancel' buttons.

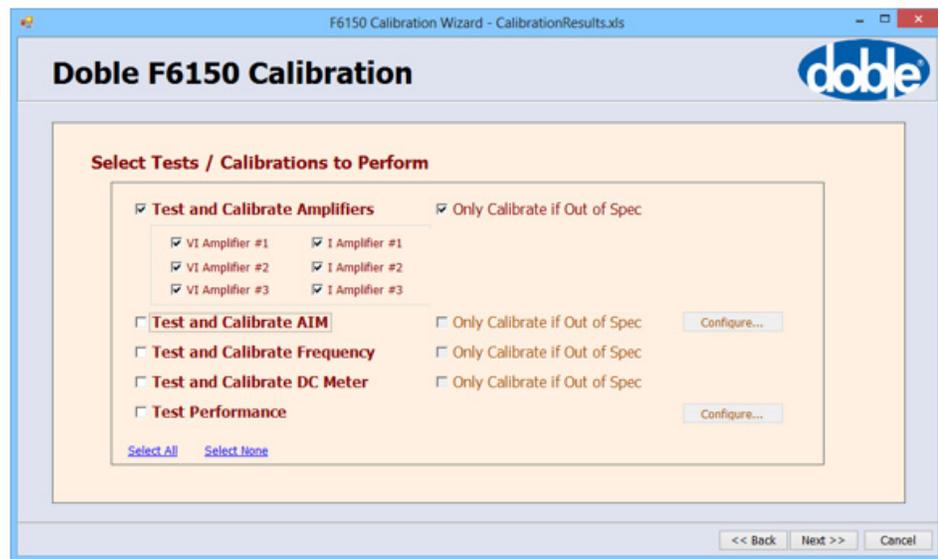
**Figure 128**

Click **Check Battery...** to get the status of the unit’s battery.

Click **Set Date/Time...** to set the F6060's timestamp.

The Serial Number displayed is what the unit generated. Click **Set Serial Number...** to set the instrument's serial number. That serial number is then retrieved by Protection Suite when running tests.

Last Calibration Date reads the instrument's last calibration date, and allows you to confirm that the serial number matches what's on the case.



**Figure 129**

The screen shown in [Figure 129](#) allows you to select from five major calibration areas.

Amplifier tests are enabled by default.

The 'Only Calibrate if Out of Spec' check box allows you to minimize time by not calibrating what is still within spec.

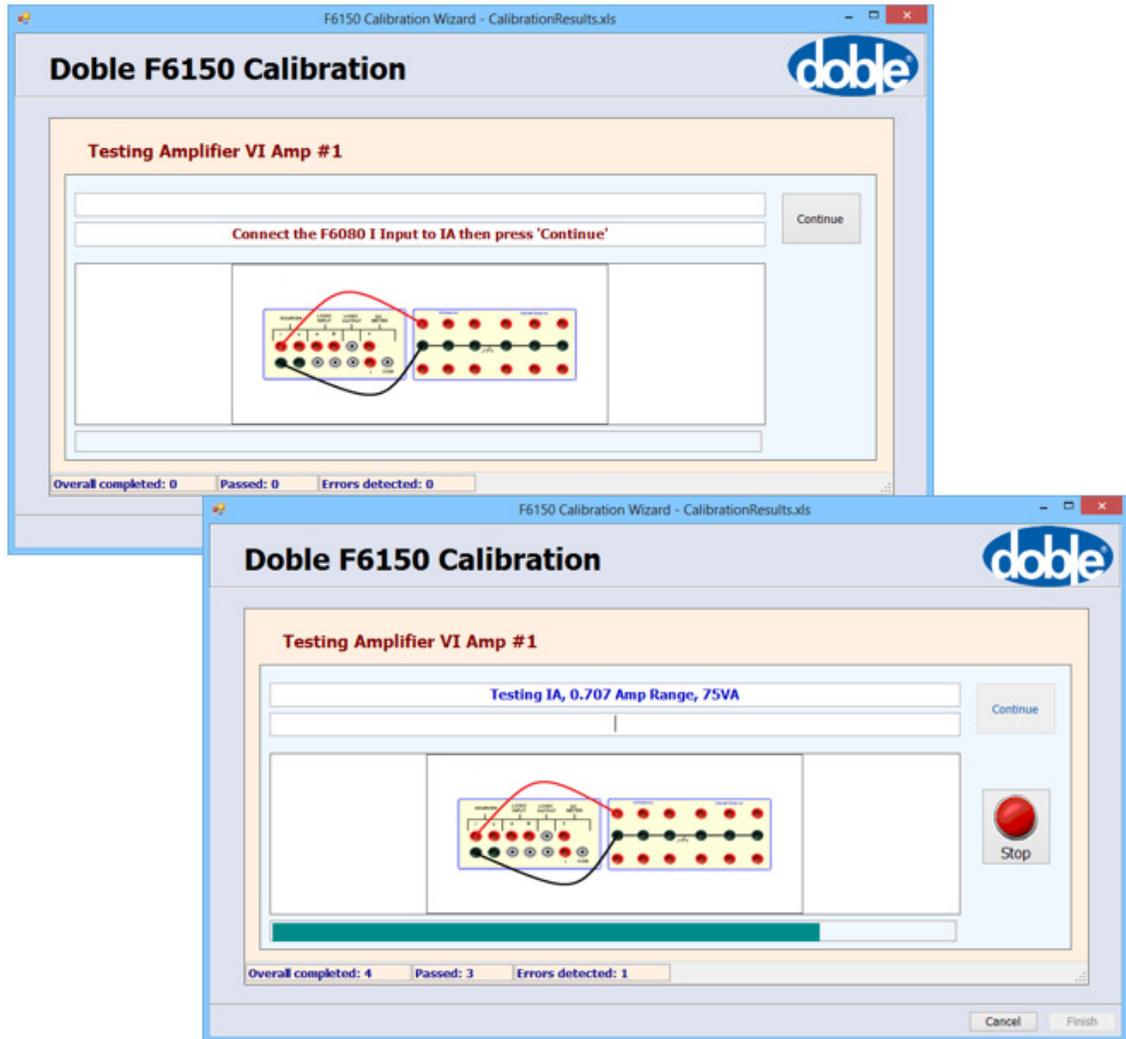
Configure individual AIM tests to select only the tests needed.

Configure performance tests. These include:

- Logic Inputs / Logic Outputs
- Logic Timing
- Battery Test

## VI Amplifier Calibration

On the initial screen (Figure 130), instructions show how cables connect. Click **Continue** to run the test.



**Figure 130**

The second screen in Figure 130 gives a description of test being run, a progress bar, and counts of completed, passed, and errors.

After calibration and before a re-test, an automatic ‘soft’ instrument reboot occurs.

When sources are applied, the emergency Stop button is always active.

When calibration is complete, the image is replaced with a summary of each test run (Figure 131).

Tests that are out of spec are highlighted in red.

There is a summary of completed and passed tests, and errors.

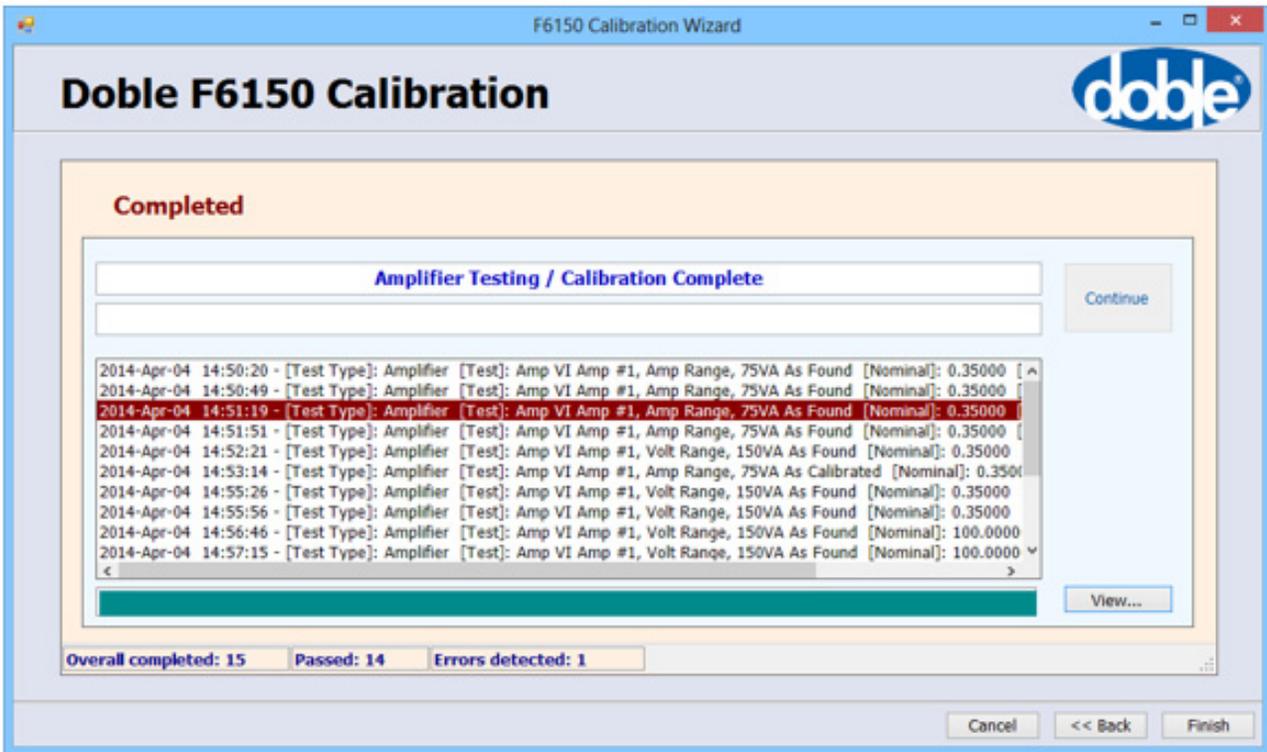
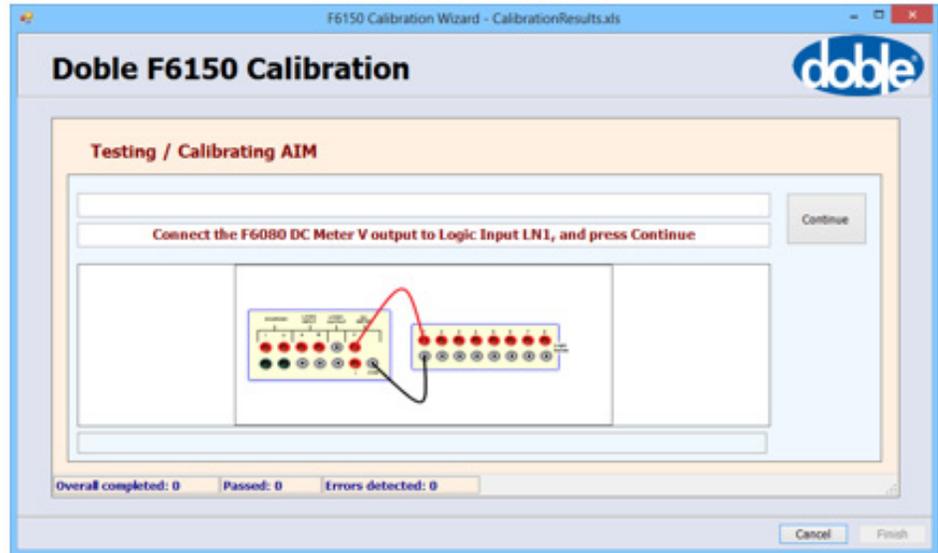


Figure 131

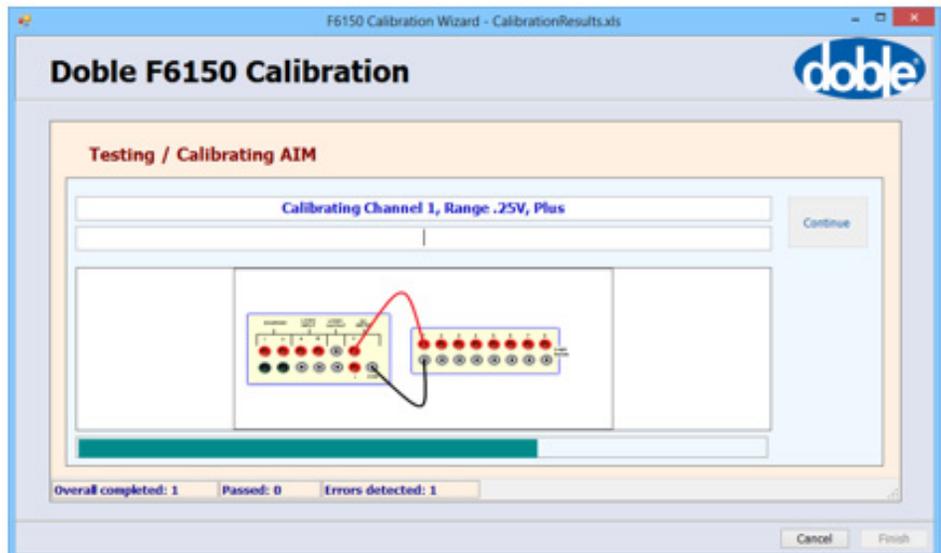
## AIM Calibration

On the initial screen (Figure 132), instructions show how cables connect.



**Figure 132**

Click **Continue** to run the test. A Progress bar and running totals (Figure 133) are shown when the tests are running.



**Figure 133**

The summary appears when the process is complete.

## DC Calibration

You will need to make cable changes for the various DC Voltmeters.

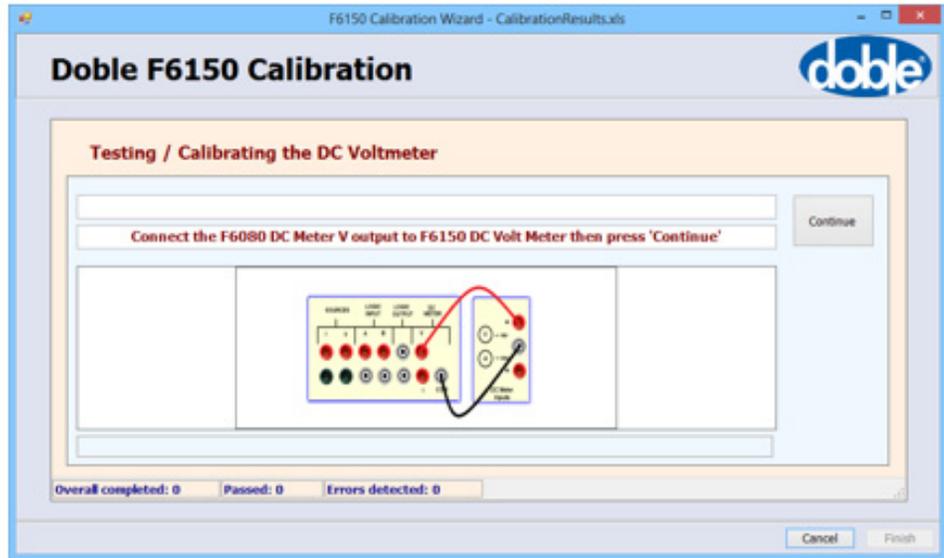


Figure 134

Figure 135 shows the test running, with the progress bar.

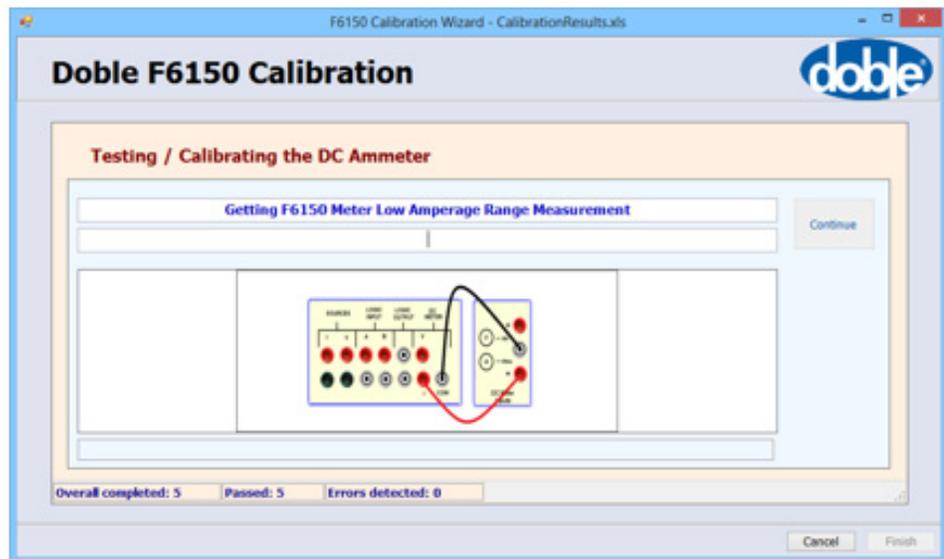


Figure 135

## Performance Tests

Select just the desired test and test option.

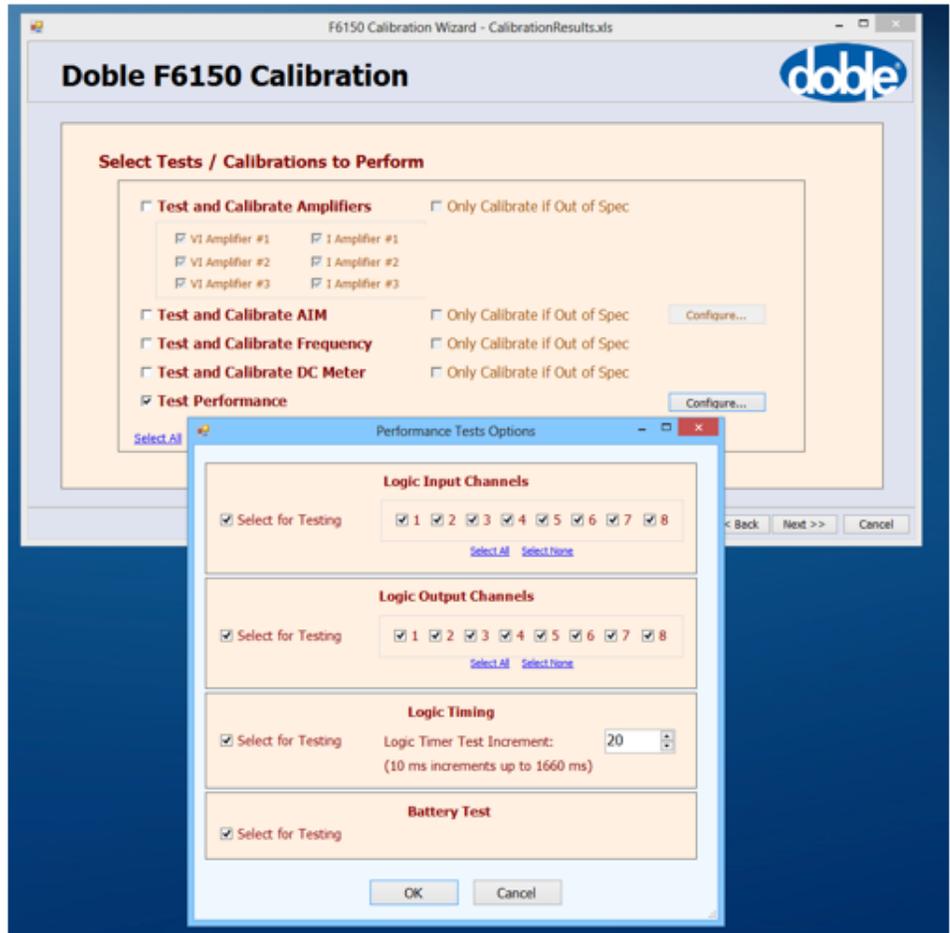


Figure 136

## Summary Document (Excel)

The Summary Document (Figure 137) contains results for all tests, and calibrations are recorded on their respective worksheets.

Individual test results are shown with a timestamp.

Most recent results appear in left-most set of data.

As additional calibrations are run, the history is move to the right.

CalibrationResults.xls [Compatibility Mode] - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW DEVELOPER ADD-INS Team Munter's Import P.Cram

Clipboard Font Alignment Number Styles Cells Editing New Group

A1

1

2 Low Current Sources 150VA

3

4 As Found Limits = +/- 0.5%

5 As Calibrated Limits = +/- 0.5%

6

7 Nominal = 0.3501 amps

8

Source	Range	Measure	As Found	%dev	Pass	As Calibrated	%dev	Pass
	DC Amps							
			2014-Apr-04 15:27			2014-Apr-04 14:53		
IA	0.35	Gain	0.3495645	-0.015	Pass	0.3498356	-0.07695	Pass
IA	0.707	Gain	0.34995695	-0.042	Pass	0.3499106	-0.05553	Pass
IA	1.414	Gain	0.35016005	0.0157	Pass	0.3565061	1.828337	Fail
						0.3502448	0.039931	Pass
IB	0.35	Gain			-100	NA		-100
IB	0.707	Gain			-100	NA		-100
IB	1.414	Gain			-100	NA		-100
IC	0.35	Gain			-100	NA		-100
IC	0.707	Gain			-100	NA		-100
IC	1.414	Gain			-100	NA		-100

READY

Cover F6Info lamp75va lamp150va Vamp75va Vamp150va LoAmp75va LoAmp150va Timers Frequenc ...

Figure 137 Summary Document

# 11. Mobile Control Panel Application

## Description

The Mobile Control Panel Application (Option number F6011) is an embedded control panel that provides a way to control settings of your F6150 instrument, using the browser on a PC, tablet (including iPad), smart phone or Android device. Although optimized for a 7-inch screen, it will run on other screen sizes. You will need to magnify the image on a smart phone.

## Requirements

### Firmware

Firmware version 4.31 or later is required for use of the mobile control panel with CPU2 instruments.

Firmware version 5.5 or later is required for use of the mobile control panel with CPU3 instruments.

The Mobile Control Panel is completely inaccessible with earlier versions of firmware, even if the application and key code have been installed.

### Software

#### Mobile Control Panel Application

If not pre-installed, you must use Protection Suite V3.0.1 or later to install the Mobile Control Panel.

1. On the Instrument Tab connect to your instrument.
2. Go to the Instrument -> Tools tab to "Upload Mobile Control Panel ...".

### Key Code

Option F6011

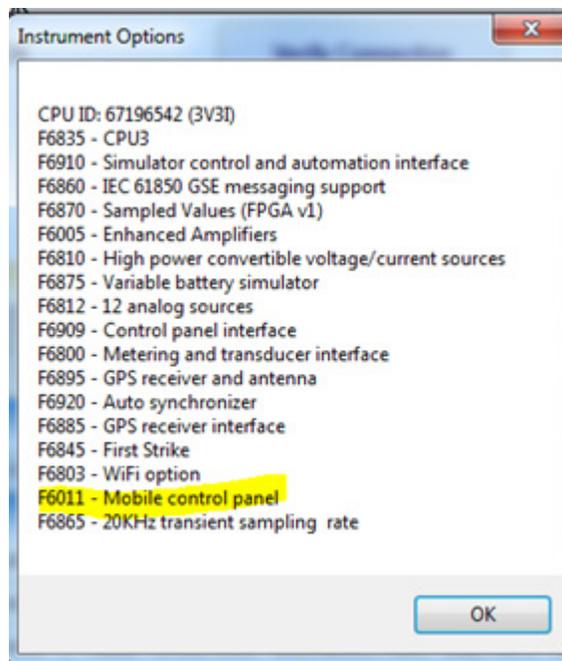
## Browser

The Mobile Control Panel will run under most recent browser versions on most recent platforms. Doble supports the following on mobile devices: Safari on iOS 7.1.2 (iPad, iPhone), Chrome on Android 4.3 (Nexus7, etc), Internet Explorer 11 on Windows Surface RT 8.1 and Windows Phones.

## Installing MCP Application

To install, use the following procedure:

1. Go to Protection Suite 3.0.1 or later Instrument -> Connect tab and connect to your F6150 instrument. Verify that you have the necessary option (F6011).



**Figure 138**

2. Go to the Instrument -> Tools tab. Click the upload mobile Control Panel button. Point the File Open dialog to the Mobile Control Panel installation package and click **Open**.

When the Protection Suite dialog displays "Upload Completed", you may access the Mobile Control Panel.

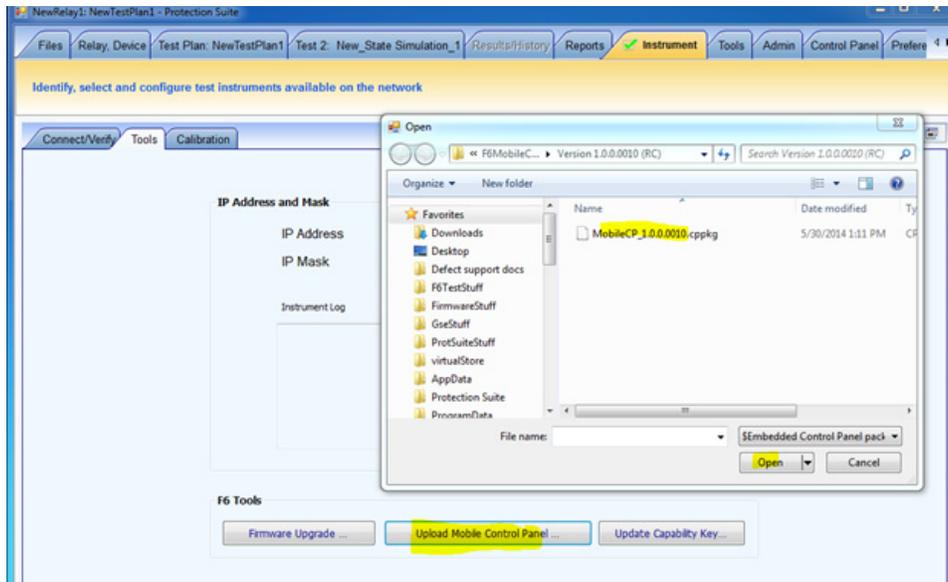
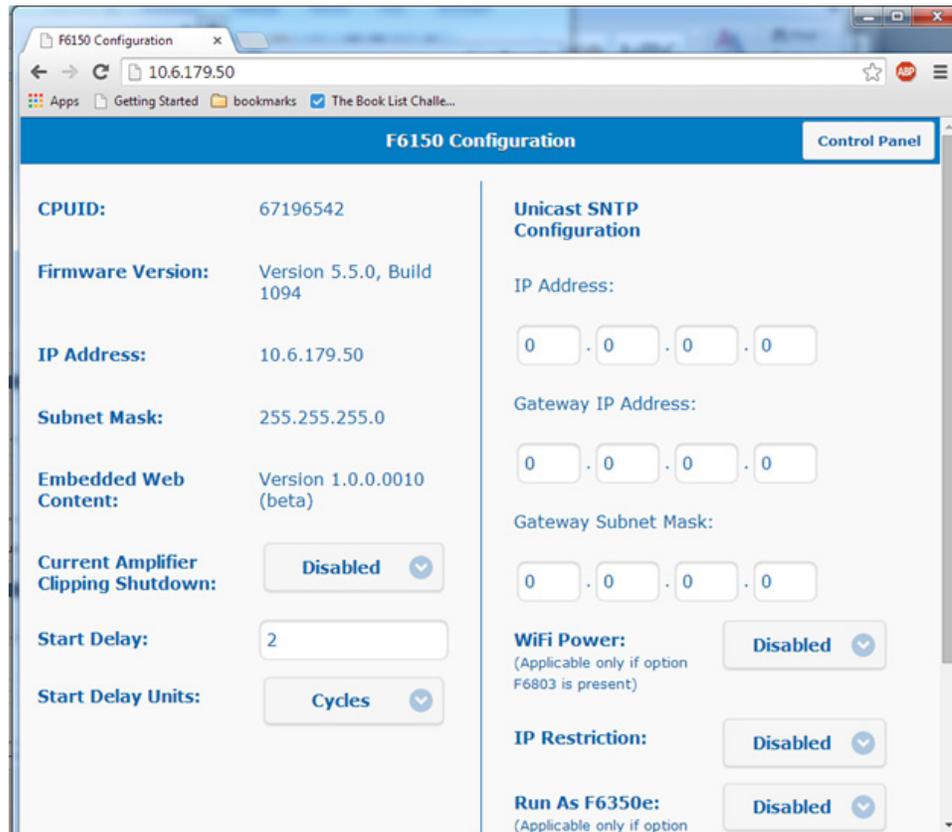


Figure 139

## Accessing the Mobile Control Panel

1. Point your web browser to the IP address of your F6150; the IP address is displayed on the instrument’s front panel when the boot process is complete. Your browser will display the F6150 Configuration Page with a button for the Mobile Control Panel in the upper right corner. Click **Control Panel**, at the top right, to go to the Mobile Control Panel.



**Figure 140 Control Panel Button**

## F6150 & Wi-Fi

Most mobile devices require a wireless connection. If your F6150 did not ship with Wi-Fi installed, you may choose to upgrade the communications panel of your instrument. **Note:** Simply having Key Code Option F6803 is not enough; you must have the Wi-Fi hardware installed.

## Mobile Devices & F6150 Connectivity

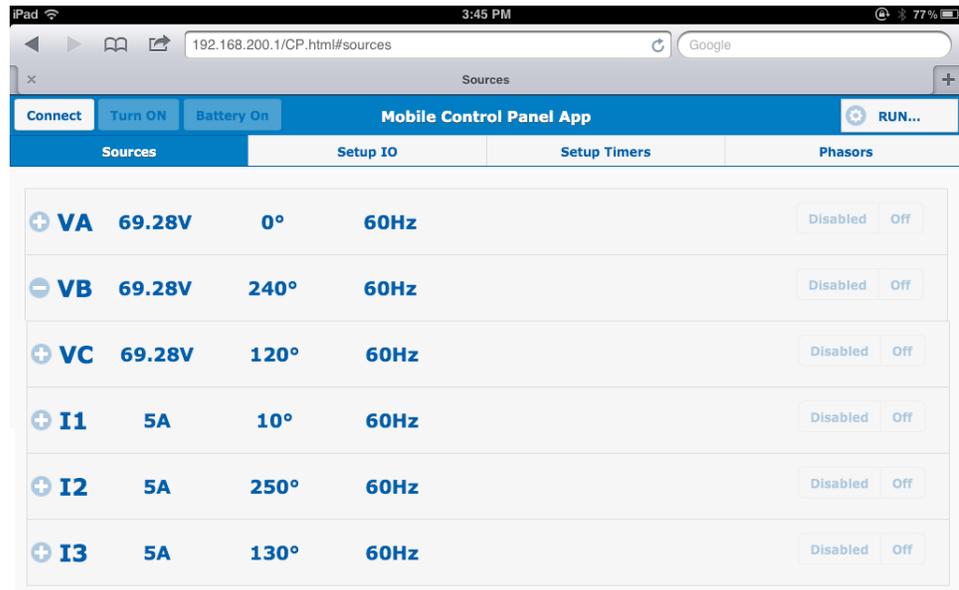
With your mobile device you must:

Connect to the Wi-Fi channel broadcast by your F6150, identified by its SSID which contains the 9 digit serial number of your instrument. For example, F6150sv040702215 or F6150e081305537.

You may need to configure the IP address of your mobile device to a fixed address in the same subnet as your F6150. Get an available IP address from your IT department. Follow the procedure provided by your mobile device manufacturer to configure its IP address.

2. To prevent other devices from connecting to your F6150, turn on the IP Restriction feature in the F6150 Configuration Page. Your F6150 will lock to the first IP Address that connects to the instrument. Once connected, the F6150 will only communicate with that IP Address until the IP Restriction is disabled or the instrument is rebooted.

## Control Panel



**Figure 141 Control Panel**

Figure 141 shows the Control Panel. The top toolbar includes three buttons, Connect, Turn ON, Battery On, and the Run.. drop-down menu.

To connect to the F6150 instrument, click **Connect**. There will be a short delay, as the connection is occurring. The button will change to “Connecting...” After a connection is established, the button is enabled and changed to “Disconnect”.

Once the connection is made, choose from the list of available sources.

The “Turn ON” button is similar to the “System Out” button in Protection Suite. It turns on enabled sources. After the sources are turned on, the button changes to “Turn OFF”.

Click **Turn Off** to immediately turn off the enabled sources.

Click **Battery On** to turn the battery on.

The RUN... drop-down menu includes options for 3 test types (Pulse, Step/ramp, and Timing), Battery settings, Enable source options, go to the Configuration page, and Toggle to a full screen browser.

There are four tabs: Sources, Setup IO, Setup Timers, and Phasors. They are explained in following sections.

## Sources Tab

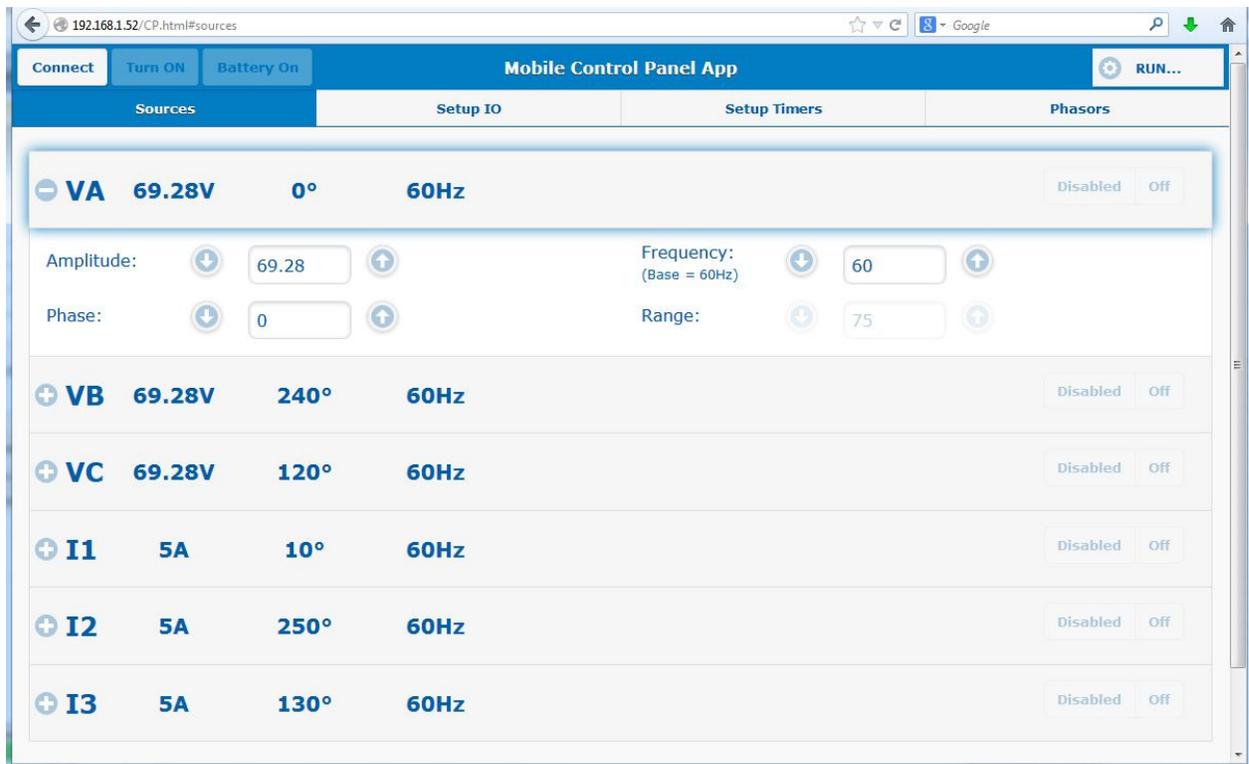
Figure 142 shows the 3 V and 3 I Sources screen with VA selected, to show its settings view. Click on a source to expand the settings view which allows you to change the amplitude, phase, frequency or range of the selected source.

In the settings view of the selected source, click the up or down arrow to **change the amplitude or phase**. You can also enter numeric values directly into the settings field.

Click the up or down arrow to **change the frequency** in multiples of the base frequency. To change the base frequency, you must disconnect from the instrument and type directly into the frequency setting field.

Click the up or down arrow to **change the range** in multiples of the machine range setting. You must be connected to the instrument to change the range.

Click the selected source to collapse its settings view.



**Figure 142 Sources Screen**

The two buttons on the right of each source allow enabling or disabling of system output and allow you to immediately turn the individual sources on or off.

## Setup IO Tab

This screen allows you to set the characteristics for each of the 6 Logic Inputs (LNs) and 6 Logic Outputs (LPs). You must be disconnected from the F6150 instrument to change these settings, when connected the settings have already been applied to the instrument and cannot be changed. See “Logic I/O” on page 64 for a detailed description of Logic Inputs and Outputs.

There are three choices for the Type of each LN: Contact, 15V, and 1.5V. Each LN can have its Normal Condition set to Open/Off or Closed/On. The "Stop on Sense" applies only to Ramps and can be set to None or any one of the LNs.

A Logic Output is a logical relay that opens or closes its contacts when its associated source turns on. A LP is normally open when its source is off. You can invert this setting for each LP by marking its Invert Output check box.

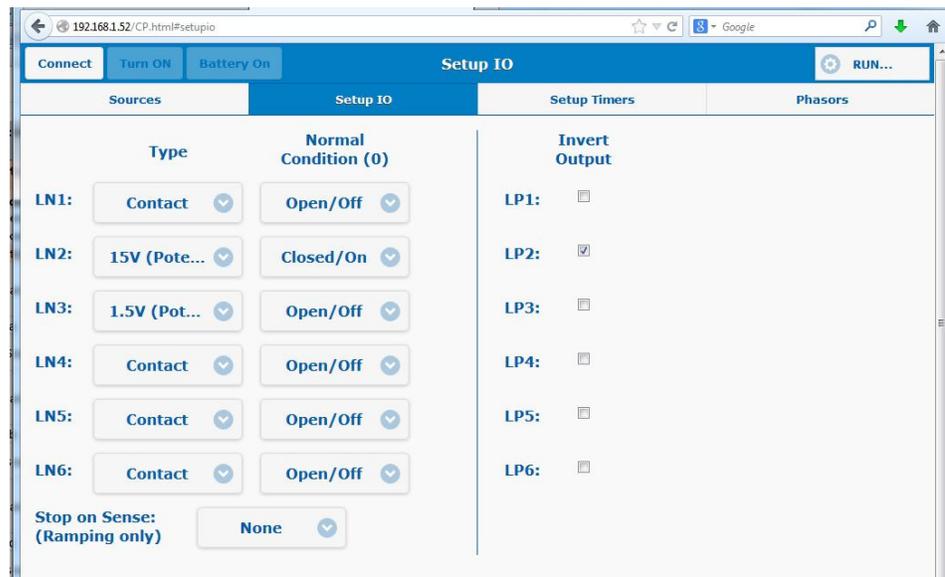
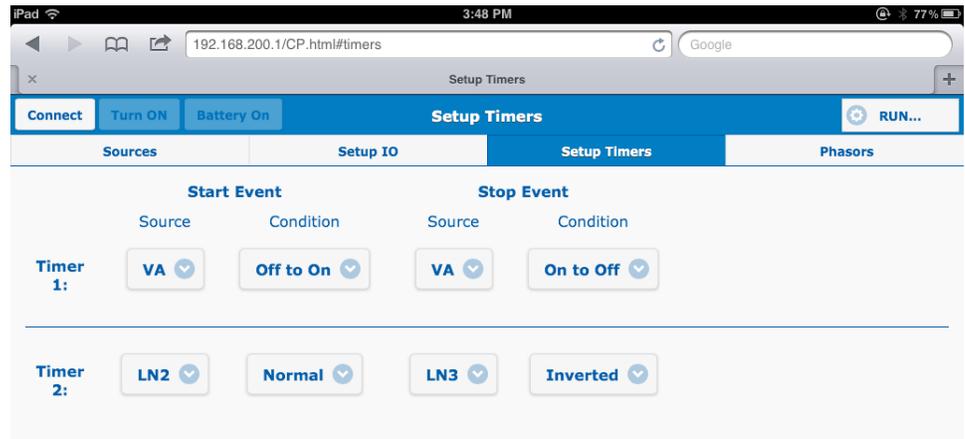


Figure 143 Setup IO

## Setup Timers Tab

This screen allows you to set up timers. Two timers are supported, at this time.



**Figure 144 Setup Timers Screen**

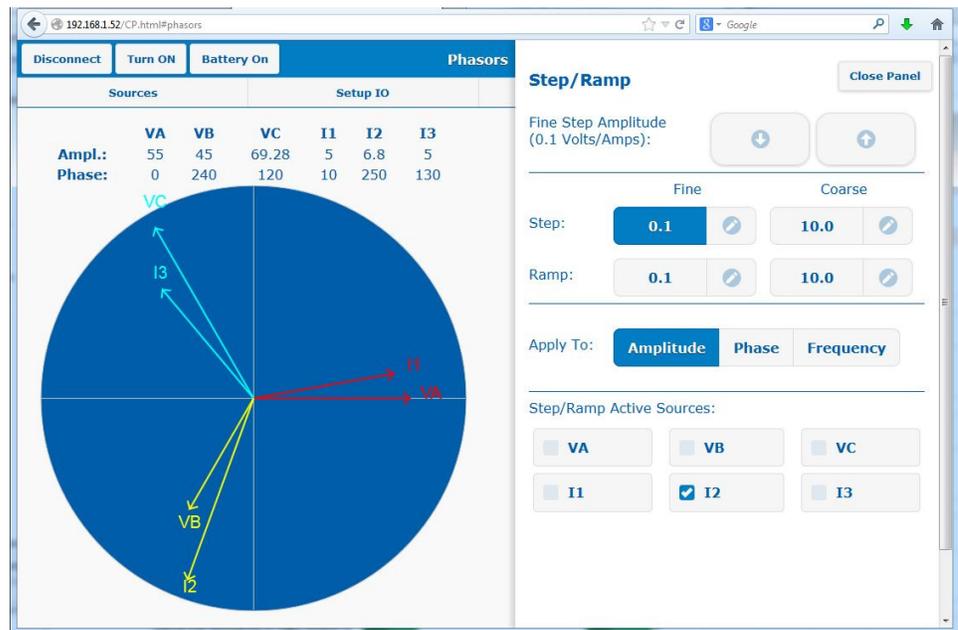
Supported conditions to start or stop timers include:

- Sources "On to Off" or "Off to On"
- LNs "Normal" or "Inverted"

**Note:** If you set two timers, both must complete for the event to cease.

# Phasors Tab

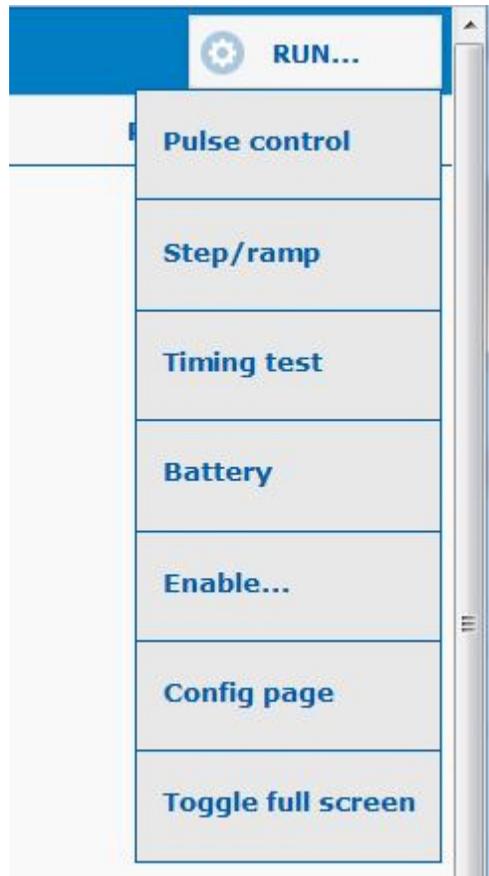
This tab displays the amplitude and phase for all sources as vectors. During Ramp and Step tests, the display is live. When a source's amplitude or phase changes, its vector is updated.



**Figure 145 Phasors with Ramp**

## RUN... Button

The RUN... button opens a drop-down menu with selections for Pulse Control, Step/Ramp, Timing Test, Battery Control, Enable..., the Configuration Page, and to Toggle your browser to full screen mode..



*Figure 146 RUN... Drop-Down Menu*

## Pulse Control

This screen allows you to set up a test such that the sources have a maximum on-time - the pulse duration. The pulse duration is not intended to be highly accurate, but simply an upper limit for the on-time.

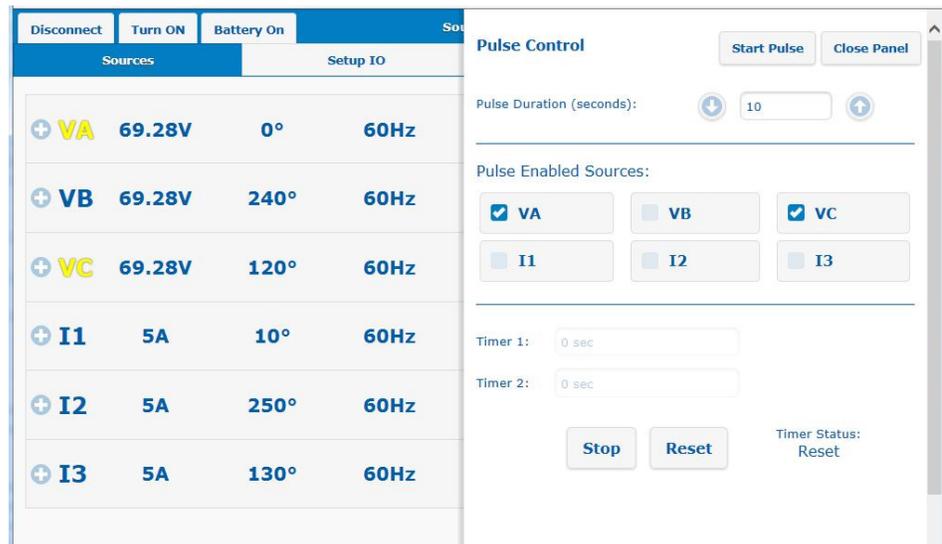
Set the pulse duration in seconds, using the up and down arrows, or type directly in the setting field. Timers may be set up; if the timer stop events occur, the sources will turn off with the timers, otherwise the test continues to the pulse duration time limit.

The Timer 1 and Timer 2 boxes show the current timer status in seconds.

Select the sources to be enabled for the pulse duration (Control panel must be connected to the instrument.) then click **Start Pulse** to begin the test.

You may choose to manually stop the test and turn off the sources with the **Stop** button.

Reset the pulse duration timer and event timers with the **Reset** button to run another test.



**Figure 147 Pulse Control Screen When Connected**

The screenshot displays a mobile control interface. At the top, there are status buttons: 'Disconnect', 'Turn OFF' (highlighted in red), and 'Battery On'. Below this is a 'Sources' table with two tabs: 'Sources' and 'Setup IO'. The table lists six sources with their respective parameters. To the right is a 'Pulse Control' panel with a 'Start Pulse' button and a 'Close Panel' button. It includes a 'Pulse Duration (seconds)' input set to 10. Under 'Pulse Enabled Sources', there are checkboxes for VA, VB, VC, I1, I2, and I3. VA and VC are checked. Below this are two timer displays, both showing 7.9716 sec, and 'Stop' and 'Reset' buttons. The 'Timer Status' is indicated as 'Running'.

Source	Voltage	Phase	Frequency
VA	69.28V	0°	60Hz
VB	69.28V	240°	60Hz
VC	69.28V	120°	60Hz
I1	5A	10°	60Hz
I2	5A	250°	60Hz
I3	5A	130°	60Hz

**Pulse Control**

Start Pulse Close Panel

Pulse Duration (seconds): 10

Pulse Enabled Sources:

VA  VB  VC

I1  I2  I3

Timer 1: 7.9716 sec

Timer 2: 7.9716 sec

Stop Reset

Timer Status: Running

Figure 148 Pulse ON

## Step/Ramp

This screen allows you to set the details of a simple Step or Ramp test. You can Step/Ramp the Amplitude, Phase or Frequency of the Activated sources using either a Fine or Coarse setting. For Ramp tests you may choose to setup a Logic Input (LN) and use the Stop on Sense option to stop the Ramp (see “Setup IO Tab” on page 236).

You must Enable the desired sources on the Sources Tab and Turn ON system output on Toolbar to begin your Step/Ramp test.

Click the Pencil Icon for each Step size and Ramp rate to edit the Fine and Coarse settings. Use the up and down arrows or type a new value directly in the pop-up dialog box. Click outside the dialog box to update the setting and close the dialog.



### Running a Test

1. Select the desired Step (Fine / Coarse) or Ramp (Fine / Coarse).
2. Select to Apply the Step/Ramp to either Amplitude, Phase or Frequency.
3. Select to Activate the Sources that will be affected by the Step/Ramp. You may choose to have sources turned on that are not Stepping/Ramping. The Control Panel must be connected to the F6150 to Activate Sources.)

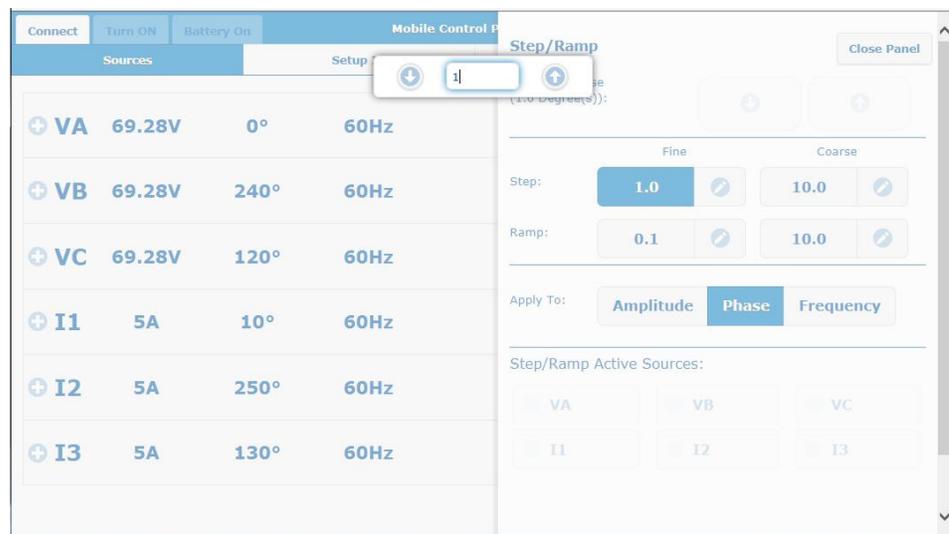


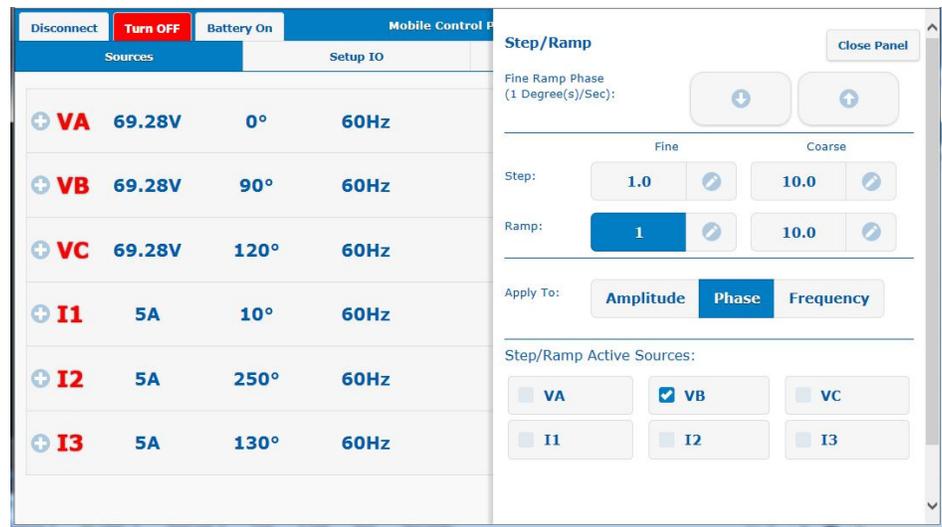
Figure 149 Editing the Fine Step Setting

After the Step/Ramp settings are selected, the desired sources enabled and turned on, the test may begin.

**Step test:** Each click of the Up or Down buttons will change the selected characteristic of the Active Sources by a single step size.

**Ramp test:** Click the active ramp button to stop the ramp or Disconnect to stop the ramp and disconnect from the instrument. All buttons except the active ramp button and the Disconnect button are disabled while a ramp test is running.

Figure 150 shows the Control Panel set for a Fine Ramp test on the Phase of source VB. The phase angle of VB will increase or decrease at a rate of 1 Degree/Sec. All sources are turned on but only VB will be affected by the ramp. Note that only the Down Ramp button and the Disconnect button are active.



**Figure 150 Settings Selected, Sources On**

## Timing Test

This screen allows you to run a Timing Test based on Logic Inputs (LNs), Logic Outputs (LPs) and Timers you have already set up. See the sections on “Setup IO Tab” on page 236 and “Setup Timers Tab” on page 237 for details.

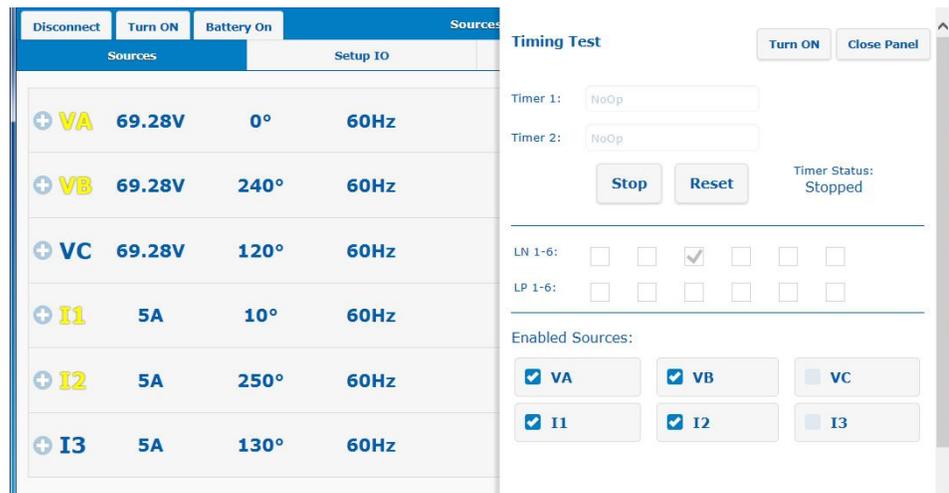
The current status of Timer 1 and Timer 2 is shown, along with the current states of the LNs and LPs. A check mark indicates the LN or LP has been triggered.

Select to Enable Sources for the test. The Control Panel must be connected to the F6150 to select the sources.

Click **Turn ON** to start the test.

If (both) the timer stop events occur, the sources will turn off with the timers, ending the test. Otherwise, the test continues until manually stopped with the **Turn OFF** or **Stop** button. The Stop button stops the timers, as well as the sources.

You may choose to Reset the timers and start a new test.



**Figure 151 Timing Test**

## Battery Control

The Battery Control screen allows you to turn the battery on or off, and to set the battery voltage.

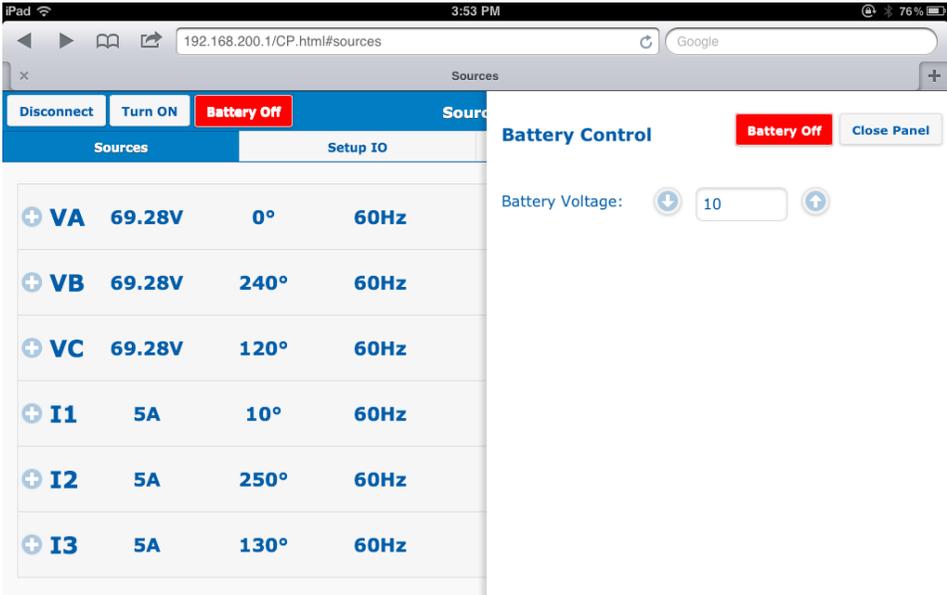


Figure 152 Battery Control Screen

## Enable...

The Enable... menu choice allows you to enable all sources, or only voltage sources, or only current sources.

All Sources	Enable...
Voltage Sources	
Current Sources	

**Figure 153 Enable... Menu Choices**

## Configuration Screen

Figure 154 shows the Configuration screen that provides general information and allows users to change certain behaviors of the instrument. See “Configuration Screen” on page 247 for details on the settings available in the Configuration screen.

The screenshot displays the 'F6150 Configuration' screen with a 'Control Panel' button in the top right corner. The screen is divided into two main sections. The left section lists system information: CPUID (67194811), Firmware Version (Version 5.5.0, Build 1013), IP Address (10.6.169.5), Subnet Mask (255.240.0.0), Embedded Web Content, Current Amplifier Clipping Shutdown (Enabled), Start Delay (0), and Start Delay Units (Cycles). The right section is titled 'Unicast SNMP Configuration' and includes fields for IP Address, Gateway IP Address, and Gateway Subnet Mask, all set to 0.0.0.0. Below these are three toggle switches: WiFi Power (Disabled), IP Restriction (Disabled), and Run As F6350 (Disabled). At the bottom right of the configuration area are 'Save Changes' and 'Refresh Config' buttons. A blue footer bar at the bottom contains the text 'Contact Doble'.

**Figure 154 Configuration Screen**

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# 12. Triggers

## Defining Triggers

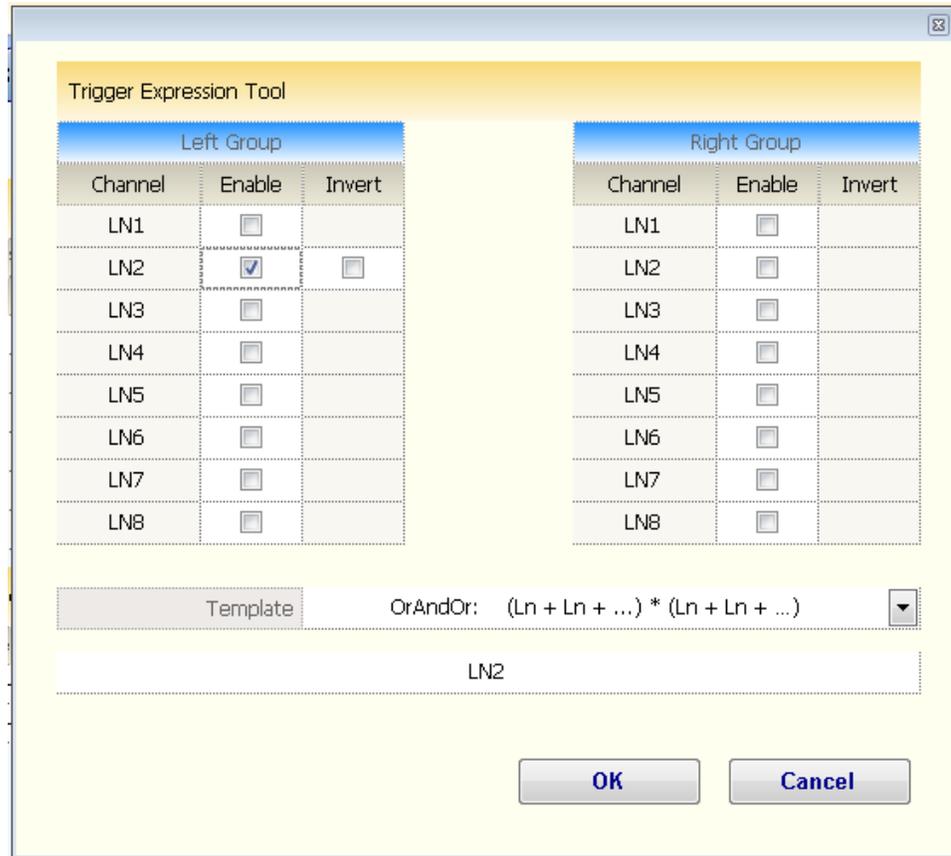
If a start condition or a stop condition requires an input signal from the relay under test or from any other source, specify the input via the Triggers display (see below). To access the Triggers dialog box, go to the Logic Settings dialog box in F6ControlPanel, ProTesT, Protection Suite ([Figure 155](#)), or other application, and click the Timers tab. From the Timers tab, click Define Triggers. A dialog box similar to the following should appear:

Logic Inputs and Outputs						
Inputs				Outputs		
Channel ID	Label	Input Type	Normal Condition (0)	Channel ID	Label	Invert Output
LN1	LN1	 ▾	Open ▾	LP1	LP1	<input type="checkbox"/>
LN2	LN2	 ▾	Open ▾	LP2	LP2	<input type="checkbox"/>
LN3	LN3	 ▾	Open ▾	LP3	LP3	<input type="checkbox"/>
LN4	LN4	 ▾	Open ▾	LP4	LP4	<input type="checkbox"/>
LN5	LN5	 ▾	Open ▾	LP5	LP5	<input type="checkbox"/>
LN6	LN6	 ▾	Open ▾	LP6	LP6	<input type="checkbox"/>
LN7	LN7	 ▾	Open ▾	LP7	LP7	<input type="checkbox"/>
LN8	LN8	 ▾	Open ▾	LP8	LP8	<input type="checkbox"/>

**Figure 155 Triggers**

Set the Input Type (**Contact**, **Potential 1.5V**, or **Potential 15V**) and Normal Condition (**Open** or **Closed**).

On the Timers tab (Protection Suite is used in this example.), go to the Logic Event Triggers setup, and select an input of Trigger Expression. See [Figure 156 on page 250](#).



**Figure 156**

Use this 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.

## Using Protection Suite

The **Timers Tab** in ProtectionSuite v2 allows setting triggers. You can label the trigger, pick what starts it, and pick what stops it.

The **Logic Event Triggers** allow you to define a more complex trigger.

Expected results let you set choices for severity rating. You can set tolerances (minus, plus, type). If you set a value, then change the type, confirm that the values are still correct.

Timer values will now show up at the bottom of the Overview window, when they are triggered while the test is running.

## 13. Cable Bags

The cable bags contains cables for connecting the F6 instruments.



This chapter covers the following:

- [“List of Contents - F6150/F6150e” on page 254](#)
- [“Illustrations of F6150 Cable Bag Contents” on page 258](#)
- [“List of Contents - F6150sv” on page 261](#)
- [“List of Contents - F6150sv-IEC/IRC” on page 264](#)
- [“List of Contents - F6150sv-SGD” on page 267](#)
- [“List of Contents - F6300” on page 271](#)
- [“List of Contents - F6300e” on page 273](#)
- [“List of Contents - F6350” on page 276](#)
- [“List of Contents - F6350e” on page 277](#)

## List of Contents - F6150/F6150e

**Table 34 F6150/F6150e Cable Bag**

Quantity	Part Number	Description
1	<b>03D-2021-01</b>	<b>KIT,TEST LEADS,SILICON,CURRENT,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
2	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN,SILICON
1	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-01	LABEL, TEST LEADS,SILICON, CURRENT, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-02</b>	<b>KIT,TEST LEADS,SILICON,VOLTAGE,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
1	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN,SILICON
2	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON

**Table 34 F6150/F6150e Cable Bag**

Quantity	Part Number	Description
1	21B-0106-02	LABEL, TEST LEADS,SILICON, VOLTAGE, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-03</b>	<b>KIT,TEST LEADS,SILICON,LOGIC I/O,F6150</b>
10	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
10	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
1	21B-0106-03	LABEL, TEST LEADS,SILICON, LOGIC I/O, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-04</b>	<b>KIT,TEST LEADS,SILICON,SPARE CABLES,F6150</b>
4	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
4	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
2	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-04	LABEL, TEST LEADS,SILICON, SPARE CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-05</b>	<b>KIT,TEST LEADS,SILICON,SHORTING CABLES,F6150</b>
5	181-0902	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,12IN,SILICON
5	181-0903	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,12IN,SILICON
1	21B-0106-05	LABEL, TEST LEADS,SILICON, SHORTING CABLES, F6150
0	73B-0428-05	ARTWORK,LABEL,TEST LEAD,SILICON,SHORTING CABLES,F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13

**Table 34 F6150/F6150e Cable Bag**

Quantity	Part Number	Description
1	<b>03D-2021-06</b>	<b>KIT,TEST LEADS,SILICON,CLIPS &amp; ADAPTERS,F6150</b>
4	212-0695	ADAPTER,MINI SPADE,RED,4MM,SOCKET
4	212-0696	ADAPTER,MINI SPADE,BLUE,4MM,SOCKET
4	212-0697	ADAPTER,MINI SPADE,YELLOW,4MM,SOCKET
7	212-0698	ADAPTER,MINI SPADE,BLACK,4MM,SOCKET
5	212-0699	ADAPTER,MINI SPADE,WHITE,4MM,SOCKET
6	212-0700	ADAPTER,MINI SPADE,GREEN,4MM,SOCKET
4	212-0701	CLIP,CROCODILE,RED,300V,10A,4MM,SOCKET
4	212-0702	CLIP,CROCODILE,BLACK,300V,10A,4MM,SOCKET
4	212-0703	CLIP,TEST,RED,1000V,1A,4MM,SOCKET
4	212-0704	CLIP,TEST,BLACK,1000V,1A,4MM,SOCKET
5	212-0705	ADAPTER,LEAD,RED,1000V,10A,4MM,SOCKET
5	212-0706	ADAPTER,LEAD,BLACK,1000V,10A,4MM,SOCKET
1	21B-0106-06	LABEL, TEST LEADS,SILICON, CLIPS & ADAPTERS, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
2	<b>05B-0619-01</b>	<b>CABLE,ADAPT,#4,R LUG-3X4MM,F, F6000</b>
3	09B-0765-01	REWORK, PLUG, CONTACTF6000
1	220-1099	PLUG,CONT,LS425-SEM,4mm,SET,Au
1.5	180-0524	WIRE, #10 AWG, WHT, SOFT
1	212-0145-S	TIE, CABLE, 4"LENGTH, CLEAR
1	212-0277	TERM RING, #4,1/4STUD

**Table 34 F6150/F6150e Cable Bag**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
3	220-1096	CONN,PLUG,KT425-SE,4mm,BLK INS
1	<b>08A-0207-01</b>	<b>CD, INSTRUMENT UTILITIES, F6000</b>
1	75A-0593-01	ARTWORK, LABEL, CD, INSTRUMENT UTILITES, F6000
1	75A-0594-01	ARTWORK, LINER, FRONT, INSTRUMENT UTILITIES, F6000
1	75A-0595-01	ARTWORK, LINER, BACK, INSTRUMENT UTILITIES, F6000
1	72A-2606-01	RELEASE NOTICE, F6000 SERIES INSTRUMENT UTILITIES
1	<b>181-0585</b>	<b>CABLE,USB TYPE A-B, 2MLONG</b>
1	<b>220-2192</b>	<b>CONNECTOR, ADAPTER, AC, NEMA5-C14 PLUG/ IEC320-C13 OUTLET, GROUND LEAD</b>
1	<b>2FB-3450-01</b>	<b>BAG, CABLE, SMALL</b>
1	<b>2FB-4206-01</b>	<b>BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850</b>
1	<b>401-0243</b>	<b>CABLE,ETHRNETC5E,RJ45/RJ45,10F</b>
1	<b>500-0213</b>	<b>MRKTNG REL NOTICE, F6000</b>
1	<b>72A-3108-01</b>	<b>USB DRIVER INSTALLATION NOTICE</b>

## Illustrations of F6150 Cable Bag Contents

	<p><b>Ten Silicone Cables with Retractable Test Leads</b> 600V, 36A, 200cm (78 inches) Colors: Red, Yellow, Blue, White, Black, and Green Part Number: 03D-1712-01</p>
	<p><b>Ten Silicone Cables with Retractable Test Leads</b> 600V, 36A, 200cm (78 inches) Colors: Red, Yellow, Blue, White, Black, and Green Part Number: 03D-1712-02</p>
	<p><b>Twenty Silicone Cables with Retractable Test Leads</b> 600V, 36A Colors: Red and Black Part Number: 03D-1712-03</p>
	<p><b>Ten Silicone Cables with Retractable Test Leads</b> 600V, 36A, 200cm (78 inches) Colors: Yellow and Blue Part Number: 03D-1712-04</p>

	<p><b>Ten Silicone Shorting Cables with Retractable Test Leads</b> 600V, 36A, 25cm (9.8 inches) Colors: Red and Black Part Number: 03D-1712-05</p>
	<p><b>Two Shorting Lugs</b> 1 Red, 1 Black part of Part Number 03D-1712-06</p>
	<p><b>10 Flexible Adapters</b> 10A 1mm socket part of Part Number 03D-1712-06</p>
	<p><b>30 Space Connectors</b> 36A 1mm socket part of Part Number 03D-1712-06</p>

	<p><b>8 Crocodile Clips</b> 10A 600V 4mm socket part of Part Number 03D-1712-06</p>
	<p><b>8 Clip Connectors</b> 6A 4mm socket part of Part Number 03D-1712-06</p>
<p>(not shown)</p>	<p><b>1 Ethernet and 1 USB cable</b></p>

## List of Contents - F6150sv

**Table 35 F6150sv Cable Bag**

Quantity	Part Number	Description
1	21B-0106-04	LABEL, TEST LEADS,SILICON, SPARE CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
<b>1</b>	<b>03D-2021-05</b>	<b>KIT,TEST LEADS,SILICON,SHORTING CABLES,F6150</b>
5	181-0902	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,12IN,SILICON
5	181-0903	CABLE,TEST LEAD, RETRACTABLE, BLACK, 600V, 41A, 12IN, SILICON
1	21B-0106-05	LABEL, TEST LEADS,SILICON, SHORTING CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
<b>1</b>	<b>03D-2021-06</b>	<b>KIT,TEST LEADS,SILICON,CLIPS &amp; ADAPTERS,F6150</b>
4	212-0695	ADAPTER,MINI SPADE,RED,4MM,SOCKET
4	212-0696	ADAPTER,MINI SPADE,BLUE,4MM,SOCKET
4	212-0697	ADAPTER,MINI SPADE,YELLOW,4MM,SOCKET
7	212-0698	ADAPTER,MINI SPADE,BLACK,4MM,SOCKET
5	212-0699	ADAPTER,MINI SPADE,WHITE,4MM,SOCKET
6	212-0700	ADAPTER,MINI SPADE,GREEN,4MM,SOCKET
4	212-0701	CLIP,CROCODILE,RED,300V,10A,4MM,SOCKET
4	212-0702	CLIP,CROCODILE,BLACK,300V,10A,4MM,SOCKET
4	212-0703	CLIP,TEST,RED,1000V,1A,4MM,SOCKET
4	212-0704	CLIP,TEST,BLACK,1000V,1A,4MM,SOCKET
5	212-0705	ADAPTER,LEAD,RED,1000V,10A,4MM,SOCKET
5	212-0706	ADAPTER,LEAD,BLACK,1000V,10A,4MM,SOCKET

**Table 35 F6150sv Cable Bag**

Quantity	Part Number	Description
1	21B-0106-06	LABEL, TEST LEADS,SILICON, CLIPS & ADAPTERS, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
<b>2</b>	<b>05B-0619-01</b>	<b>CABLE,ADAPT,#4,R LUG-3X4MM,F, F6000</b>
3	09B-0765-01	REWORK, PLUG, CONTACTF6000
1	220-1099	PLUG,CONT,LS425-SEM,4mm,SET,Au
1.5	180-0524	WIRE, #10 AWG, WHT, SOFT
1	212-0145-S	TIE, CABLE, 4"LENGTH, CLEAR
1	212-0277	TERM RING, #4,1/4STUD
3	220-1096	CONN,PLUG,KT425-SE,4mm,BLK INS
1	<b>08A-0207-01</b>	<b>CD, INSTRUMENT UTILITIES, F6000</b>
1	75A-0593-01	ARTWORK, LABEL, CD, INSTRUMENT UTILITES, F6000
1	75A-0594-01	ARTWORK, LINER, FRONT, INSTRUMENT UTILITIES, F6000
1	75A-0595-01	ARTWORK, LINER, BACK, INSTRUMENT UTILITIES, F6000
1	72A-2606-01	RELEASE NOTICE, F6000 SERIES INSTRUMENT UTILITIES
1	<b>181-0585</b>	<b>CABLE,USB TYPE A-B, 2MLONG</b>
1	<b>181-0846</b>	<b>CABLE, FIBER, DUPLEX, 62.5 UM, 2M, SC - MTRJ CROSSOVER</b>
1	<b>181-0847</b>	<b>CABLE, FIBER, DUPLEX, 62.5 UM, 2M, ST - MTRJ MALE</b>
1	<b>220-2192</b>	<b>CONNECTOR, ADAPTER, AC, NEMA5-C14 PLUG/ IEC320-C13 OUTLET, GROUND LEAD</b>
1	<b>2FB-3450-01</b>	<b>BAG, CABLE, SMALL</b>
1	<b>2FB-4206-01</b>	<b>BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850</b>

**Table 35 F6150sv Cable Bag**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
1	401-0243	CABLE,ETHRNETC5E,RJ45/RJ45,10F
1	500-0213	MRKTNG REL NOTICE, F6000
1	72A-3108-01	USB DRIVER INSTALLATION NOTICE

## List of Contents - F6150sv-IEC/IRC

**Table 36 F6150sv-IEC/IRC Cable Bag**

Quantity	Part Number	Description
1	<b>03D-2021-03</b>	<b>KIT,TEST LEADS,SILICON,LOGIC I/O,F6150</b>
10	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
10	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
1	21B-0106-03	LABEL, TEST LEADS,SILICON, LOGIC I/O, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-04</b>	<b>KIT,TEST LEADS,SILICON,SPARE CABLES,F6150</b>
4	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
4	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
2	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-04	LABEL, TEST LEADS,SILICON, SPARE CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-05</b>	<b>KIT,TEST LEADS,SILICON,SHORTING CABLES,F6150</b>
5	181-0902	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,12IN,SILICON
5	181-0903	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,12IN,SILICON
1	21B-0106-05	LABEL, TEST LEADS,SILICON, SHORTING CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-06</b>	<b>KIT,TEST LEADS,SILICON,CLIPS &amp; ADAPTERS,F6150</b>

**Table 36 F6150sv-IEC/IRC Cable Bag**

Quantity	Part Number	Description
4	212-0695	ADAPTER,MINI SPADE,RED,4MM,SOCKET
4	212-0696	ADAPTER,MINI SPADE,BLUE,4MM,SOCKET
4	212-0697	ADAPTER,MINI SPADE,YELLOW,4MM,SOCKET
7	212-0698	ADAPTER,MINI SPADE,BLACK,4MM,SOCKET
5	212-0699	ADAPTER,MINI SPADE,WHITE,4MM,SOCKET
6	212-0700	ADAPTER,MINI SPADE,GREEN,4MM,SOCKET
4	212-0701	CLIP,CROCODILE,RED,300V,10A,4MM,SOCKET
4	212-0702	CLIP,CROCODILE,BLACK,300V,10A,4MM,SOCKET
4	212-0703	CLIP,TEST,RED,1000V,1A,4MM,SOCKET
4	212-0704	CLIP,TEST,BLACK,1000V,1A,4MM,SOCKET
5	212-0705	ADAPTER,LEAD,RED,1000V,10A,4MM,SOCKET
5	212-0706	ADAPTER,LEAD,BLACK,1000V,10A,4MM,SOCKET
1	21B-0106-06	LABEL, TEST LEADS,SILICON, CLIPS & ADAPTERS, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
2	<b>05B-0619-01</b>	<b>CABLE,ADAPT,#4,R LUG-3X4MM,F, F6000</b>
3	09B-0765-01	REWORK, PLUG, CONTACTF6000
1	220-1099	PLUG,CONT,LS425-SEM,4mm,SET,Au
1.5	180-0524	WIRE, #10 AWG, WHT, SOFT
1	212-0145-S	TIE, CABLE, 4"LENGTH, CLEAR
1	212-0277	TERM RING, #4,1/4STUD
3	220-1096	CONN,PLUG,KT425-SE,4mm,BLK INS

**Table 36 F6150sv-IEC/IRC Cable Bag**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
1	<b>08A-0207-01</b>	<b>CD, INSTRUMENT UTILITIES, F6000</b>
1	75A-0593-01	ARTWORK, LABEL, CD, INSTRUMENT UTILITES, F6000
1	75A-0594-01	ARTWORK, LINER, FRONT, INSTRUMENT UTILITIES, F6000
1	75A-0595-01	ARTWORK, LINER, BACK, INSTRUMENT UTILITIES, F6000
1	72A-2606-01	RELEASE NOTICE, F6000 SERIES INSTRUMENT UTILITIES
1	<b>181-0585</b>	<b>CABLE,USB TYPE A-B, 2MLONG</b>
1	<b>181-0846</b>	<b>CABLE, FIBER, DUPLEX, 62.5 UM, 2M, SC - MTRJ CROSSOVER</b>
1	<b>181-0847</b>	<b>CABLE, FIBER, DUPLEX, 62.5 UM, 2M, ST - MTRJ MALE</b>
1	<b>220-2192</b>	<b>CONNECTOR, ADAPTER, AC, NEMA5-C14 PLUG/ IEC320-C13 OUTLET, GROUND LEAD</b>
1	<b>2FB-3450-01</b>	<b>BAG, CABLE, SMALL</b>
1	<b>2FB-4206-01</b>	<b>BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850</b>
1	<b>401-0243</b>	<b>CABLE,ETHRNETC5E,RJ45/RJ45,10F</b>
1	<b>500-0213</b>	<b>MRKTNG REL NOTICE, F6000</b>
11	<b>72A-3108-01</b>	<b>USB DRIVER INSTALLATION NOTICE</b>

## List of Contents - F6150sv-SGD

**Table 37 F6150sv-SGD Cable Bag**

Quantity	Part Number	Description
1	<b>03D-2021-01</b>	<b>KIT,TEST LEADS,SILICON,CURRENT,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
2	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN,SILICON
1	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-01	LABEL, TEST LEADS,SILICON, CURRENT, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-03</b>	<b>KIT,TEST LEADS,SILICON,LOGIC I/O,F6150</b>
10	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
10	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
1	21B-0106-03	LABEL, TEST LEADS,SILICON, LOGIC I/O, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-04</b>	<b>KIT,TEST LEADS,SILICON,SPARE CABLES,F6150</b>
4	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON

**Table 37 F6150sv-SGD Cable Bag**

Quantity	Part Number	Description
4	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
2	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-04	LABEL, TEST LEADS,SILICON, SPARE CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-05</b>	<b>KIT,TEST LEADS,SILICON,SHORTING CABLES,F6150</b>
5	181-0902	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,12IN,SILICON
5	181-0903	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,12IN,SILICON
1	21B-0106-05	LABEL, TEST LEADS,SILICON, SHORTING CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-06</b>	<b>KIT,TEST LEADS,SILICON,CLIPS &amp; ADAPTERS,F6150</b>
4	212-0695	ADAPTER,MINI SPADE,RED,4MM,SOCKET
4	212-0696	ADAPTER,MINI SPADE,BLUE,4MM,SOCKET
4	12-0697	ADAPTER,MINI SPADE,YELLOW,4MM,SOCKET
7	212-0698	ADAPTER,MINI SPADE,BLACK,4MM,SOCKET
5	212-0699	ADAPTER,MINI SPADE,WHITE,4MM,SOCKET
6	212-0700	ADAPTER,MINI SPADE,GREEN,4MM,SOCKET
4	212-0701	CLIP,CROCODILE,RED,300V,10A,4MM,SOCKET
4	212-0702	CLIP,CROCODILE,BLACK,300V,10A,4MM,SOCKET
4	212-0703	CLIP,TEST,RED,1000V,1A,4MM,SOCKET
4	212-0704	CLIP,TEST,BLACK,1000V,1A,4MM,SOCKET

**Table 37 F6150sv-SGD Cable Bag**

Quantity	Part Number	Description
5	212-0705	ADAPTER,LEAD,RED,1000V,10A,4MM,SOCKET
5	212-0706	ADAPTER,LEAD,BLACK,1000V,10A,4MM,SOCKET
1	21B-0106-06	LABEL, TEST LEADS,SILICON, CLIPS & ADAPTERS, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
2	<b>05B-0619-01</b>	<b>CABLE,ADAPT,#4,R LUG-3X4MM,F, F6000</b>
3	09B-0765-01	REWORK, PLUG, CONTACTF6000
1	220-1099	PLUG,CONT,LS425-SEM,4mm,SET,Au
1.51	180-0524	WIRE, #10 AWG, WHT, SOFT
1	212-0145-S	TIE, CABLE, 4"LENGTH, CLEAR
1	212-0277	TERM RING, #4,1/4STUD
3	220-1096	CONN,PLUG,KT425-SE,4mm,BLK INS
1	<b>08A-0207-01</b>	<b>CD, INSTRUMENT UTILITIES, F6000</b>
1	75A-0593-01	ARTWORK, LABEL, CD, INSTRUMENT UTILITES, F6000
1	75A-0594-01	ARTWORK, LINER, FRONT, INSTRUMENT UTILITIES, F6000
1	75A-0595-01	ARTWORK, LINER, BACK, INSTRUMENT UTILITIES, F6000
1	72A-2606-01	RELEASE NOTICE, F6000 SERIES INSTRUMENT UTILITIES
1	<b>181-0585</b>	<b>CABLE,USB TYPE A-B, 2MLONG</b>
1	<b>181-0846</b>	<b>CABLE, FIBER, DUPLEX, 62.5 UM, 2M, SC - MTRJ CROSSOVER</b>
1	<b>181-0847</b>	<b>CABLE, FIBER, DUPLEX, 62.5 UM, 2M, ST - MTRJ MALE</b>
1	<b>220-2192</b>	<b>CONNECTOR, ADAPTER, AC, NEMA5-C14 PLUG/ IEC320-C13 OUTLET, GROUND LEAD</b>

**Table 37 F6150sv-SGD Cable Bag**

Quantity	Part Number	Description
1	2FB-3450-01	BAG, CABLE, SMALL
1	2FB-4206-01	BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850
1	401-0243	CABLE,ETHRNETC5E,RJ45/RJ45,10F
1	500-0213	MRKTNG REL NOTICE, F6000
1	72A-3108-01	USB DRIVER INSTALLATION NOTICE

## List of Contents - F6300

**Table 38 F6300 Cable Bag**

Quantity	Part Number	Description
1	<b>03D-2021-01</b>	<b>KIT,TEST LEADS,SILICON,CURRENT,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW, 600V, 41A, 79IN, SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN, SILICON
2	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN, SILICON
1	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN, SILICON
1	21B-0106-01	LABEL, TEST LEADS,SILICON, CURRENT, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
6	<b>05B-0531-01</b>	<b>CABLE,90A, 5 FT,BLK F2250.</b>
3	149-0124-S	TUBING,SHRINK 1/2 THIN W/ADHSV
5	181-0083	CABLE WELDING #4
1	20B-0331-01	LABEL, CABLE, HIGH CURRENT, M4000
1	212-0277	TERM RING, #4,1/4STUD
1	220-0807	CONN,SOCKET,RND,1-POLE,BLACK
1	2FB-2774-01	FERRULE, SPACER,HIGH CURRENT CABLE, F2250

**Table 38 F6300 Cable Bag**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
6	05B-0619-02	CABLE ADAPTER,LK 6MM,M/3X4MM,M
3	09B-0765-01	REWORK, PLUG, CONTACTF6000
1	220-1099	PLUG,CONT,LS425-SEM,4mm,SET,Au
1	09B-0788-01	REWORK,TERMINAL,RING,6AWG,1/4 STUD
1	212-0572	TERMINAL,RING,6AWG,1/4STUD
0	149-0124-S	TUBING,SHRINK 1/2 THIN W/ADHSV
2	180-0524	WIRE, #10 AWG, WHT, SOFT
1	220-0805	CONN,PLUG,RND,1-POLE,BLACK
3	220-1096	CONN,PLUG,KT425-SE,4mm,BLK INS
1	2FB-3487-01	COVER, CONNECTOR
1	181-0696	CABLE,15P,F6300,W/JACKSCREW,5FT,M/M
6	212-0527	ADAPTER,SMALL SPDE LUG-4mm, BLK
6	212-0528	ADAPTER,SMALL SPDE LUG-4mm,RED
1	2FB-3450-01	BAG, CABLE, SMALL
1	2FB-4206-01	BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850
1	401-0167	CABLE,RS232,INSTR-PC 10FT
1	401-0243	CABLE,ETHRNETC5E,RJ45/RJ45,10F
1	401-0303	ADAPTER,CROSSOVERCABLE,RJ45MF
1	500-0457	REL NOT,F6300 HI PWR CURAMPL
1	500-0462	USER GUIDE,F6300 PWR SYSSIM

## List of Contents - F6300e

**Table 39 F6300e Cable Bag**

Quantity	Part Number	Description
2	<b>03D-2021-01</b>	<b>KIT,TEST LEADS,SILICON,CURRENT,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
2	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN,SILICON
1	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-01	LABEL, TEST LEADS,SILICON, CURRENT, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
6	<b>05B-0531-01</b>	<b>CABLE,90A, 5 FT,BLK F2250.</b>
3	149-0124-S	TUBING,SHRINK 1/2 THIN W/ADHSV
5	181-0083	CABLE WELDING #4
1	20B-0331-01	LABEL, CABLE, HIGH CURRENT, M4000
1	212-0277	TERM RING, #4,1/4STUD
1	220-0807	CONN,SOCKET,RND,1-POLE,BLACK
1	2FB-2774-01	FERRULE, SPACER,HIGH CURRENT CABLE, F2250
6	<b>05B-0619-02</b>	<b>CABLE ADAPTER,LK 6MM,M/3X4MM,M</b>

**Table 39 F6300e Cable Bag**

Quantity	Part Number	Description
3	09B-0765-01	REWORK, PLUG, CONTACTF6000
1	220-1099	PLUG,CONT,LS425-SEM,4mm,SET,Au
1	09B-0788-01	REWORK,TERMINAL,RING,6AWG,1/4 STUD
1	212-0572	TERMINAL,RING,6AWG,1/4STUD
0	149-0124-S	TUBING,SHRINK 1/2 THIN W/ADHSV
2	180-0524	WIRE, #10 AWG, WHT, SOFT
1	220-0805	CONN,PLUG,RND,1-POLE,BLACK
3	220-1096	CONN,PLUG,KT425-SE,4mm,BLK INS
1	2FB-3487-01	COVER, CONNECTOR
0	800-0051-S	ADHESIVE,INSTANT,411PRISM
1	<b>08A-0207-01</b>	<b>CD, INSTRUMENT UTILITIES, F6000</b>
1	75A-0593-01	ARTWORK, LABEL, CD, INSTRUMENT UTILITES, F6000
1	75A-0594-01	ARTWORK, LINER, FRONT, INSTRUMENT UTILITIES, F6000
1	75A-0595-01	ARTWORK, LINER, BACK, INSTRUMENT UTILITIES, F6000
1	72A-2606-01	RELEASE NOTICE, F6000 SERIES INSTRUMENT UTILITIES
1	<b>181-0696</b>	<b>CABLE,15P,F6300,W/JACKSCREW,5FT,M/M</b>
6	<b>212-0527</b>	<b>ADAPTER,SMALL SPDE LUG-4mm, BLK</b>
6	<b>212-0528</b>	<b>ADAPTER,SMALL SPDE LUG-4mm,RED</b>
1	<b>220-2192</b>	<b>CONNECTOR, ADAPTER, AC, NEMA5-C14 PLUG/ IEC320-C13 OUTLET, GROUND LEAD</b>
1	<b>2FB-3450-01</b>	<b>BAG, CABLE, SMALL</b>
1	<b>2FB-4206-01</b>	<b>BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850</b>
1	<b>401-0167</b>	<b>CABLE,RS232,INSTR-PC 10FT</b>

**Table 39 F6300e Cable Bag**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
1	401-0243	CABLE,ETHRNETC5E,RJ45/RJ45,10F
1	401-0303	ADAPTER,CROSSOVERCABLE,RJ45MF

## List of Contents - F6350

Quantity.	Part Number	Description
3	05B-0616-01	CABLE, IOOUTPUT, F6000
1	05B-0617-01	CABLE, V OUTPUT, F6000
2	05B-0619-01	CABLE, ADAPT,#4,R LUG-3X4MM,F,F6000
1	05B-0730-03	CABLE, INTERFACE, LOW LEVEL SOURCES, 25FT, F6350
1	08A-0146-01	CD, F6350, S/W USER INTERFACE
1	08A-0189-01	CD F6 MULTIPLE AMPLIFIER CONFIGURATOR S/W
1	181-0585	CABLE, USB TYPE A-B, 2MLONG
1	181-0088	CORD, AC POWER, 14AWGX3, USA PLUG, 10 FT
4	212-0527	ADAPTER, SMALL, SPDE LUG-4MM, BLK
1	212-0528	ADAPTER, SMALL, SPDE LUG-4MM, RED
9	212-0529	ADAPTER, SMALL, SPDE LUG-4MM, WHT
2	212-0542	CLIP, CROCODILE, BLK, 4MMSOCKET2 EA
2	212-0543	CLIP, CROCODILE, RED, 4MMSOCKET
1	2FB-3450-01	BAG, CABLE, SMALL
1	401-0243	CABLE, ETHRNETC5E, RJ45, 10F
1	72A-3245-01	USER GUIDE, F6 HARDWARE
3	903-0011	BAG, ZIP-all, 10.5 X 8.0

## List of Contents - F6350e

**Table 40 F6350e Cable Bag**

Quantity	Part Number	Description
1	<b>03D-2021-01</b>	<b>KIT,TEST LEADS,SILICON,CURRENT,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
2	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN,SILICON
1	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-01	LABEL, TEST LEADS,SILICON, CURRENT, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-02</b>	<b>KIT,TEST LEADS,SILICON,VOLTAGE,F6150</b>
2	181-0896	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,79IN,SILICON
2	181-0897	CABLE,TEST LEAD,RETRACTABLE,BLUE,600V,41A,79IN,SILICON
2	181-0898	CABLE,TEST LEAD,RETRACTABLE,YELLOW,600V,41A,79IN,SILICON
1	181-0899	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,79IN,SILICON
1	181-0900	CABLE,TEST LEAD,RETRACTABLE,GREEN,600V,41A,79IN,SILICON

**Table 40 F6350e Cable Bag**

Quantity	Part Number	Description
2	181-0901	CABLE,TEST LEAD,RETRACTABLE,WHITE,600V,41A,79IN,SILICON
1	21B-0106-02	LABEL, TEST LEADS,SILICON, VOLTAGE, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>03D-2021-05</b>	<b>KIT,TEST LEADS,SILICON,SHORTING CABLES,F6150</b>
5	181-0902	CABLE,TEST LEAD,RETRACTABLE,RED,600V,41A,12IN,SILICON
5	181-0903	CABLE,TEST LEAD,RETRACTABLE,BLACK,600V,41A,12IN,SILICON
1	21B-0106-05	LABEL, TEST LEADS,SILICON, SHORTING CABLES, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>3D-2021-06</b>	<b>KIT,TEST LEADS,SILICON,CLIPS &amp; ADAPTERS,F6150</b>
4	212-0695	ADAPTER,MINI SPADE,RED,4MM,SOCKET
4	212-0696	ADAPTER,MINI SPADE,BLUE,4MM,SOCKET
4	212-0697	ADAPTER,MINI SPADE,YELLOW,4MM,SOCKET
7	212-0698	ADAPTER,MINI SPADE,BLACK,4MM,SOCKET
5	212-0699	ADAPTER,MINI SPADE,WHITE,4MM,SOCKET
6	212-0700	ADAPTER,MINI SPADE,GREEN,4MM,SOCKET
4	212-0701	CLIP,CROCODILE,RED,300V,10A,4MM,SOCKET
4	212-0702	CLIP,CROCODILE,BLACK,300V,10A,4MM,SOCKET
4	212-0703	CLIP,TEST,RED,1000V,1A,4MM,SOCKET
4	212-0704	CLIP,TEST,BLACK,1000V,1A,4MM,SOCKET
5	212-0705	ADAPTER,LEAD,RED,1000V,10A,4MM,SOCKET
5	212-0706	ADAPTER,LEAD,BLACK,1000V,10A,4MM,SOCKET

**Table 40 F6350e Cable Bag**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
1	21B-0106-06	LABEL, TEST LEADS,SILICON, CLIPS & ADAPTERS, F6150
1	903-0025	BAG, ANTI-STATIC, 9X12, PINK, SR-13
1	<b>08A-0207-01</b>	<b>CD, INSTRUMENT UTILITIES, F6000</b>
1	75A-0593-01	ARTWORK, LABEL, CD, INSTRUMENT UTILITES, F6000
1	75A-0594-01	ARTWORK, LINER, FRONT, INSTRUMENT UTILITIES, F6000
1	75A-0595-01	ARTWORK, LINER, BACK, INSTRUMENT UTILITIES, F6000
1	72A-2606-01	RELEASE NOTICE, F6000 SERIES INSTRUMENT UTILITIES
1	<b>181-0585</b>	<b>CABLE,USB TYPE A-B, 2MLONG</b>
1	<b>220-2192</b>	<b>CONNECTOR, ADAPTER, AC, NEMA5-C14 PLUG/ IEC320-C13 OUTLET, GROUND LEAD</b>
1	<b>2FB-3450-01</b>	<b>BAG, CABLE, SMALL</b>
1	<b>2FB-4206-01</b>	<b>BAG, ZIPPER, NYLON, BLUE, 12.5 X 7, DOBLE LOGO, F5850</b>
1	<b>401-0243</b>	<b>CABLE,ETHRNETC5E,RJ45/RJ45,10F</b>
1	<b>72A-3108-01</b>	<b>USB DRIVER INSTALLATION NOTICE</b>

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# 14. Other Cable Information

## Low Voltage Input Cables

This section covers the following cables:

- “05B-0730-01: F6350 Low level cable (obsolete)” on page 282
- “05B-0730-02: F6300 Low level cable (obsolete)” on page 283
- “05B-0730-03: F6350 Low level cable twisted pair (obsolete)” on page 284
- “05B-0730-04: F6300 Low level cable twisted pair (obsolete)” on page 287
- “05B-0730-05: Universal Low-Level Cable” on page 290

### 05B-0730-01: F6350 Low level cable (obsolete)

Refer to 05B-0730-05.

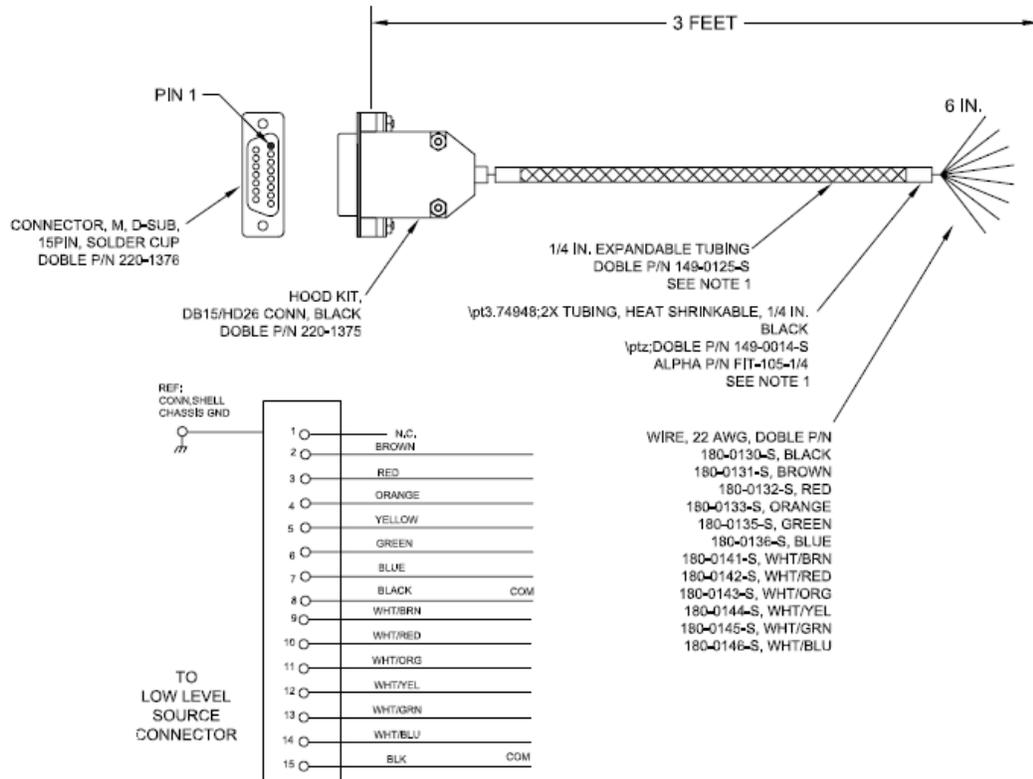


Figure 157 Overall

### 05B-0730-02: F6300 Low level cable (obsolete)

Refer to 05B-0730-05.

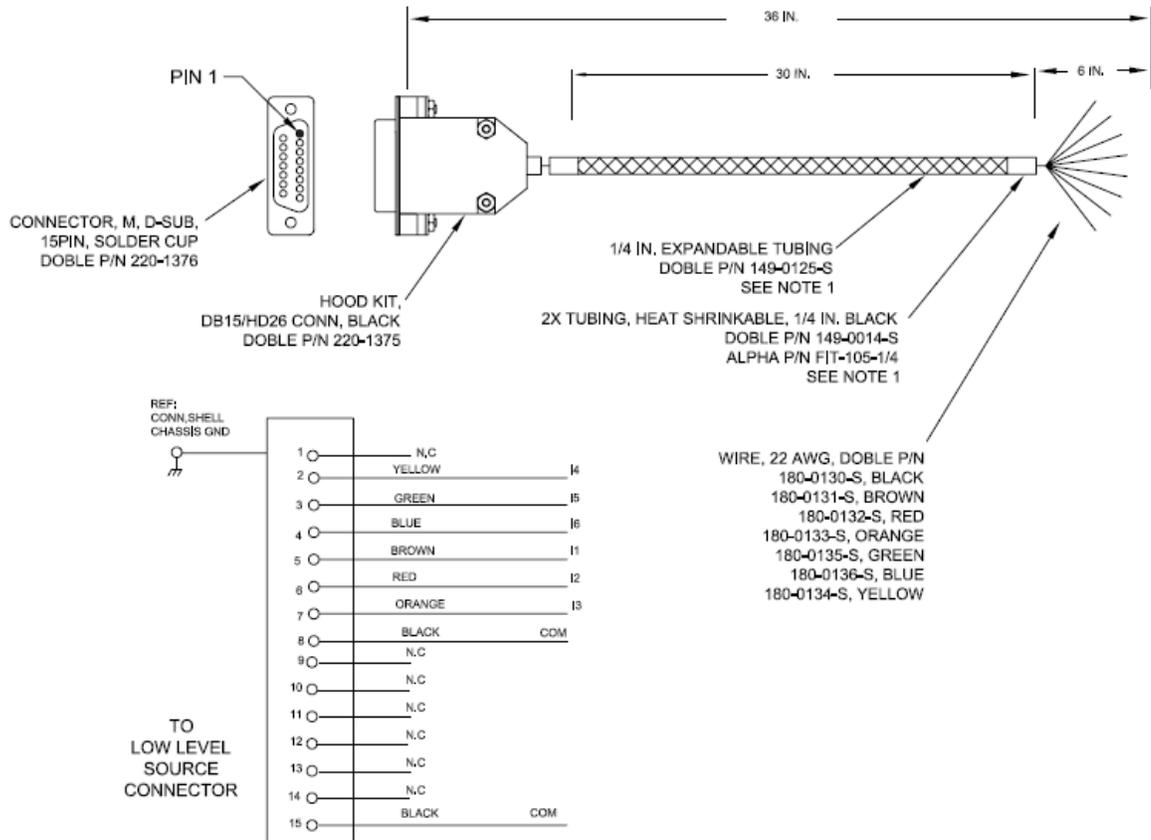
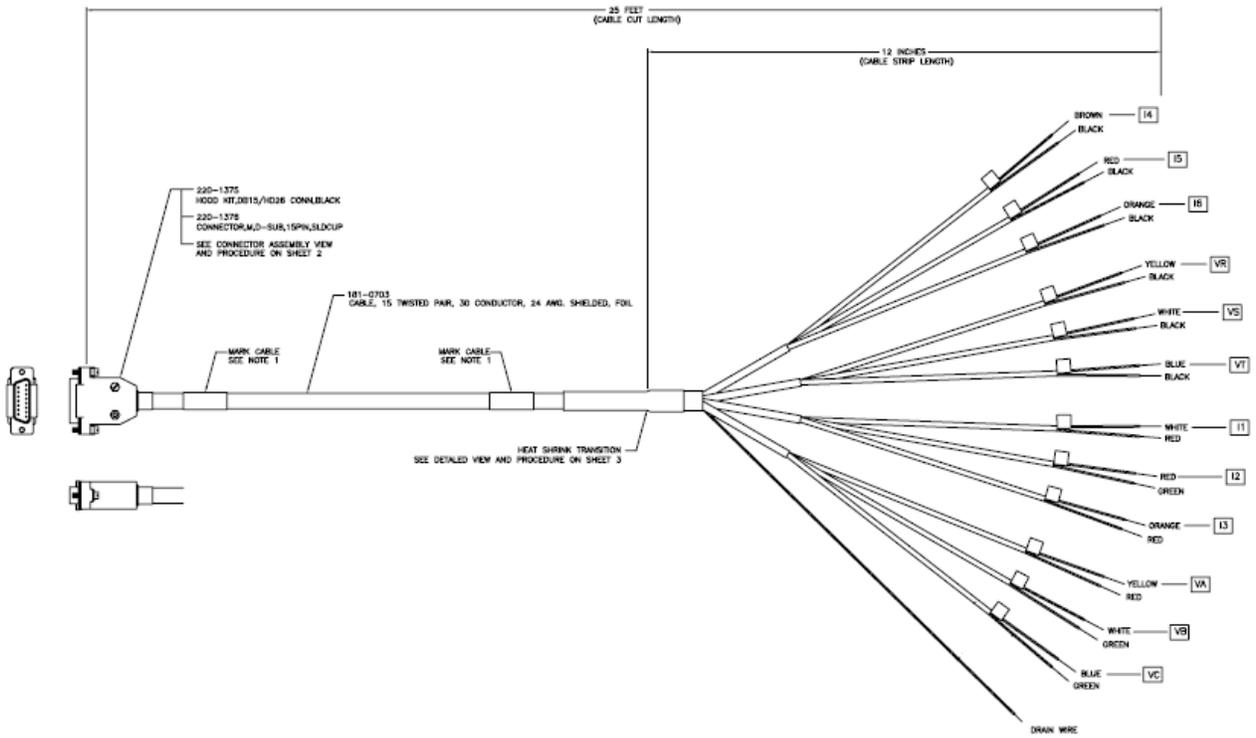


Figure 158 Overall

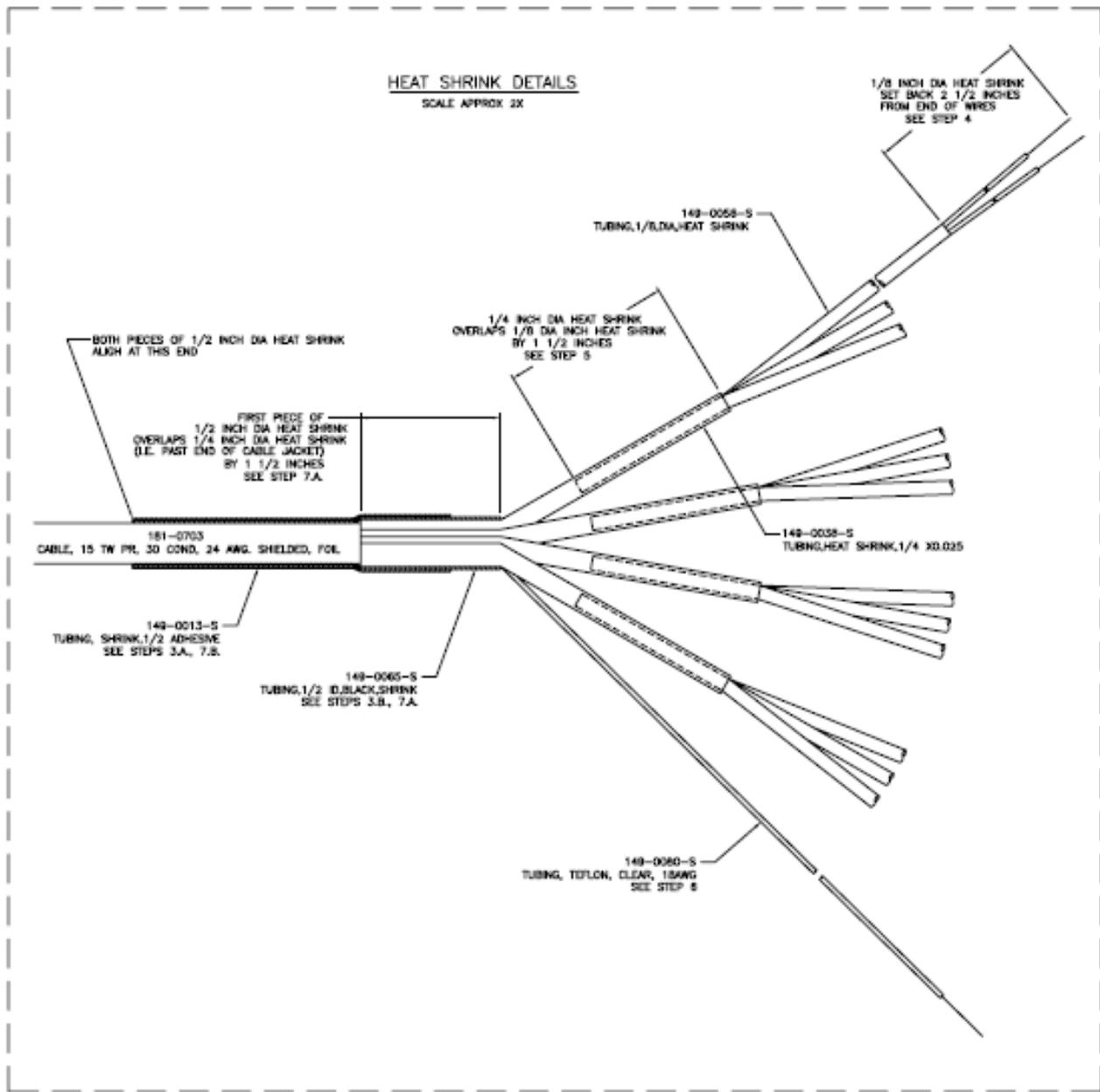
### 05B-0730-03: F6350 Low level cable twisted pair (obsolete)

Refer to 05B-0730-05.



**Figure 159 Overall**





**Figure 161 Heat Shrink Details**

### 05B-0730-04: F6300 Low level cable twisted pair (obsolete)

Refer to 05B-0730-05.

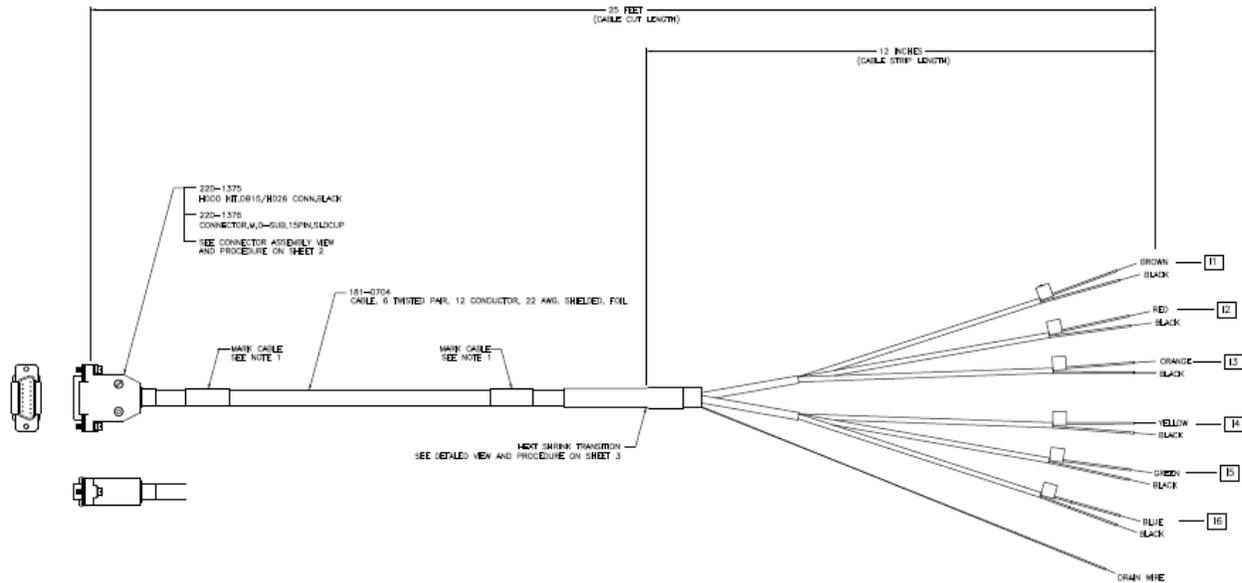


Figure 162 Overall

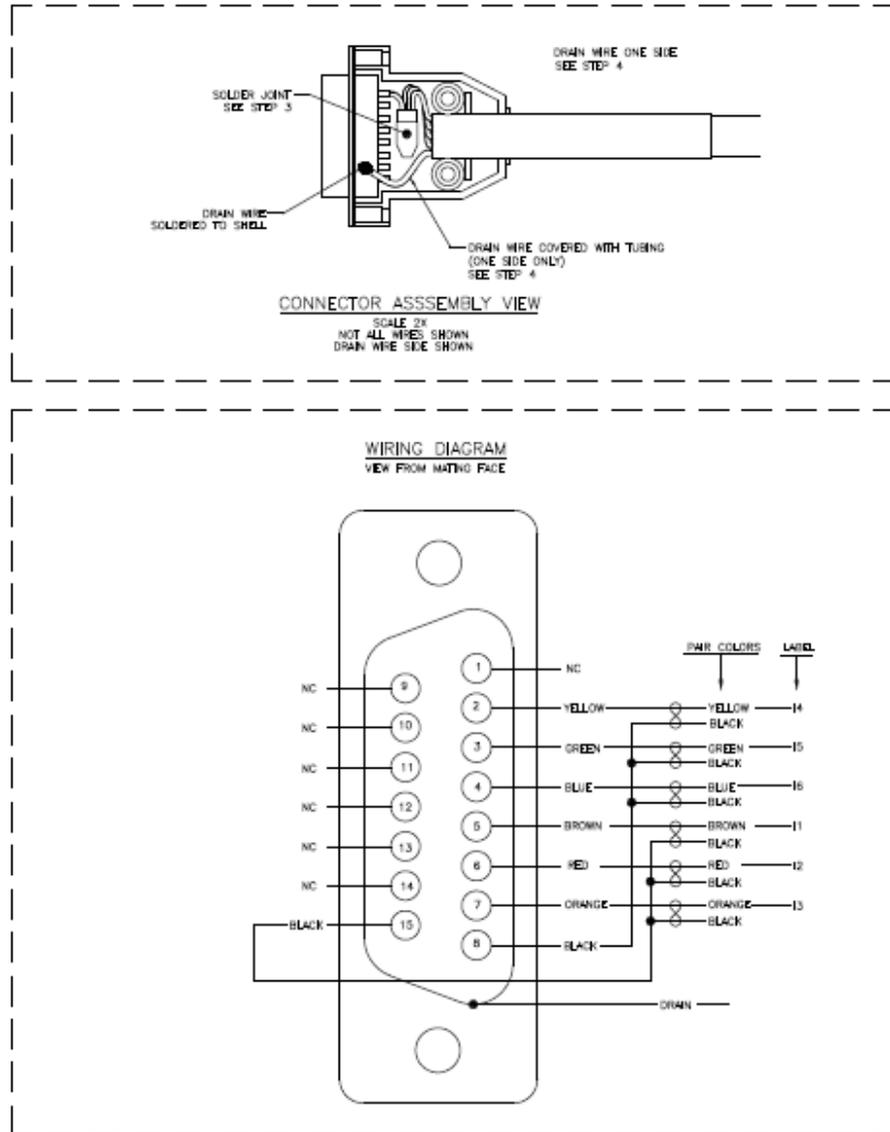
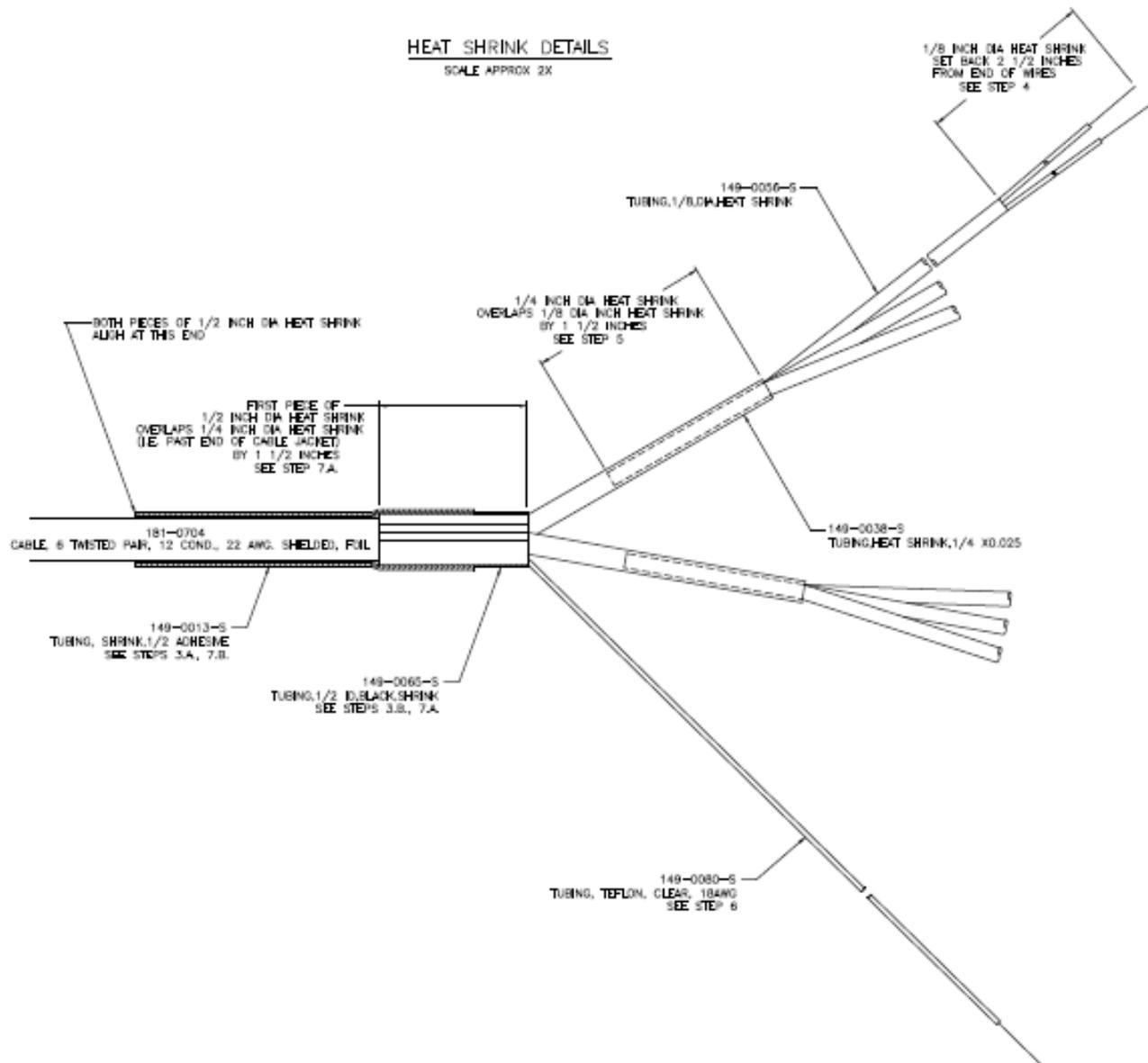


Figure 163 Connector Details



**Figure 164 Heat Shrink Details**

## 05B-0730-05: Universal Low-Level Cable

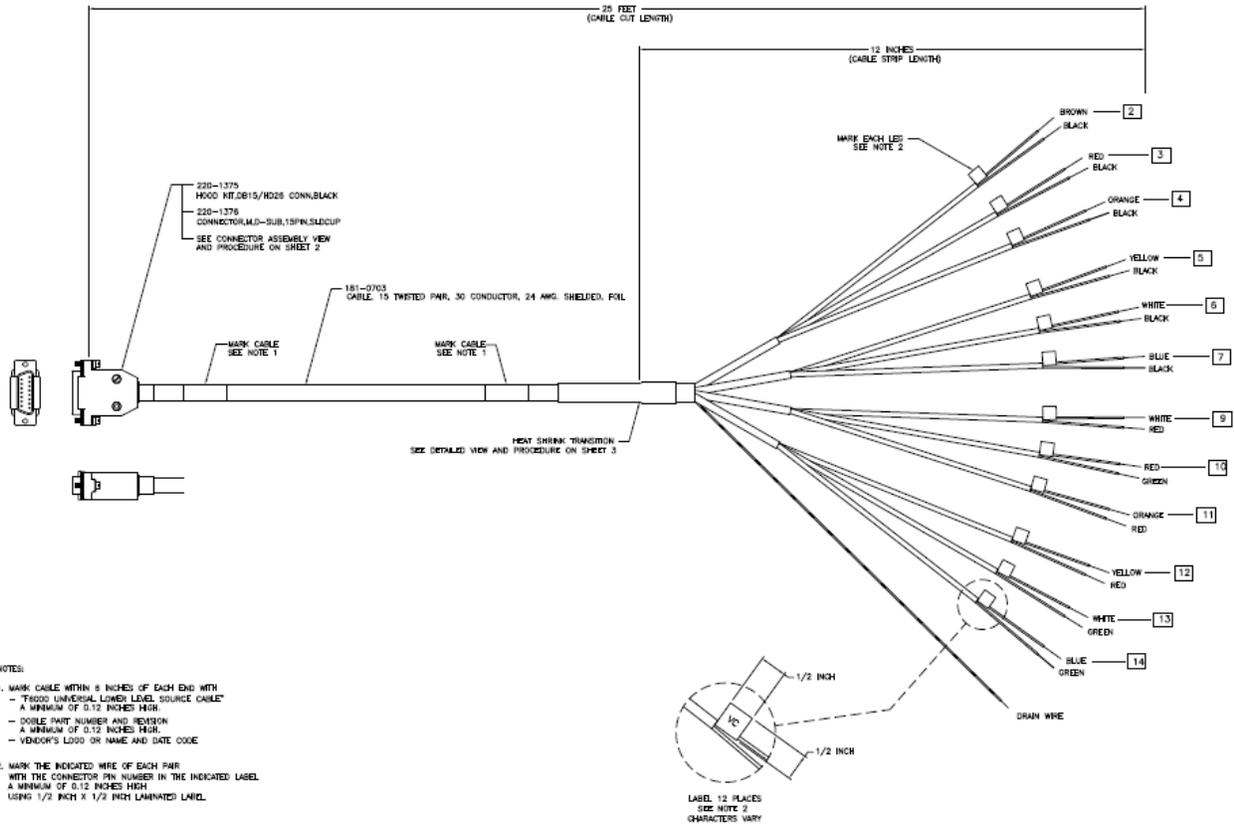


Figure 165 Overall

## Universal Low-Level Cable Pinouts

This cable contains 12 twisted-pair leads that connect to the pins of the Low Level Sources connector. Each of these pins controls the output from one of the upper or lower channels of the amplifier, as shown in the first three columns of the table.

**Table 41 Universal Low-Level Cable Pinouts and Wire Colors for Sources with the F6 Multiple Amplifier Configurator**

Pin Number	F6350 -F6350e Channels	F6350 – F6350e Sources	F6300 Channels	F6300 Sources	F6300e Channels	F6300e Sources	Wire Color (Pos. First)
9	Amp4-Ch1	I1	Not used		Amp4-Ch2	ID	White-Red
10	Amp5-Ch1	I2	Not used		Amp5-Ch2	IE	Red-Green
11	Amp6-Ch1	I3	Not used		Amp6-Ch2	IF	Orange-Red
2	Amp4-Ch2	I4	Amp4-Ch1	14	Amp4-Ch1	I4	Brown-Black
3	Amp5-Ch2	I5	Amp5-Ch1	15	Amp5-Ch1	I5	Red-Black
4	Amp6-Ch2	I6	Amp6-Ch1	16	Amp6-Ch1	I6	Orange-Black
12	Amp1-Ch1	VA or IA	Not used		Amp1-Ch2	IA	Yellow-Red
13	Amp2-Ch1	VB or IB	Not used		Amp2-Ch2	IB	White-Green
14	Amp3-Ch1	VC or IC	Not used		Amp3-Ch2	IC	Blue-Green
5	Amp1-Ch2	VR or IR	Amp1-Ch1	I1	Amp1-Ch1	I1	Yellow-Black
6	Amp2-Ch2	VS or IS	Amp2-Ch1	I2	Amp2-Ch1	I2	White-Black
7	Amp3-Ch2	VT or IT	Amp3-Ch1	I3	Amp3-Ch1	I3	Blue-Black

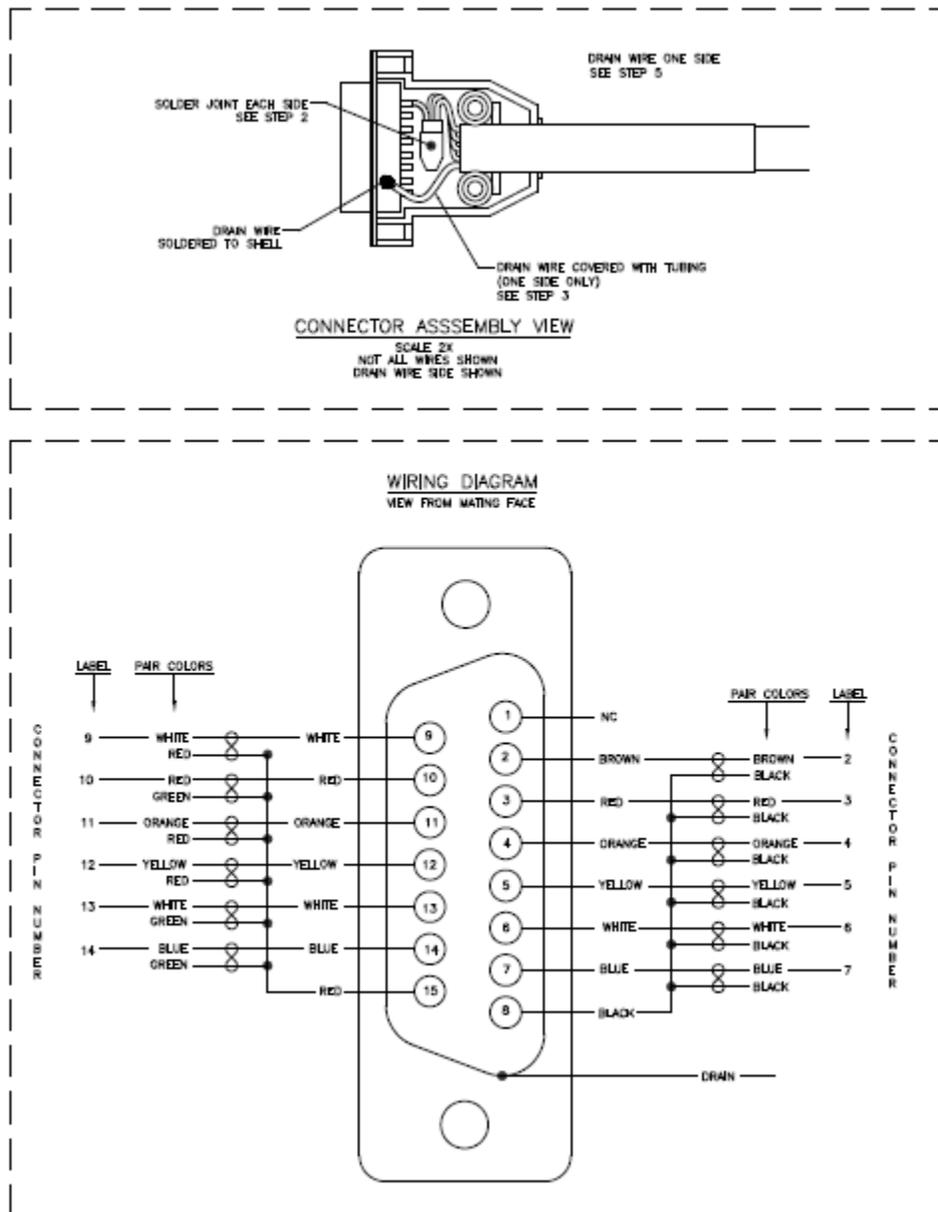
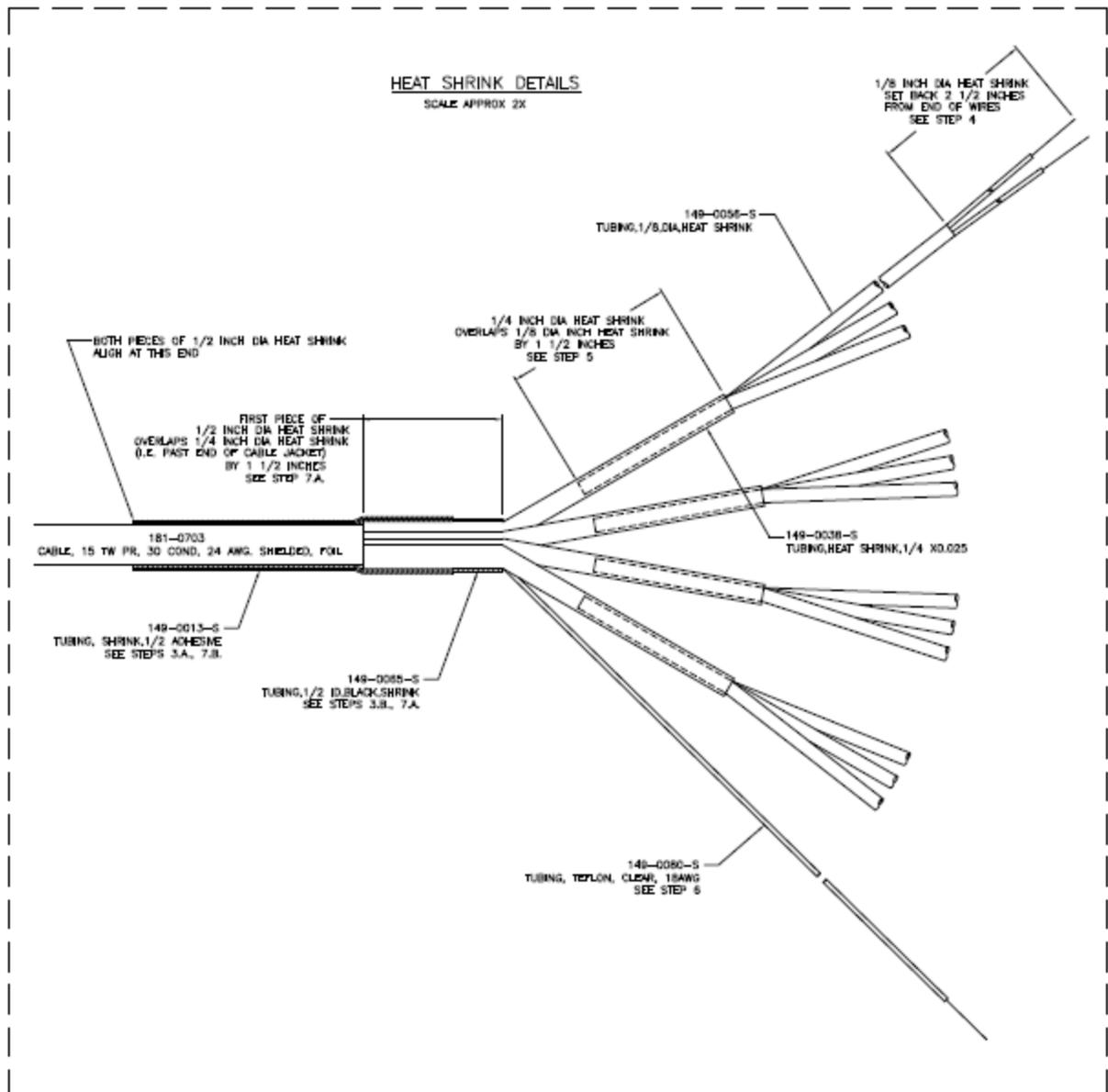


Figure 166 Pinouts



**Figure 167 Heat Shrink Details**

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# 15. Adding the SV Upgrade

## Introduction

These instructions describe the procedure for upgrading certain F6150 CPU2 configurations to the current F6150 configuration including:

- Three enhanced current amplifier boards
- A new power supply board
- A CPU 3 board with the Sampled Values (SV) option
- A Wi-Fi enabled Comm Module with fiber and USB connectors.

This procedure is part of Doble P/N 03D-1964-01, KIT, UPGRADE, CPU 2 W/ COMM TO UPGRADE, CPU 3 W/ SV AND WIFI, F6150, which contains the boards, assemblies, cables, and hardware required for the upgrade. The full contents of this kit are listed in [“Upgrade Kit Contents” on page 330](#).

## Applicability

The only applicable baseline configuration is an F6150 that contains a CPU 2 board (P/N 04S-0799-01) and has a separate removable comm module. This configuration has been manufactured since 2007.

	<p><b>NOTE:</b> This upgrade CAN be applied to F6150s with the AIM option installed. This upgrade CAN NOT be applied to any type of F6150A. This upgrade CAN NOT be applied to F6150s with a solid front panel.</p>
---	---

## Conventions

In the following procedure:

- **Left** and **right** refer to the instrument, front panel, or board, as viewed from the front.
- **Top** and **bottom** refer to the instrument, front panel, or board, as it would be seen in normal operation.
- **F6150** refers to the instrument.

## Required Tools

- 3/32" (2.5 mm) hex wrench
- Large flat-blade screwdriver
- Medium Phillips screwdriver
- Small Phillips screwdriver
- Wire cutters or cable tie cutters

## 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 the following warnings:



**WARNING!** Before proceeding, disconnect the power cable from the front panel. Make sure 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!.

**WARNING!** 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.



**CAUTION!** These units contain electrostatic-sensitive components. Practice safe handling methods to protect components against electrostatic discharge.

## Procedure

### Before You Begin

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

### Opening the Chassis

#### Removing the Cover

1. Use a flat-head screwdriver to remove the top two rubber feet from the back of the instrument.



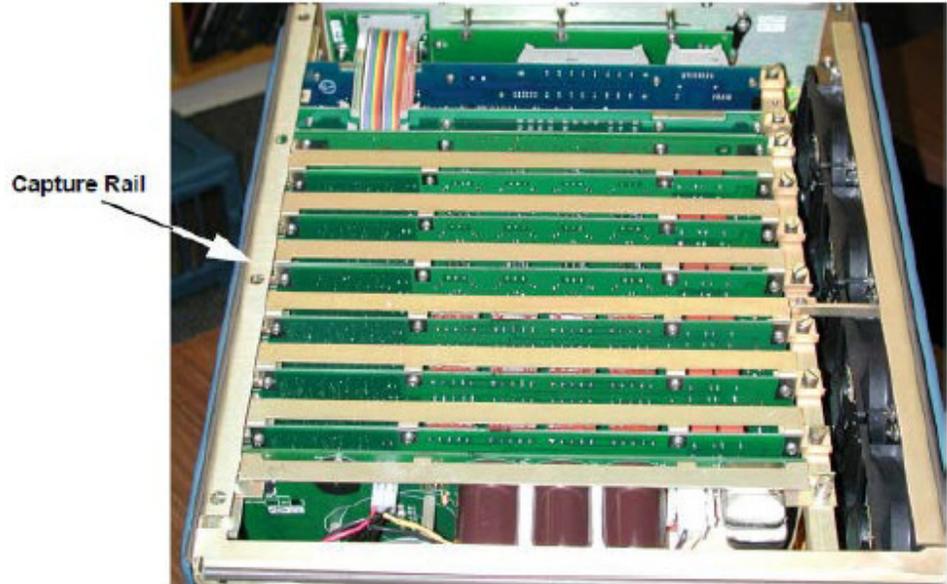
**Figure 168 Rubber Foot Removal**

2. Remove the cover.

### Removing the Capture Rail

1. On the side of the capture rail ([Figure 169 on page 299](#)), use a Phillips-head screwdriver to remove the screw at the right end.
2. On top of the capture rail, remove the four screws that hold the capture rail to the chassis by inserting a flat-head screwdriver into each hole.

3. Remove the capture rail.



*Figure 169 Internal Components and Capture Rail – Rear View*

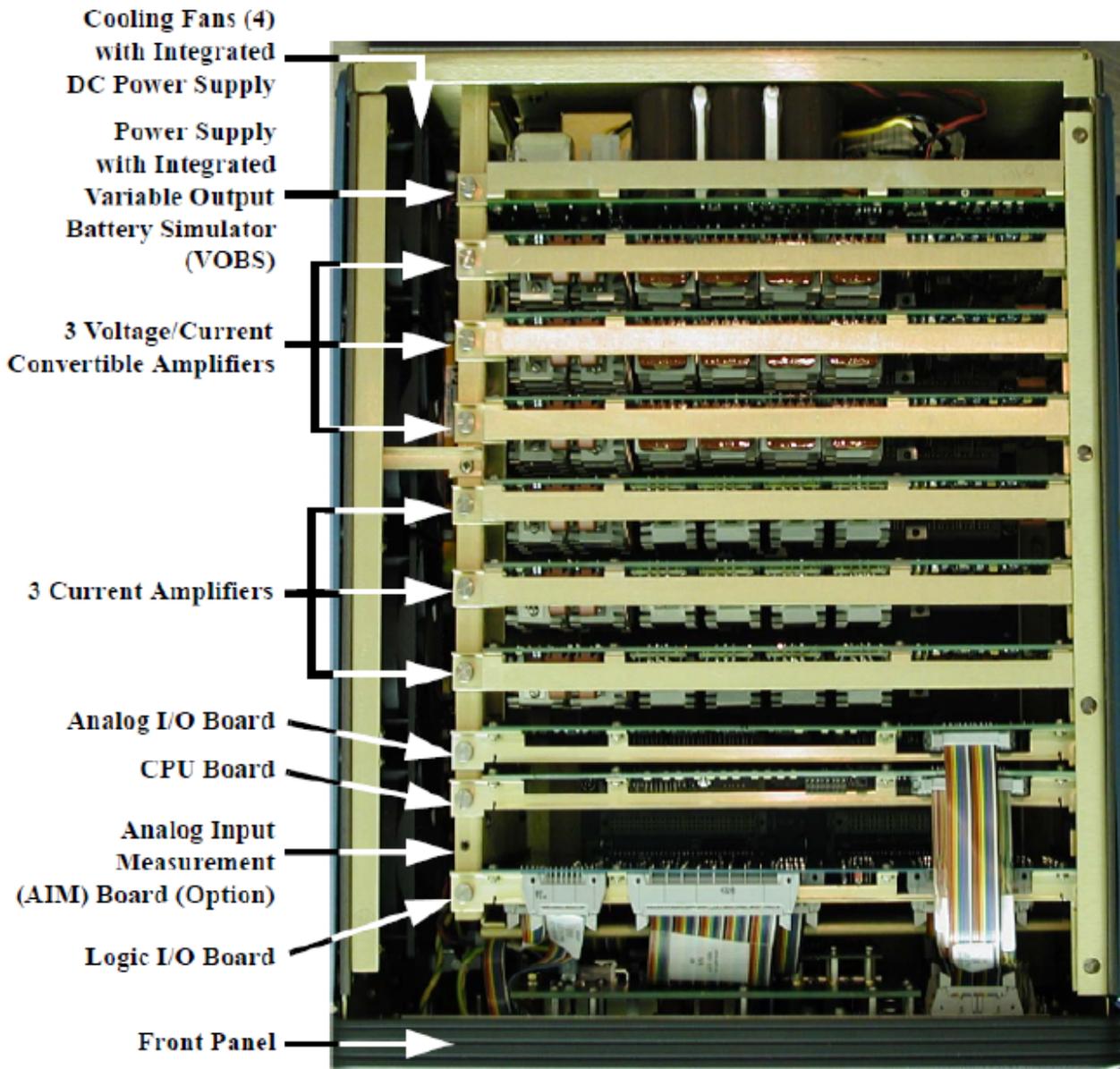
## Replacing Current Amplifier Boards

This section explains how to remove and replace the three (3) Current Amplifier boards.



**NOTE:** The unit contains three (3) Current Amplifier boards (Part Number 04S-0678-02) that you will replace with three (3) Enhanced Current Amplifier boards (Part Number 04X-1008-01).

1. Stand in front of the open instrument and look down and use the following figure to locate the boards. The Current Amplifier boards are located in slots 5, 6, and 7.



**Figure 170 F6150 Components**

2. Remove each board as follows:
  - a. Unscrew the captive fasteners on each end of the circuit board bracket.
  - b. Firmly grasp the board and pull it straight up.
3. Install each new board as follows:
  - a. Orient the board properly. For the Current Amplifier boards, the component side of the board faces the front of the chassis.
  - b. Place the new board firmly in the card guides and make sure it is squarely seated.
  - c. Make certain all backplane connectors are properly engaged and press down firmly on the end of the board at the same time to make sure that the pins are seated in the connectors.
  - d. Tighten the captive fasteners on each end of the circuit board bracket.

## Replacing Power Supply Board

This section explains how to remove and replace the Power Supply board.



**NOTE:** The unit contains a Power Supply board (Part Number 04S-0794-01, revision N or earlier) that you will replace with a newer Power Supply board (Part Number 04S-0794-01, Revision P).

1. Stand in front of the open instrument and look down and use the above figure to locate the board. The Power Supply board is located in slot 11.
2. Unscrew the captive fasteners on each end of the circuit board bracket.
3. Firmly grasp the board and pull it straight up.
4. Orient the board properly. For the Power Supply board, the component side of the board faces the rear of the chassis.
5. Place the new board firmly in the card guides and make sure it is squarely seated.
6. Make certain all backplane connectors are properly engaged and press down firmly on the end of the board at the same time to make sure that the pins are seated in the connectors.
7. Tighten the captive fasteners on each end of the circuit board bracket.

## Removing the Cables and Comm Module

Remove the following cables that go from various boards to the front panel.

1. Disconnect W7A (P/N 05B-0606-02, a 20 conductor ribbon cable) from J1 on the top right of the analog I/O board (P/N 04S-0673-01) in slot 4.
2. Disconnect W6 (P/N 05B-0605-01, a 30 conductor ribbon cable) from J2 on the top right of the CPU 1 (P/N 04S-0670-01) or CPU 2 board (P/N 04S-0799-01) in slot 4.
3. Disconnect W2 (P/N 05B-0603-01, a 34 conductor ribbon cable) from J6 on the top right of the Logic I/O board (P/N 04S-0820-01) in slot 1.
4. Remove the existing comm module and the three cables (disconnected in steps 1-3 above) that are attached to it.
5. Disconnect the cables from the comm module and save them for reuse with the new comm module. Discard the comm module itself.

## Removing the Old CPU and Analog I/O Board

This section explains how to remove the CPU and Analog I/O boards. To begin, stand in front of the open instrument and look down and use [Figure 170 on page 300](#) to locate the boards.



**CAUTION!** Remove and insert circuit assemblies carefully to avoid damage to their mating connectors.

1. Unscrew the captive fastener on the top left and right of the CPU1 or CPU2 circuit board in slot 3.
2. Grasp the board firmly and pull it upward, rocking it gently from side to side if necessary to free the pins from the connectors. Discard this board; it will not be used again.



**NOTE:** Dispose of all electronics in accordance with all local, state, and federal regulations.

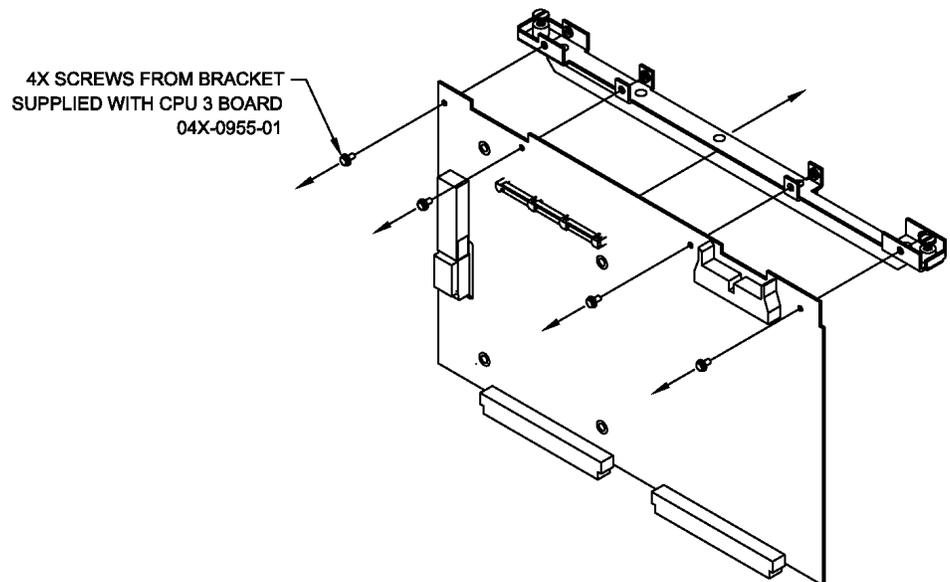
3. Unscrew the captive fastener on the top left and right of the analog I/O circuit board in slot 4.
4. Grasp the board firmly and pull it upward, rocking it gently from side to side if necessary to free the pins from the connectors. Set the board aside; you will be modifying and reinstalling this board in the next section.

## Assembling the New CPU Board and Analog I/O Board



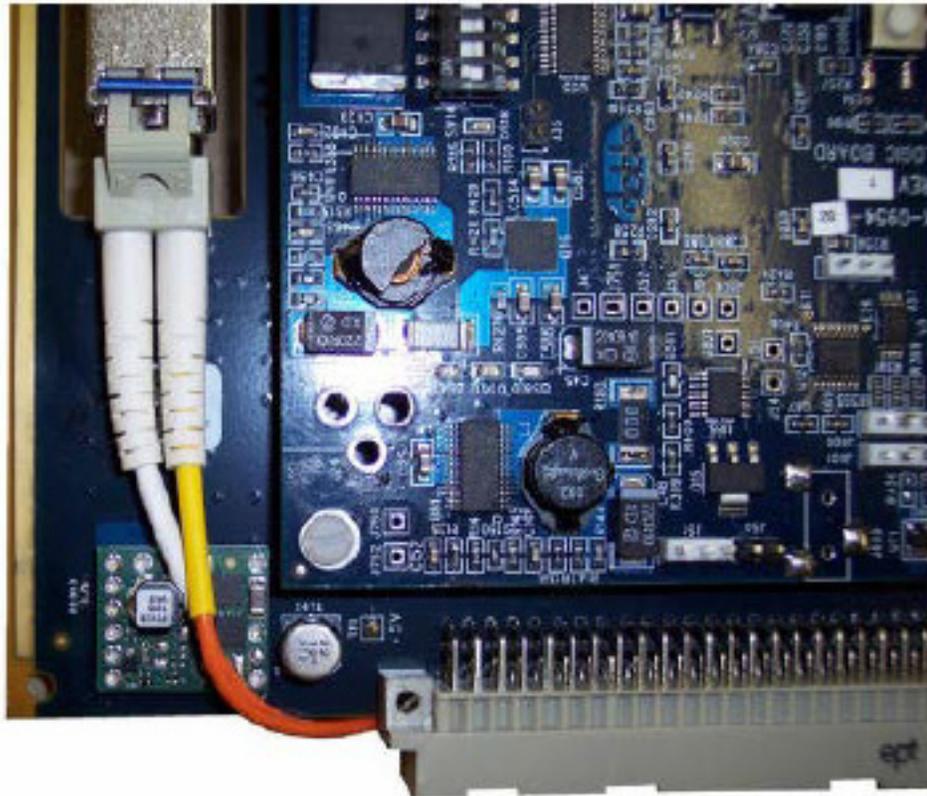
**NOTE:** The new CPUs and SV boards must be pre-assembled to the Analog I/O board before being installed into the instrument.

1. Remove the bracket (P/N 2FB-4135-01) from circuit side of the new CPU 3 board (P/N 04X-0955-01) and retain the four screws (Figure 171). At this time leave the 4 screws that are installed into the other side of the bracket.



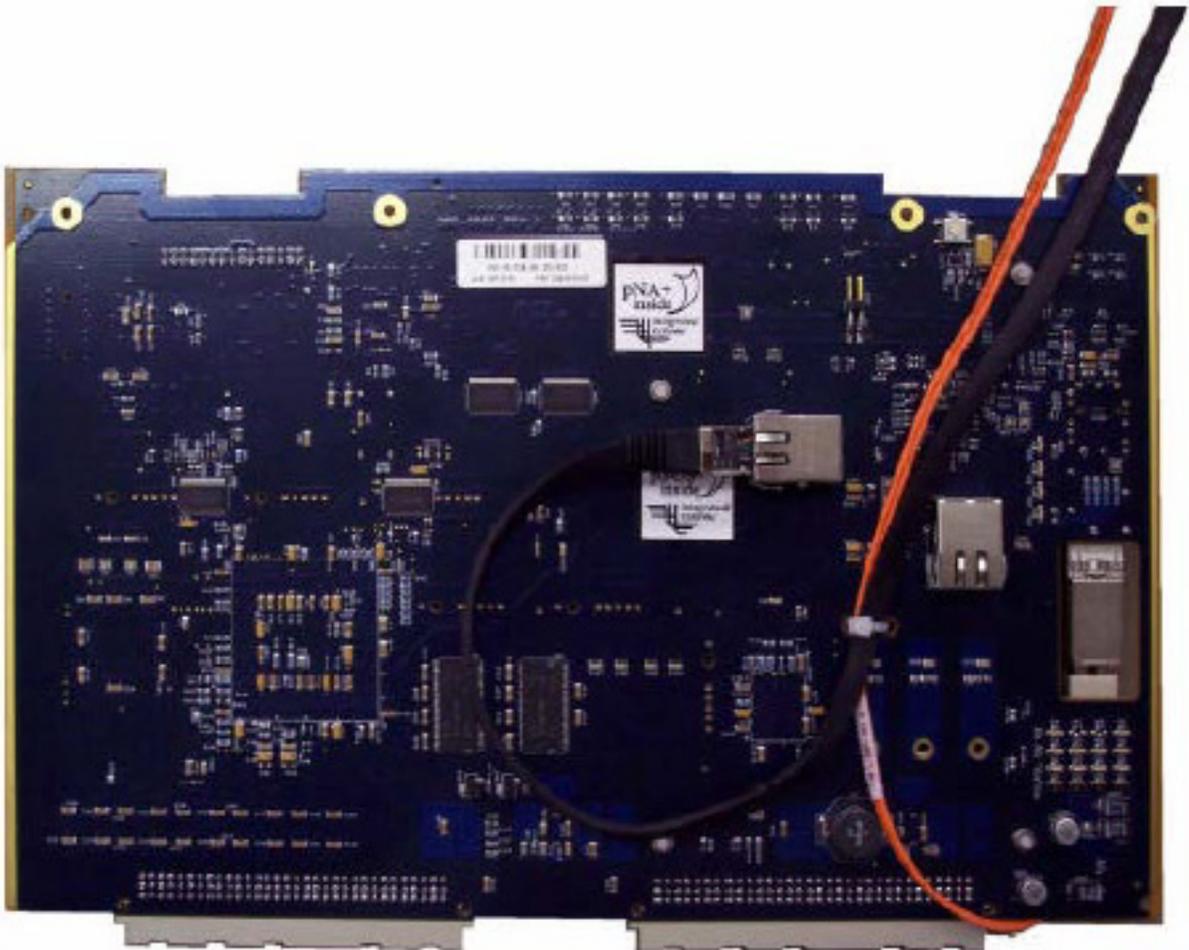
**Figure 171 Removing Bracket from CPU 3 Board**

2. Fit transceiver (P/N 401-0374) to UF600 cage on component side of CPU board.
3. Fit the light grey connectors on the fiber cable (P/N 181-0843) to the transceiver, and route the cable around back side of the board (Figure 172). Maximize the bend radius of the cable. Place the cable to the right of, and not over, the component at the lower left of the board.



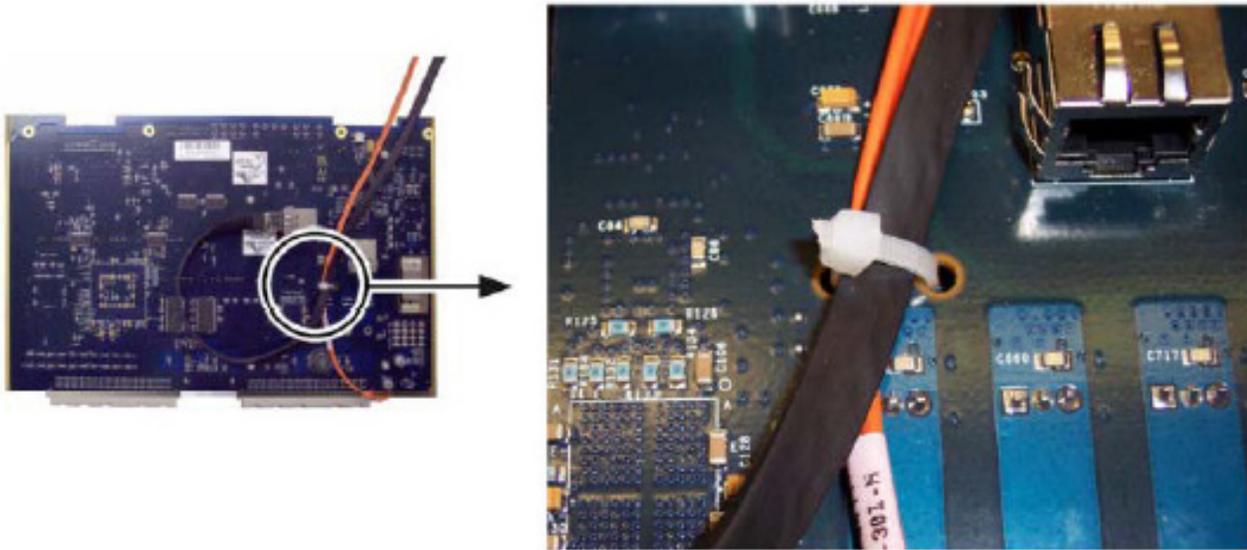
**Figure 172 Routing Fiber Cable under CPU 3 Board**

4. On the other side of the board, fit unmodified end of reworked Cat 5 network cable (P/N 09B-0847-01) to J950 on CPU board. Note that the modified end (with the strain relief cut back) must be at the other end. Bend this cable around to top of board ([Figure 173 on page 305](#)).



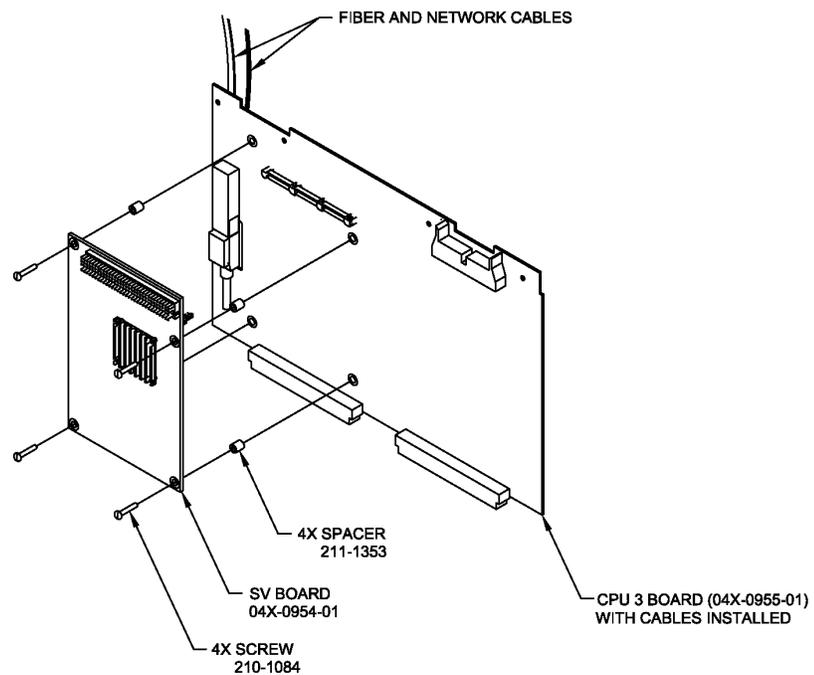
**Figure 173 Routing Network and Fiber Cables**

5. Secure the network cable and the fiber cable to the board using a 4 inch cable tie (P/N 212-0145-S) thru the two holes in the board ([Figure 174 on page 306](#)). Start cable tie from circuit side shown. The black network cable should be over the fiber cable. To avoid damaging the fiber cable, do not pull the tie too tight.



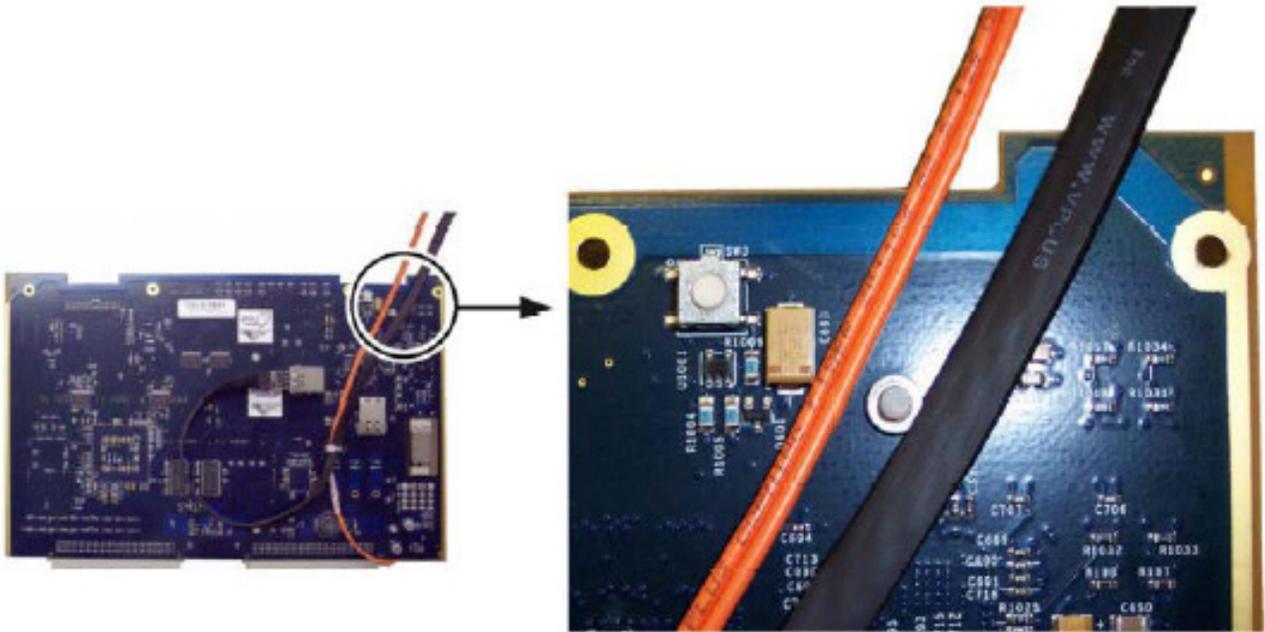
**Figure 174 Cable Tie Securing Fiber and Network Cables**

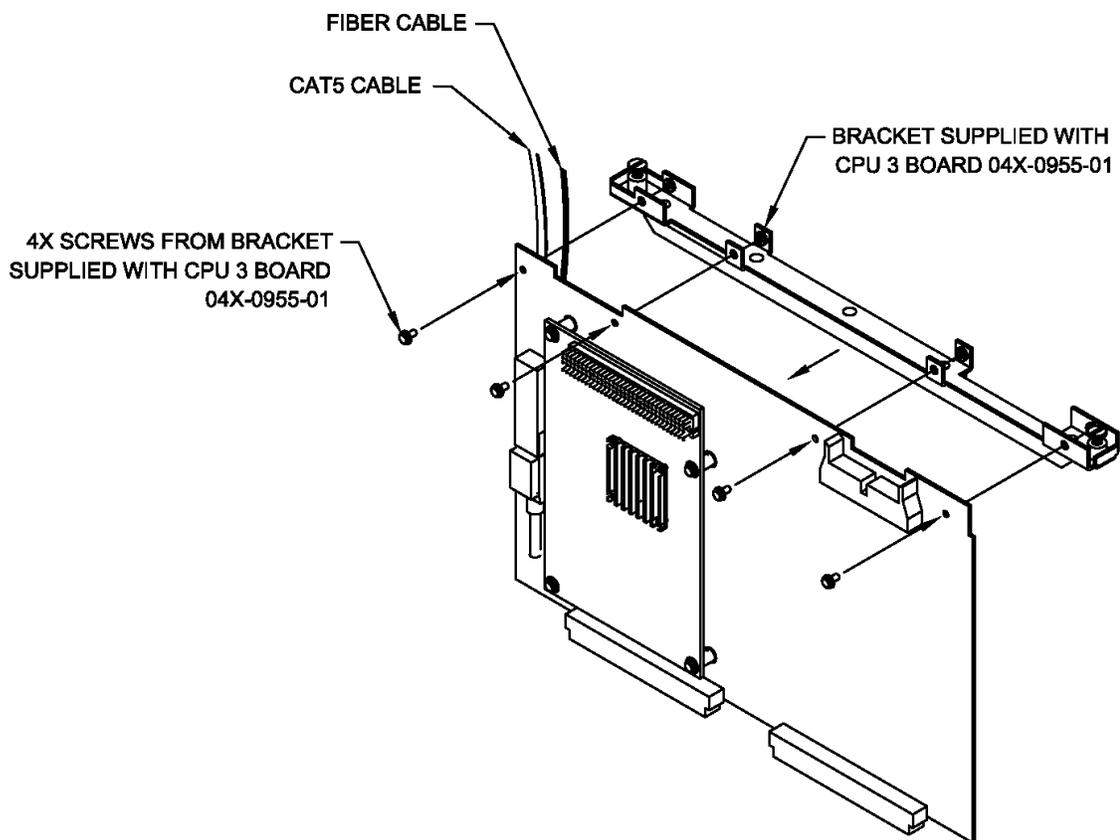
6. Assemble sv board (P/N 04X-0954-01) to component side of CPU3 board using spacers (P/N 211-1353) and nylon screws (P/N 210-1084) (Figure 175). Note that two connectors mate when the boards are assembled.



**Figure 175 Assembling the sv Board**

7. Reattach the bracket that was removed from the CPU 3 board in step 1 as follows:
  - a. Position the 2 cables around the press nut and nylon screw near the corner of the CPU 3 board with the fiber optic cable to the left side and the network cable to the right ([Figure 176](#)).



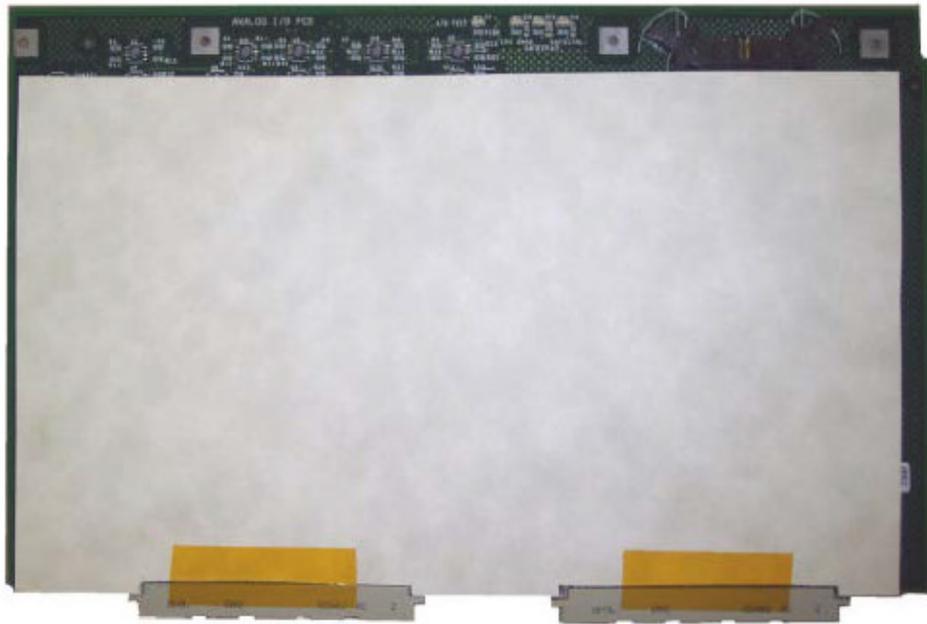


**Figure 177 CPU3 Bracket Reassembly**



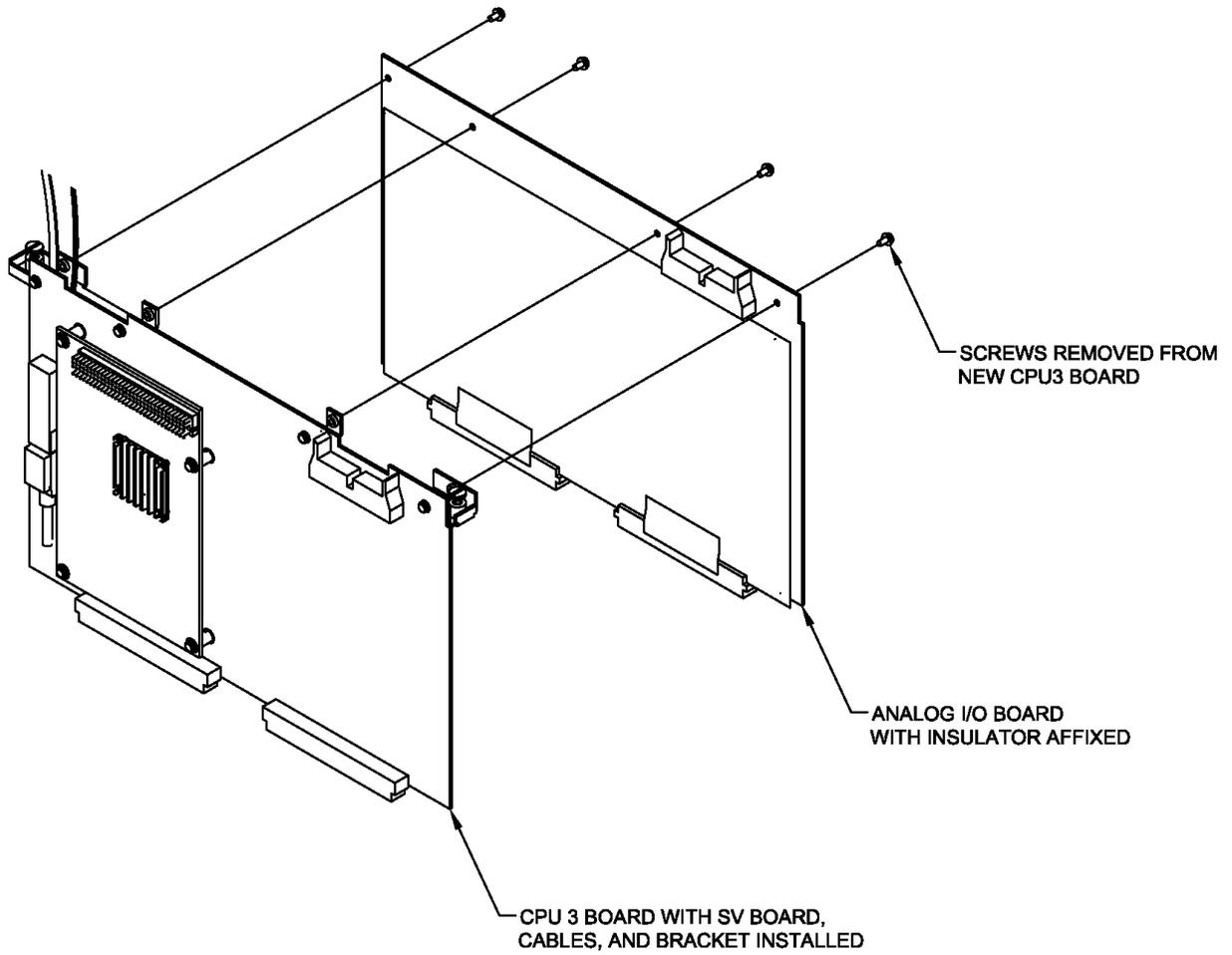
**Figure 178 Cables Passing Through Notch in Bracket**

8. Remove the bracket from the Analog I/O board (P/N 04S-0673-01). Discard or restock the bracket and the four screws.
9. Attach the insulator (P/N 2FB-4136-01) to the Analog I/O board (P/N 04S-0673-02) as follows:
  - a. Place the insulator (P/N 2FB-4136-01) over the component side of the Analog I/O board (P/N 04S-0673-02, fitting the notches in the insulator over the connectors ([Figure 179 on page 310](#)). Note that there are two similar insulators supplied (P/N 2FB-4136-01 and P/N 2FB-4167-01), this is the one with two notches along one edge. The notches are not symmetric and the insulator must be placed as shown.
  - b. Secure the insulator with a strip of Kapton (P/N 902-0041-S) over each connector.



**Figure 179 Analog I/O Board Insulator**

- 10.** Attach the Analog I/O board to the bracket on the CPU 3 board as follows:
  - a. Remove the 4 screws from the exposed side of the bracket on the CPU 3 board.
  - b. Attach the Analog I/O board to the bracket on the CPU 3 board using the four screws removed in the previous step or those removed from the analog I/O board in Step 8 ([Figure 180 on page 311](#)). The component side of the Analog I/O board (the side with the insulator) faces the CPU 3 board.



**Figure 180 Attaching the Analog I/O Board to the Bracket**

This assembly is now ready to be fit into the chassis.

## Installing the New CPU3 and Analog I/O Board Assembly

1. Insert the CPU3/Analog I/O board assembly into slots 3 and 4. The CPU3 board should be towards the front of the chassis.



**CAUTION!** If the AIM option board is installed (F6150 only), this will be a tight fit. To prevent the higher components on the sv board from catching on the AIM board when you insert the combined CPU3/Analog I/O board assembly, place the second insulator (P/N 2FB-4167-01) between the CPU3/Analog I/O board assembly and the AIM board.

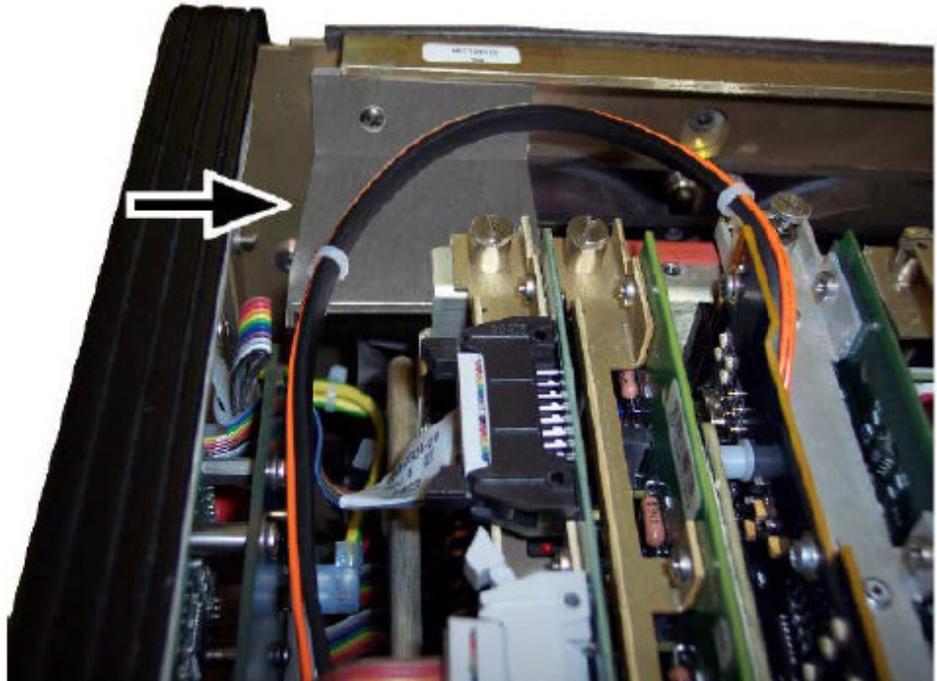
2. Make certain all backplane connectors are properly engaged and press down firmly on the end of EACH board at the same time to make sure that the pins are seated in the connectors.
3. Tighten the captive fastener on the top left and right of the common board bracket.
4. The use of the second insulator is determined by the presence of the AIM option board.
  - If the AIM option board IS installed and you did not leave the insulator (P/N 2FB-4167-01) between the CPU3 board and the AIM option board, then insert it between these two boards now.
  - If the AIM option board IS NOT installed, save the insulator (P/N 2FB-4167-01) for use if the AIM option is installed at a later date.

## Installing Cable Support Bracket

A new bracket is necessary to support the fiber optic and network cables.

Install this bracket as follows:

1. Remove the one 6-32 x 1/2 long screw from the keyhole slot at the front corner of the fan plate. The fan plate is on the inside left wall of the chassis when viewed from the front.
2. Fit the bracket (P/N 2FB-4168-01) in place ([Figure 181 on page 313](#)).
3. Reinstall the screw from Step 1.



**Figure 181 Cable Support Bracket**

## Routing and Securing New Cables

In this stage of the upgrade you will bring the fiber optic and network cables from the new CPU 3 assembly around to the Comm Module opening in the front panel and secure the cables in place.

1. Take the orange fiber and black network cables that come from the CPU 3 and Analog I/O Assembly and secure them together approximately every 6 inches using the 4 inch cable ties (P/N 212-0145-S). At each position, lay the fiber optic cable flat against the network cable and make the cable ties snug but not tight ([Figure 182 on page 314](#)).



**Figure 182 Fiber Optic and Network Cable Tie**

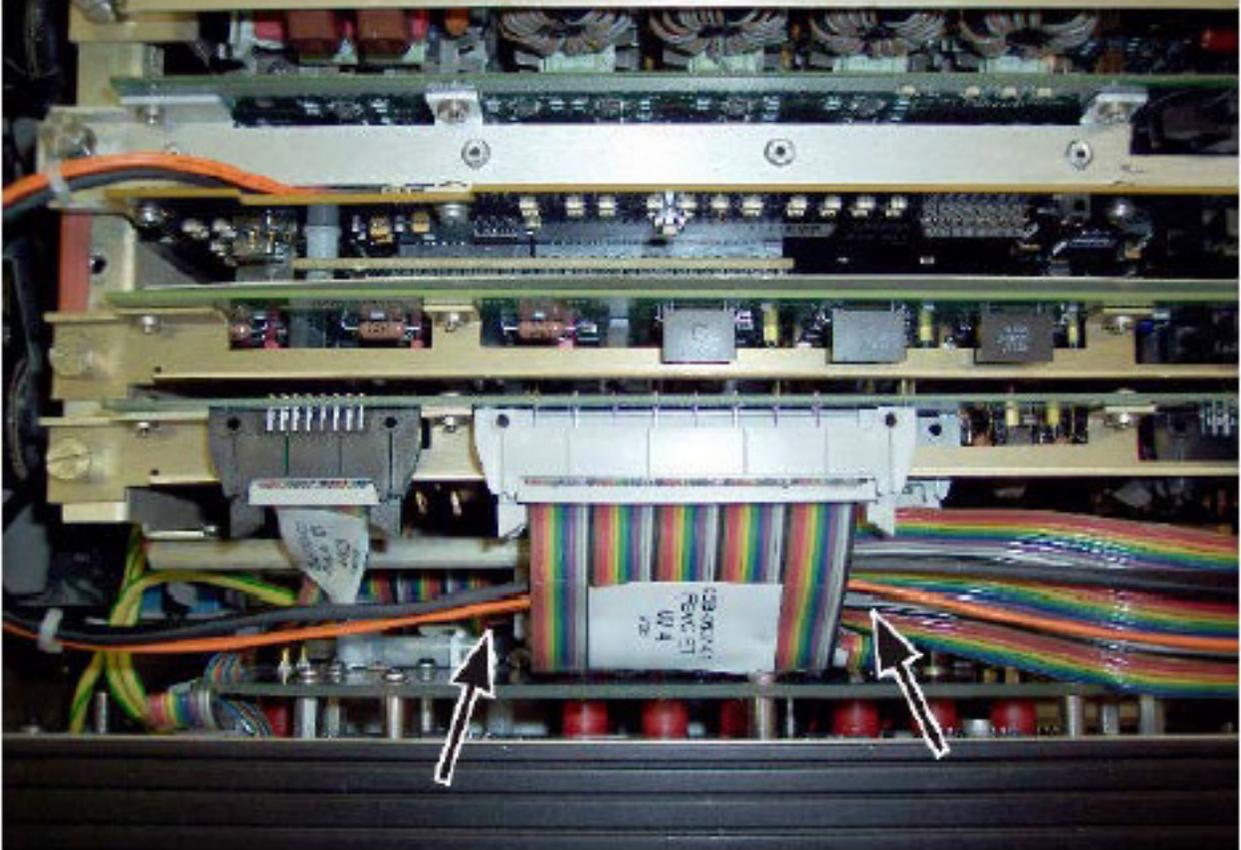
2. The fiber and network cables come out of the CPU 3 / Analog I/O board assembly to the left. Loop the two bundled cables towards the front, over the new cable support bracket, and across the front of the chassis (Figure 183).
3. Lay the bend of the cables on the cable support bracket.



**Figure 183 Fiber Optic and Network Cable Placement**

4. Remove W4 from the Logic I/O board (P/N 04S-0820-01) in slot 1 (Figure 184).

5. Place the two bundled cables under W4 and reattach W4 to the board (Figure 184).



**Figure 184 Fiber Optic and Network Cables under W4**

Route the two bundled cables behind through the front panel Comm Module opening (see [Installing the Wi-Fi New Comm Module](#), below).

## Installing the Wi-Fi New Comm Module

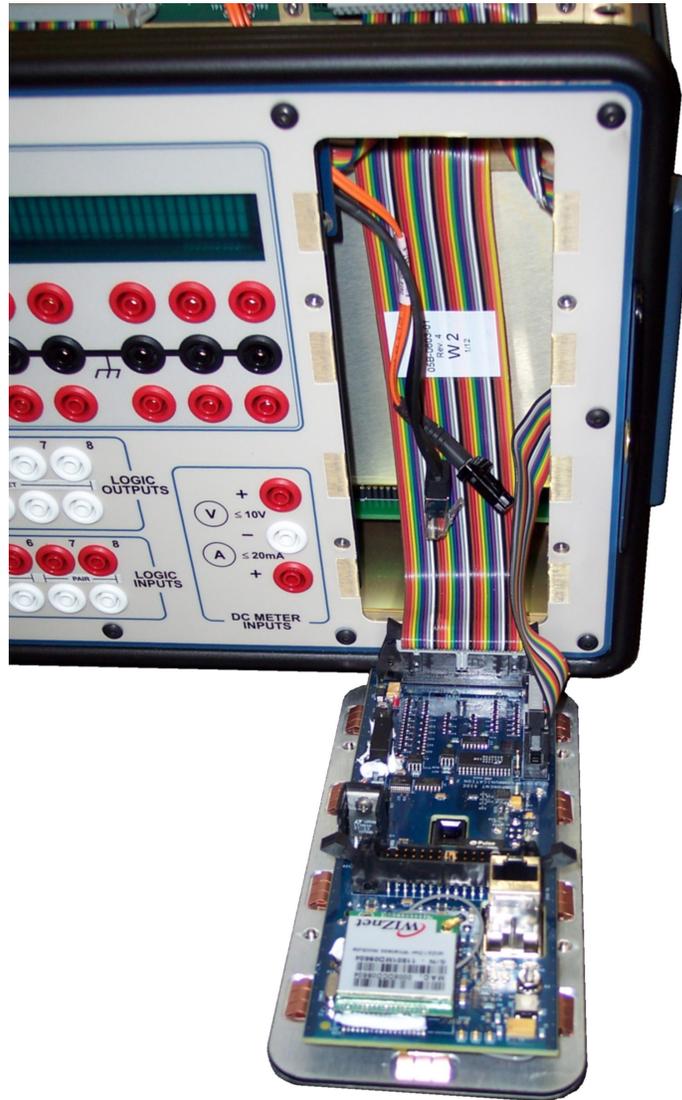
In this stage of the upgrade, you will install the new comm module (P/N 03D-1962-02).

1. Lay the comm module down in front of the comm module opening in the front panel ([Figure 185 on page 317](#)).
2. Attach the 34 conductor ribbon cable W2 (P/N 05B-0603-01) retained from the disassembly, as follows:

- a. Attach either end of W2 to J7 (the bottom connector) on the comm module board (P/N 04X-0956-01).
  - b. Run W2 behind the fiber optic and network cables and attach the other end to J6 at the top right of the logic I/O board (04S-0820-01) in slot 1.
3. Attach the 20 conductor ribbon cable W7A (P/N 05B-0606-02, retained from the disassembly) as follows:
- a. Attach the end of W7A with the connector key facing the end of the cable to J6 (the side connector) on the comm module board (P/N 04X-0956-01)
  - b. Route W7A through the comm module cut-out and leave it hanging over the right side of the chassis.



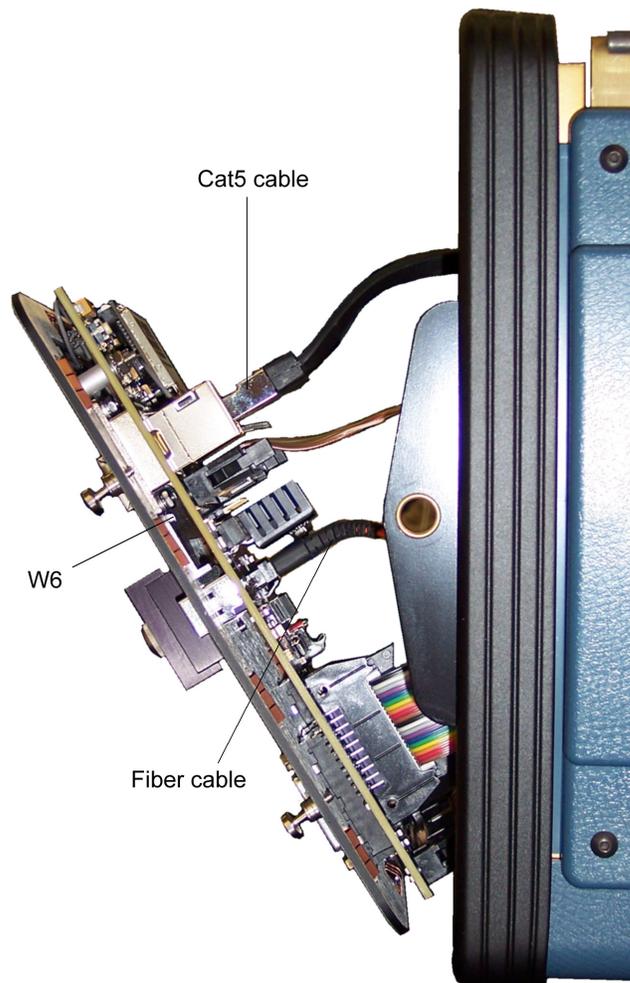
**NOTE:** The fiber optic cables should be visible through the opening, as shown in [Figure 185 on page 317](#).



**Figure 185 Fiber Optic and Network Cables**

4. Hook the bottom of the comm module board over the bottom edge of the comm module cutout in the front panel such that the comm module is at an angle.
5. Connect the remaining cables to the comm module ([Figure 186 on page 318](#)) as follows:

- a. Plug the end of the fiber optic cable into the fiber optic bulkhead connector on the comm module.
- b. Attach the end of the 30 conductor ribbon cable W6 (P/N 05B-0605-01) retained from the disassembly with the connector key facing away from the end of the cable to J3 (the top connector) on the comm module board (P/N 04X-0956-01).
- c. Route W6 through the comm module cutout and leave it hanging over the right side of the chassis.
- d. Plug the end of the Cat 5 cable into the RJ45 bulkhead connector on the comm module. Note that this end of the cable has the boot cut down so that it can make a tighter bend. When the comm module is fully installed, this cable should make a tight turn in the up direction.



**Figure 186 Connecting Cables**

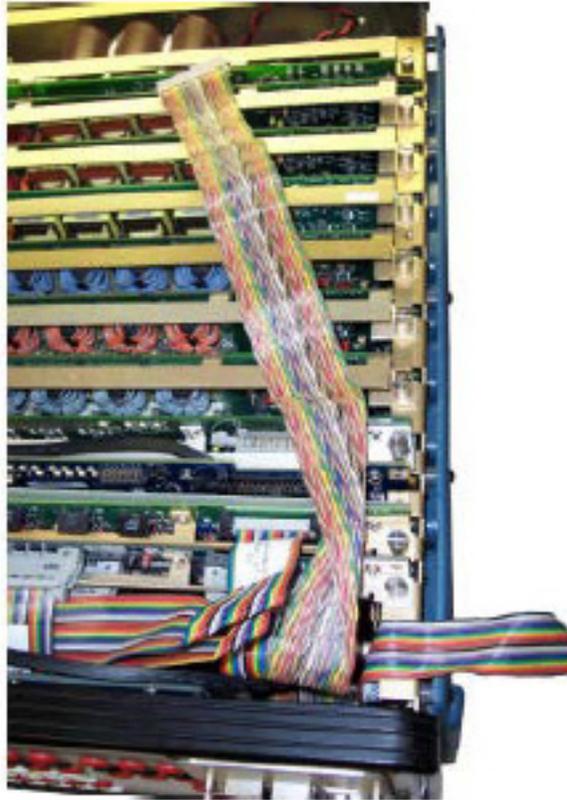
6. Fit the comm module to the front panel. Note that the comm module board is slightly bigger than the opening so you must manipulate the module as follows to get the board through the opening.
  - a. Hold the module vertically close to the front panel and hook the right side of the board inside the right edge of the opening (Figure 187).
  - b. Swing the module in until it is flush against the panel.
  - c. Tighten the four panel fasteners.



**Figure 187 Panel Fasteners**

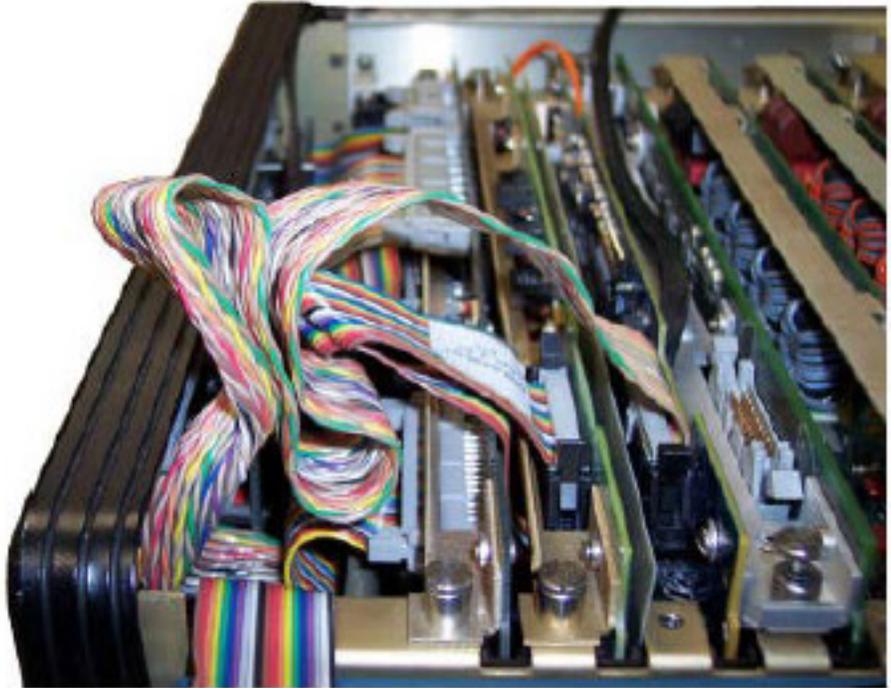
7. Connect W6, the 30 conductor flat twisted-pair cable laying over the cards, as follows:

- a. From the top of the chassis, take W6 and make half a twist in it (below).



**Figure 188 Half-twist in W6 Cable**

- b. Attach the end of W6 to J2 on the CPU 3 board (04X-0955-01) in slot 3.
- c. Make several folds in W6 ([Figure 189 on page 321](#)) and fit the folded cable into the space behind the comm module ([Figure 190 on page 322](#)).

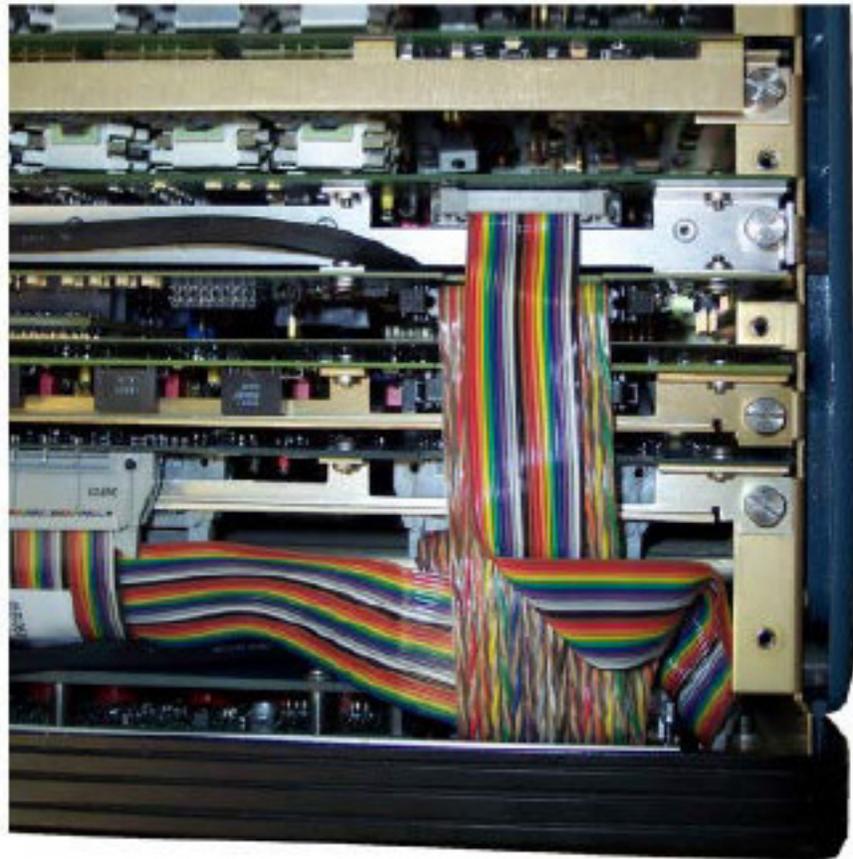


**Figure 189** *Folded W6 Cable*



**Figure 190 Fitted W6 Cable**

8. Connect W7A, the 20 conductor ribbon cable that is laying off to the right side of the cage (below), as follows.
  - a. About 3 inches from the end, make a 90 degree fold in the cable.
  - b. Attach the end of W7A to J1 on the analog I/O (04S-0673-01) board in slot 4.
  - c. Fit the excess cable to the right of W6 and behind the comm module.



*Figure 191 Excess Cable Behind the Comm Module*

## Verifying Operation



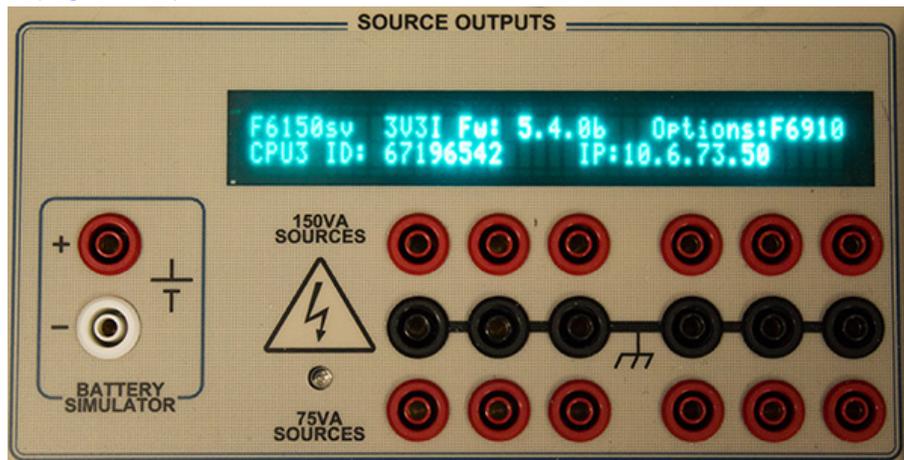
**WARNING!** Before proceeding, make sure that all preceding steps have been implemented and confirmed.



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

Before closing up the instrument, verify the operational status as follows:

1. Plug in 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 that the front panel display shows CPU3 and the CPU ID number (Figure 192).



**Figure 192 Front Panel Display**

4. Verify, by the sound, that the four cooling fans are operating.
5. Power down and unplug the instrument.
6. Then:
  - If the instrument powers up and displays CPU3 as described above, then continue with the next section.
  - If the instrument is not functioning properly, then:
    - a. Review the preceding steps and verify all boards and cards are installed properly.
    - b. Refer to “Troubleshooting” in the *F6 Hardware User Guide*.
    - c. If necessary, call Doble Customer Service.

## Applying Labels

### Applying Serial Number Labels

Installing the new CPU 3 and sv boards, as well as the new comm module, negates any existing agency approvals indicated on the unit's serial number labels. Thus, new labels without approvals must be applied.

1. Using a black fine point Sharpie (or other similar permanent marker), carefully record the unit serial number onto both of the 2 new serial number labels (P/N 21B-0095-01).
2. Apply the serial number label to the rear of the new chassis (Figure 193).



**Figure 193 Serial Number on Bottom of F6150 Chassis**

3. Apply the second serial number label to the bottom shell over the existing serial number label, as shown in [Figure 194](#).



**Figure 194 Serial Number Plate on the Bottom of the Shell**

## Applying Front Panel Labels

The presence of the front panel input and output labels is determined by the version of the logic I/O board installed. When applicable:

- The Relay/FET label (P/N 20B-0347-01) is applied between the two rows of logic outputs.
- The Logic I/O label (P/N 20B-0362-01) is applied between the two rows of logic inputs.

1. Determine the part number and revision of the Logic I/O board installed in slot 1. The part number is on the silk screen on the component side (facing the front of the chassis) and the revision is marked next to it. You may be able to read the information without removing the card but remove it and replace it if necessary.
2. Use [Table 42 on page 327](#) to determine which labels (or parts of) to apply and then apply as shown in [Figure 195 on page 328](#).



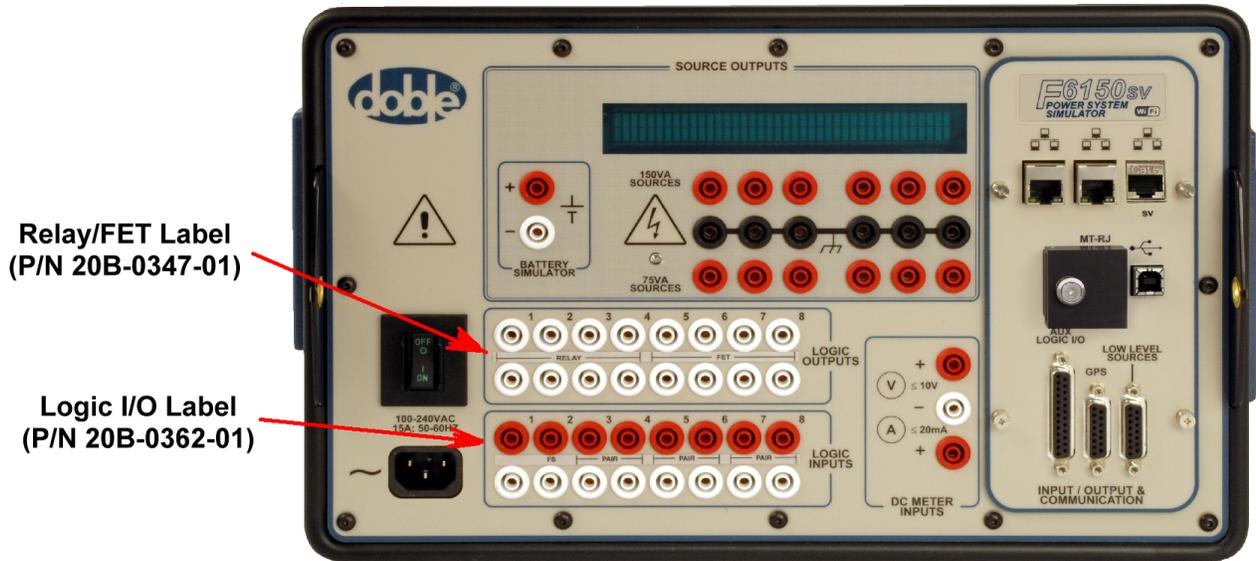
**NOTE:** In some cases, only a portion of the logic I/O label is applied. If that is the case, apply the indicated part of the label positioned as it would be if the entire label had been applied.

**Table 42 Labels**

Logic I/O Board Version and P/N	Relay/FET Label (top label)	Logic I/O Label (bottom label)
Logic I/O 1 (04S-0672-01)	Do not apply.	Do not apply.
Logic I/O 2 (04S-0742-01) thru rev C	Apply entire label.	Cut of “FS” and apply rest of label.
Logic I/O 2 (04S-0742-01) rev D only	Apply entire label.	Apply entire label. Also requires second label for FS on channel 1.
Logic I/O 3 (04S-0813-01)	Apply entire label.	Apply entire label. Also requires second label for FS on channel 1.
Logic I/O 4 (04S-0820-01)	Apply entire label.	Apply entire label.
Logic I/O 5 (04S-0837-01)	Do not apply.	Cut off “FS” and apply “FS” part on channel 2.



**NOTE:** Logic I/O 4 (P/N 04S-0820-01) is the most recent and the most common board used.



**Figure 195 Front Panel I/O Labels**

## Closing the Chassis

### Replacing the Capture Rail

1. Set the capture rail in place.
2. On top of the capture rail, tighten the four screws holding the capture rail to the chassis by inserting a flat-head screwdriver into each hole.
3. On the side of the capture rail, tighten the screw at the right end, using a Phillips-head screwdriver.

### Replacing the Cover

1. Reinstall the cover.
2. Reinstall the two rubber feet at the top rear of the instrument housing.

## Loading the USB Driver

Your new F6150 Power System Simulator front panel includes a USB connector. This connector is used for serial communication between your computer and the F6150 instrument.

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 this kit or downloaded from the Doble website ([www.doble.com/support/download.html](http://www.doble.com/support/download.html)). See the *USB Driver Installation Notice* (72A-3108-01) for instructions on installing the driver.

## Upgrade Cables

A vinyl bag is included in each sv upgrade kit. It contains two fiber optic cables for use with the fiber optic connector on the new comm Module. The bag with the cables is Doble P/N 03D-1712-07. It contains:

- A two-meter (6½ foot) duplex fiber optic cable with SC and MTRJ connectors (Doble P/N 181-0846).
- A two-meter (6½ foot) duplex fiber optic cable with ST and MTRJ connectors (Doble P/N 181-0847).

Place the bag with the optic cables in your F6150 cable bag, using caution to prevent damage to the optic cables.

## Upgrade Kit Contents

The following table lists the contents of the Doble P/N 03D-1964-01, KIT, UPGRADE, CPU 2 W/ COMM TO CPU 3 W/ SV AND Wi-Fi, F6150.

**Table 43 Contents of the Doble P/N 03D-1964-01 Upgrade Kit**

Quantity	Part Number	Description
1	03D-1712-07	Kit, Fiber Optic Leads, Current, F6150
1	03D-1962-02	Assy.Comm Module 3, F6150SV Wi-Fi
1	04S-0794-01	Assembly,PCB,PS PFC,F6000 (Rev P)
1	04X-0954-01	Assembly CPU3 Sampled Values,F6150
1	04X-0955-01	Assembly,PCB,CPU3 Processor,F6150
3	04X-1008-01	Assembly,PCB,Enhanced I Amplifier,F6150SV
1	08A-0133-01	CD, F6000 Utilities, V5.0
1	09B-0847-01	Rework, CAT 5 Cable, F6150sv
1	181-0843	Cable, Fiber, Duplex, 62.5 UM, 35 IN, LC - MTRJ Female
4	210-1084	Screw, PH, PHD,4-40 x .625, Nylon
4	211-1353	Spacer, 3 mm X 6 mm X 7 MM LG, Round, Nylon
6	212-0145-S	Tie, Cable, 4"Length, Clear
2	21B-0095-01	Label, Serial, F6150, CPU 3 W/SV Upgrade
1	2FB-4136-01	Insulator, ANALOG I/O BOARD, F6150sv
1	2FB-4167-01	Insulator, CPU3 Board, F6150sv
1	2FB-4168-01	Bracket, Cable Support, F6150sv

**Table 43 Contents of the Doble P/N 03D-1964-01 Upgrade Kit**

<b>Quantity</b>	<b>Part Number</b>	<b>Description</b>
1	401-0374	SFP Transceiver,Fiber 100 BASE-FX
1	72A-3223-01	Procedure, Upgrade, CPU 3 W/ SV, F6150
1	76D-0369-01	Cabling Diagram, F6150sv
1	902-0051	Tape, Kapton, 1 MIL, 3/4 Wide, 5 Yds, Silicone ADH

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# 16. Conversion - F6150sv to F6350e

## Introduction

These instructions describe the procedure for conversion of a Doble F6150sv instrument to an F6350e instrument, using the older Analog I/O board. This does not apply to units with the newer Analog I/O board, where conversion is done through the Mobile Control Panel application ([Chapter 11, “Mobile Control Panel Application.”](#)).

The F6350e is equivalent to an F6350 with enhanced amplifiers.

## Conversions

The procedure described uses a Doble P/N 03D-1669-01, F6350 Upgrade kit. However, this procedure is applicable for those who already have the necessary hardware for the conversion.

It is possible to convert an F6150sv to an F6350e, providing voltage and current amplifiers. These amplifiers are controlled by the RTDS<sup>®</sup> (Real Time Digital Simulator). Low level signals from the RTDS are fed to the F6350e through special Doble-furnished cables. The F6350e outputs amplified signals that are supplied to the relays or protection schemes under test. You can use multiple F6350e instruments to get as many voltage and current signals that you need for complete testing of relays and protection schemes.

Conversion requires:

- Replacement of an I/O card
- Installation of new firmware

You can convert the F6350e back to an F6150sv by replacing the original I/O card and installing new firmware.

## Applicability

The only applicable baseline configuration is an F6150sv or an F6350e.

## Conventions

In this guide:

- **Left** and **right** refer to the instrument, front panel, or board, as viewed from the front.
- **Top** and **bottom** refer to the instrument, front panel, or board, as it would be seen in normal operation.
- **F6150sv** and **F6350e** refer to the instrument.

## Required Tools

- 3/32" (2.5 mm) hex wrench
- Large flat-blade screwdriver
- Medium Phillips-head screwdriver
- Small Phillips-head screwdriver

## Safety Precautions

To avoid electrical shocks, burns, or equipment damage, be sure to follow all safety precautions. When handling components in an F6150sv, read and follow the following warnings:



**WARNING!** Before proceeding, disconnect the power cable from the front panel. Make sure 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!.

**WARNING!** 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.



**CAUTION!** These units contain electrostatic-sensitive components. Practice safe handling methods to protect components against electrostatic discharge.

## Preparatory Steps

When you purchase the F6350e conversion option, the following items are provided:

- Analog I/O board (Doble Part Number 04S-0825-01)
- CD containing the firmware and the interface software
- Cable for connecting the RTDS to the F6350E

Your F6150 has an Analog I/O board in slot 4. This circuit board must be replaced by the one provided to you as part of the F6350e package.

## Before You Begin

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

## Opening the Chassis

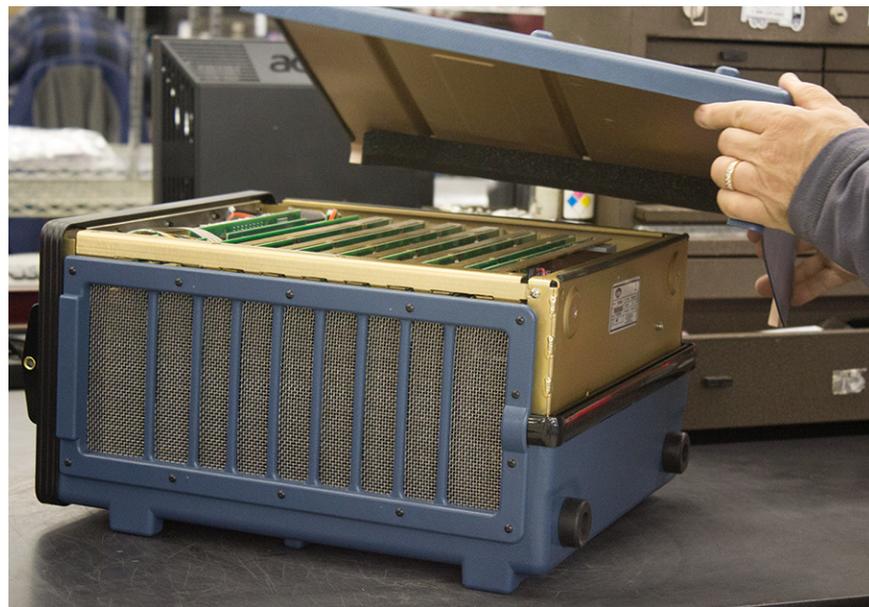
### Removing the Cover

1. Use a flat-head screwdriver to remove the top two rubber feet from the back of the instrument.



**Figure 196 Rubber Foot Removal**

2. Remove the cover.

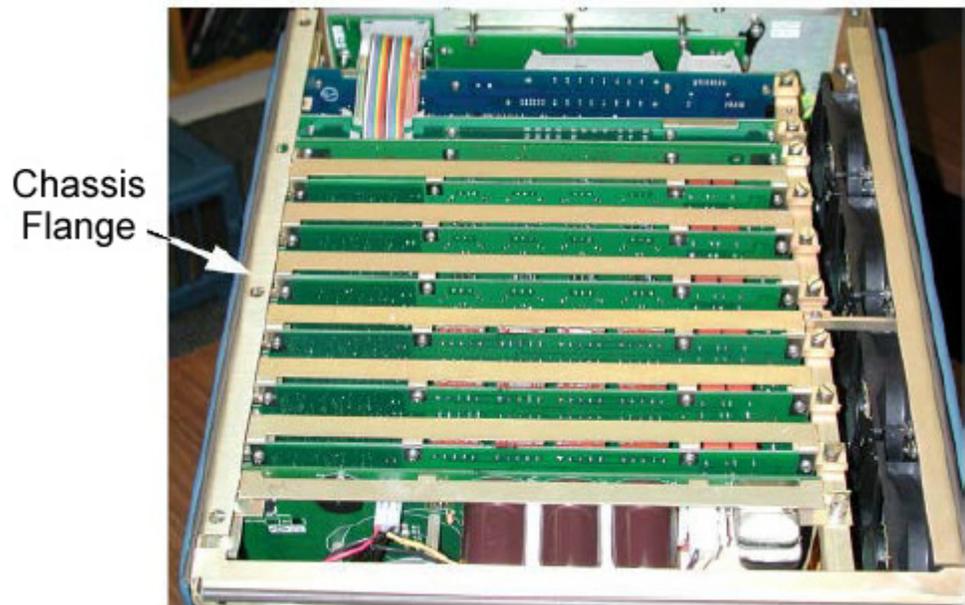


**Figure 197 Cover Removal**

## Swapping Analog I/O Boards

### Removing Chassis Flange

1. On top of the chassis flange, remove the four screws that hold the chassis flange to the chassis by inserting a flat-head screwdriver into each hole. See [Figure 198 on page 337](#).
2. Remove the chassis flange.



**Figure 198 Internal Components and Chassis Flange – Rear View**

## Disconnect Cables

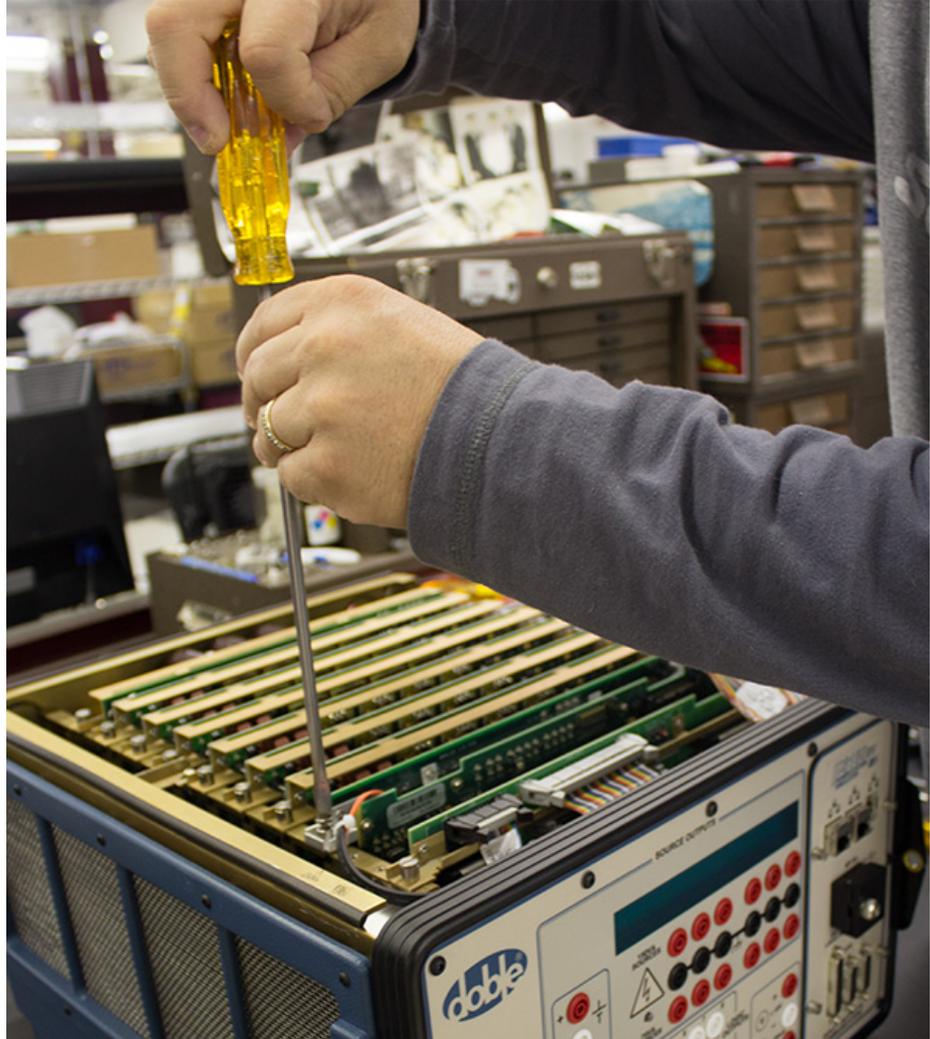
Disconnect the two cables (1 and 2) from the top of the bracket between the boards in slots 3 and 4. Disconnect the cable (3) from the board in slot 1. This third disconnect is done to allow the bracket to be removed from the chassis without damaging the fiber optic cable.



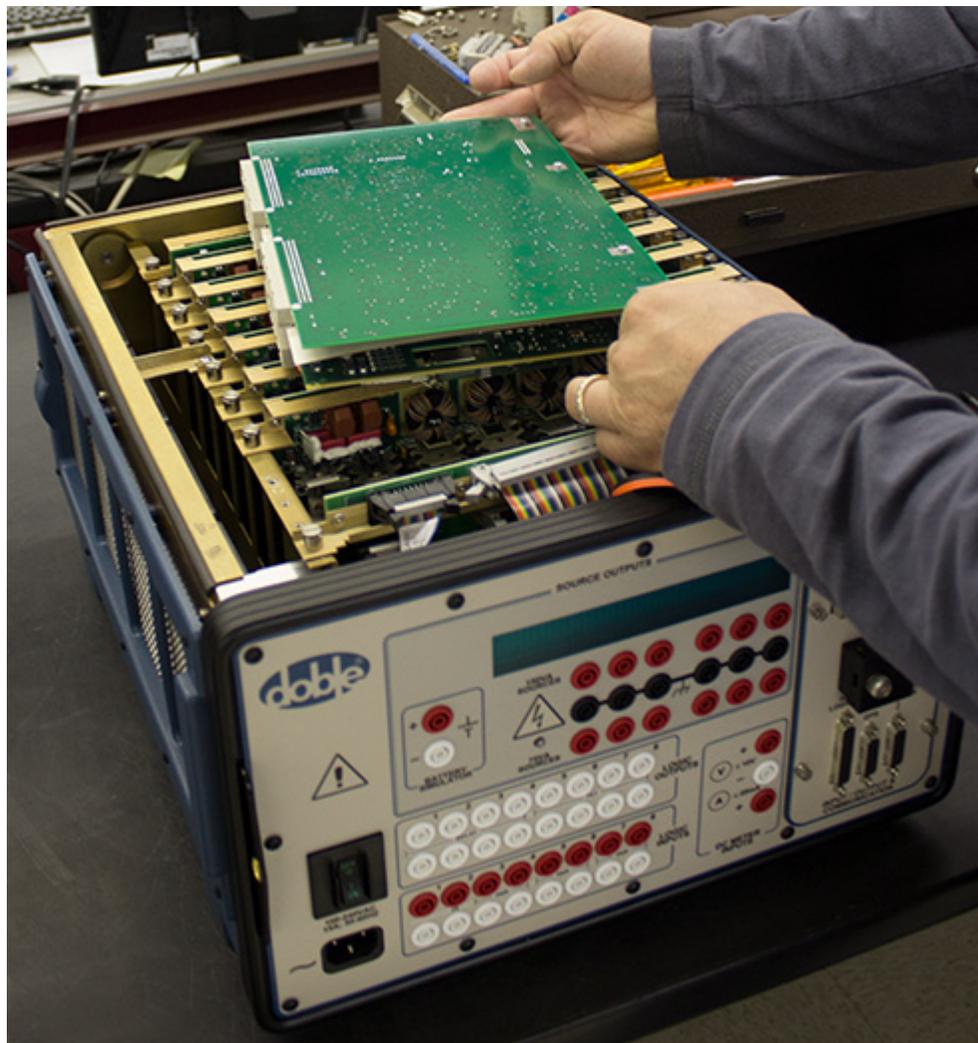
**Figure 199 Disconnecting Cable**

## Removing Bracket

1. Remove the screws from the left and right ends of the bracket.



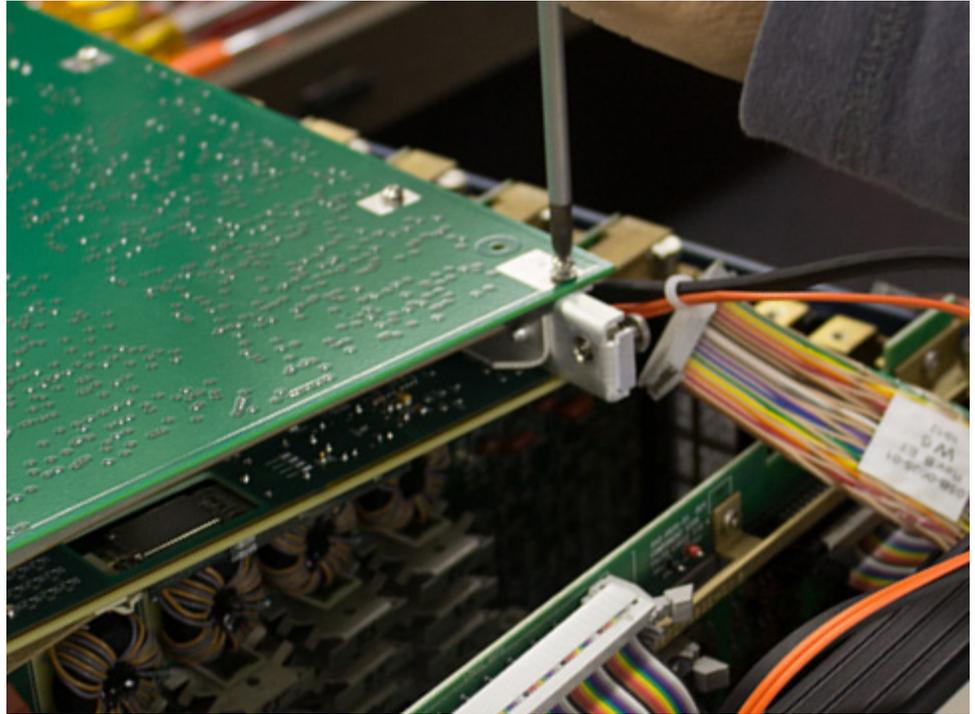
2. Using care to not kink or otherwise damage the orange fiber optic cable, pull the bracket straight up and lay it carefully across the tops of the other boards. The analog board (the one with the attached sheet of insulation) should be on top.



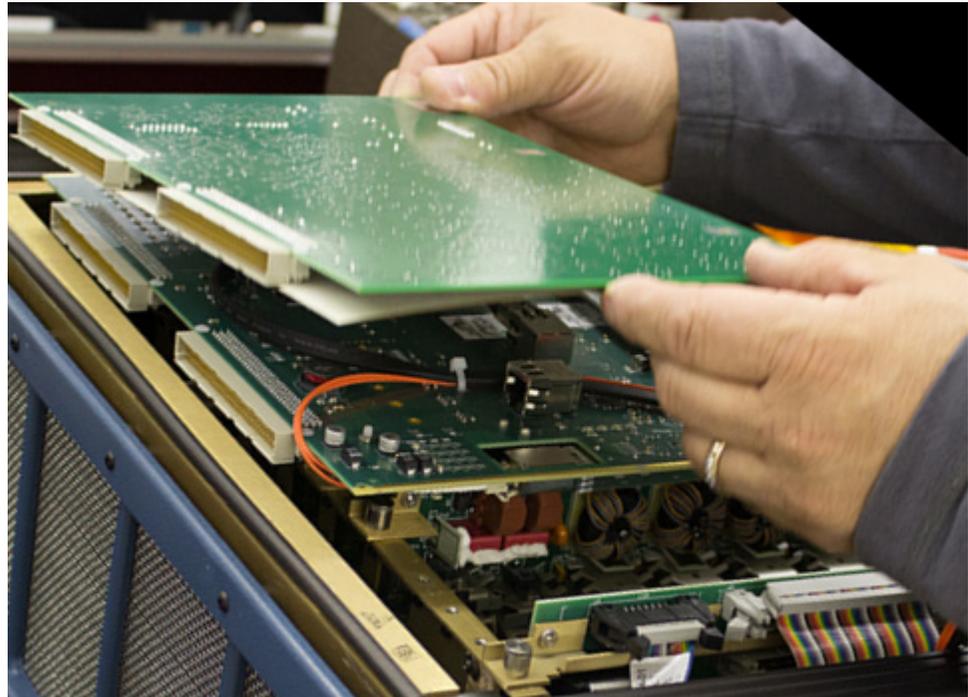
**Figure 200 Laying Assembly Flat**

## Disassemble Board Assembly

Remove the four screws from the analog I/O board (the one with the attached sheet of insulation), and remove the board from the bracket.



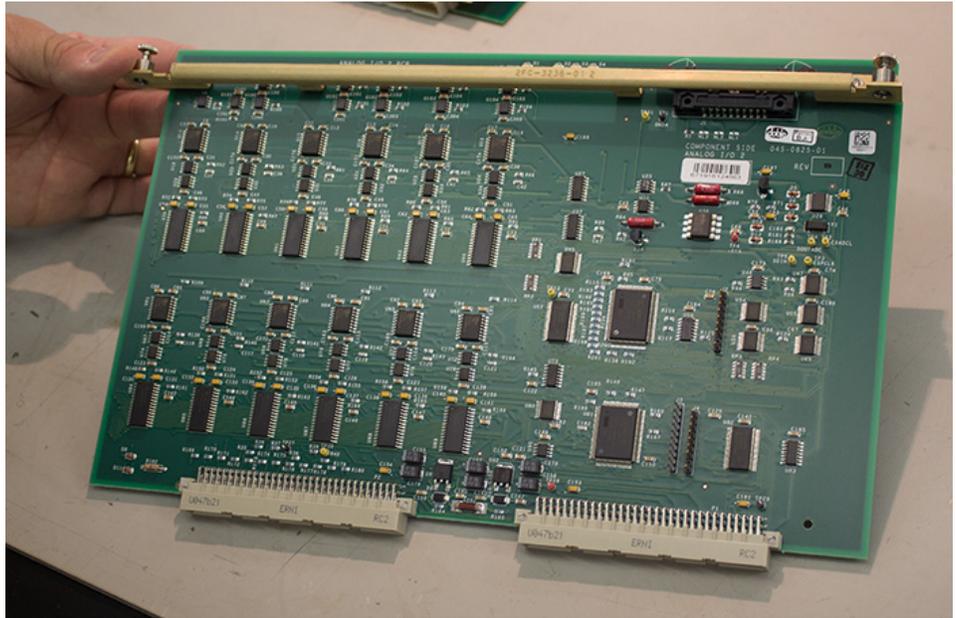
**Figure 201 Removing Four Screws from Analog I/O Board**



**Figure 202 Removing Analog I/O Board from Bracket**

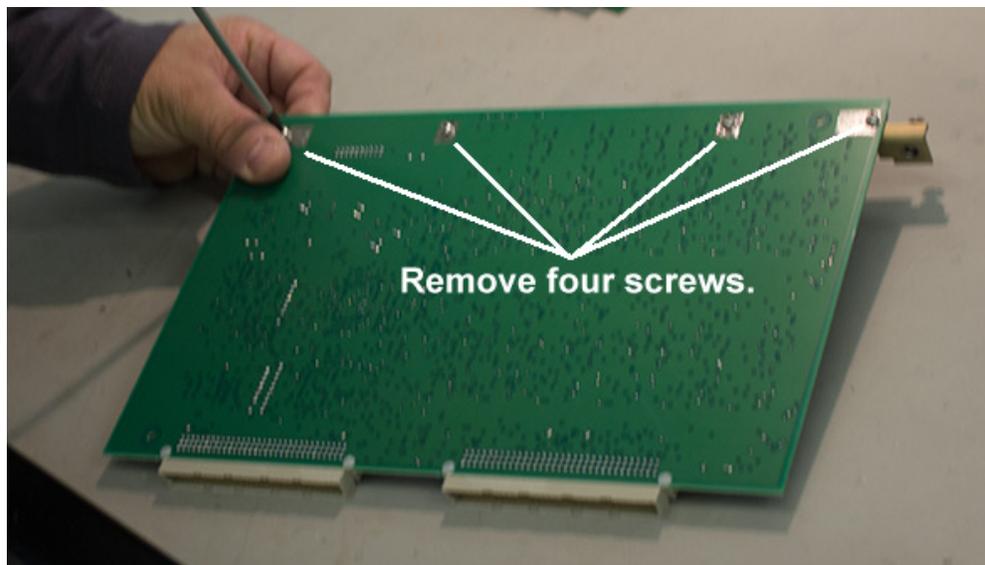
## Replacing Analog I/O Board

Remove the new Analog I/O board from the upgrade kit. The new board is p/n 04S-0825-01.

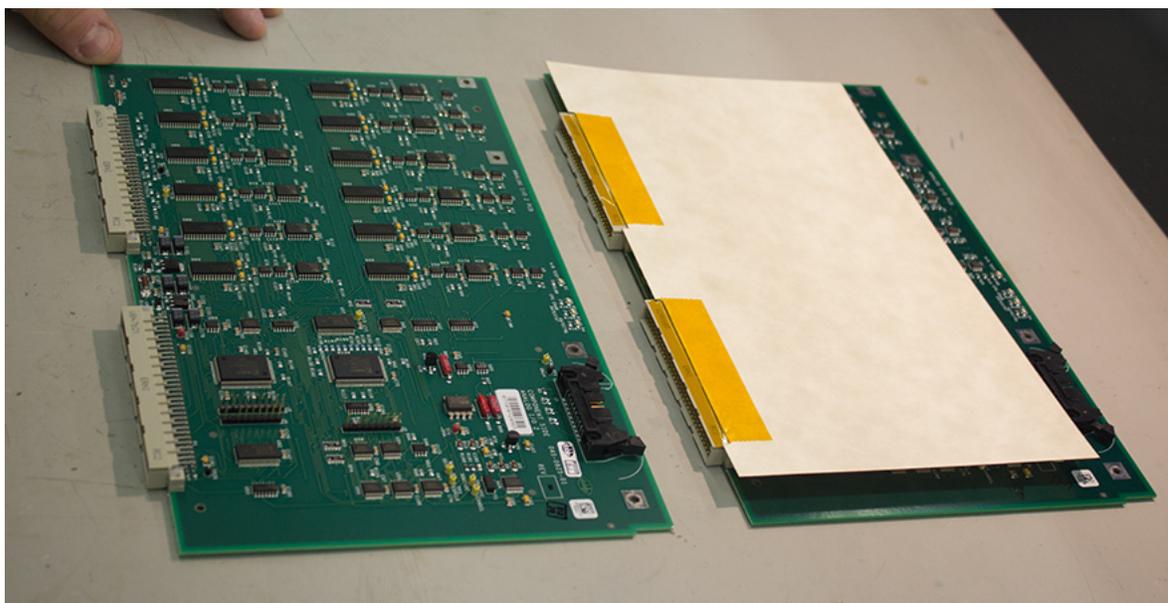


**Figure 203 New Analog I/O Board**

Remove the four screws from the new board, and remove the bracket from the board.

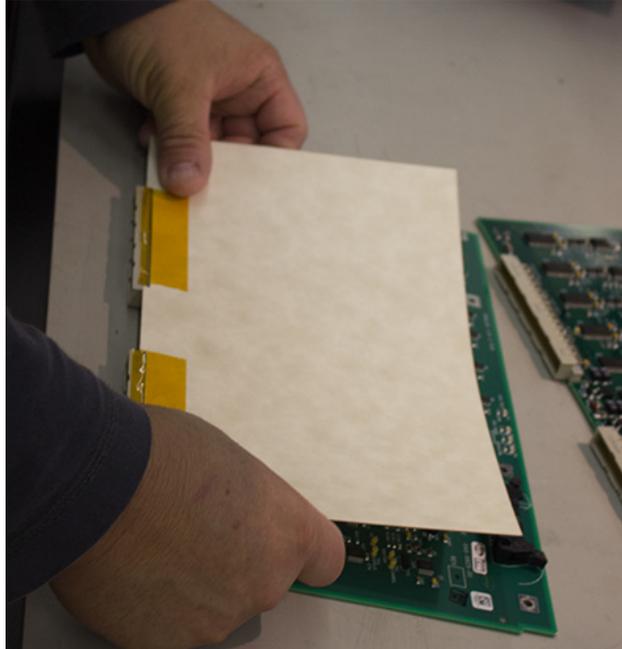


**Figure 204 Removing Four Screws from New Board**



**Figure 205 New Board and Old Board**

Note, in [Figure 205 on page 344](#), that the old board has a sheet of insulation attached. Carefully remove the insulation from the old board and place it on the new board, aligning it to lay square.



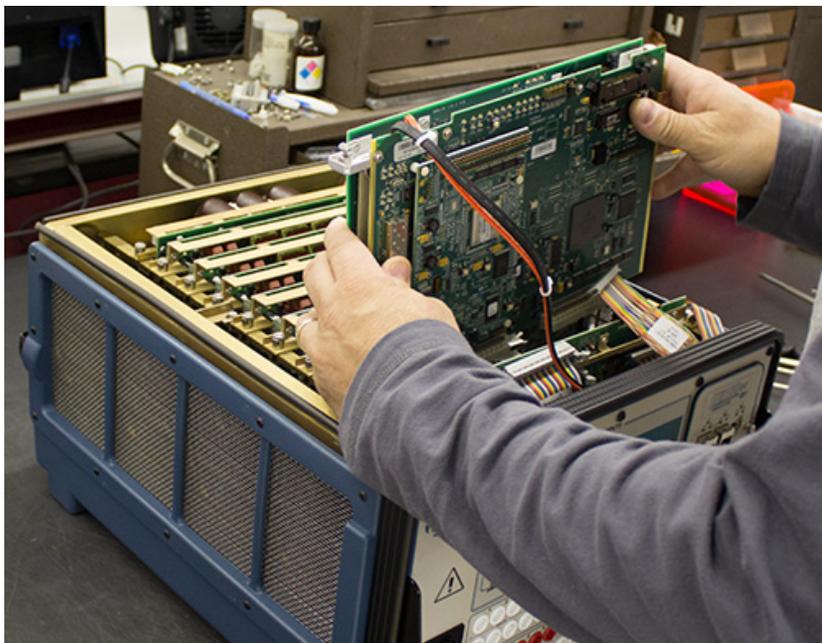
**Figure 206 Applying Insulation Sheet to New Board**

Attach the new Analog I/O board to the instrument bracket, replacing the four screws.



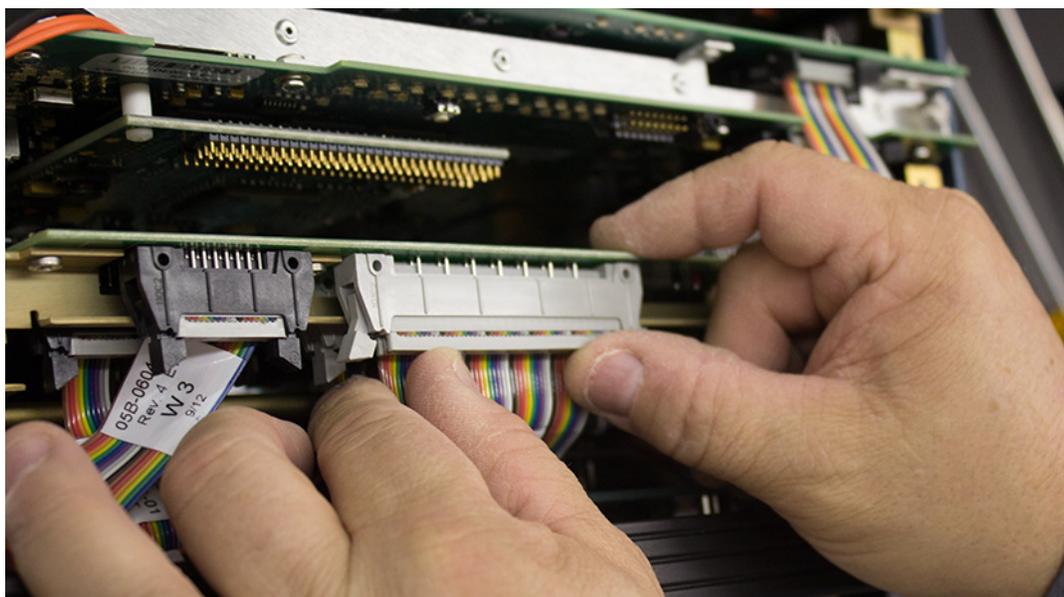
**Figure 207 New Board Attached to the Instrument Bracket**

Place the bracket back into the instrument, and replace the two screws on the ends of the bracket.



**Figure 208 Placing Bracket Into Instrument**

Reconnect the three cables previously removed.



**Figure 209 Reconnecting Cables**

## Replacing Chassis Flange

Place the chassis flange back in position in the instrument and place and tighten the four screws.

## Closing the Chassis

Reversing the steps from “[Preparatory Steps](#)” on page 134, replace the cover and feet that were removed earlier.

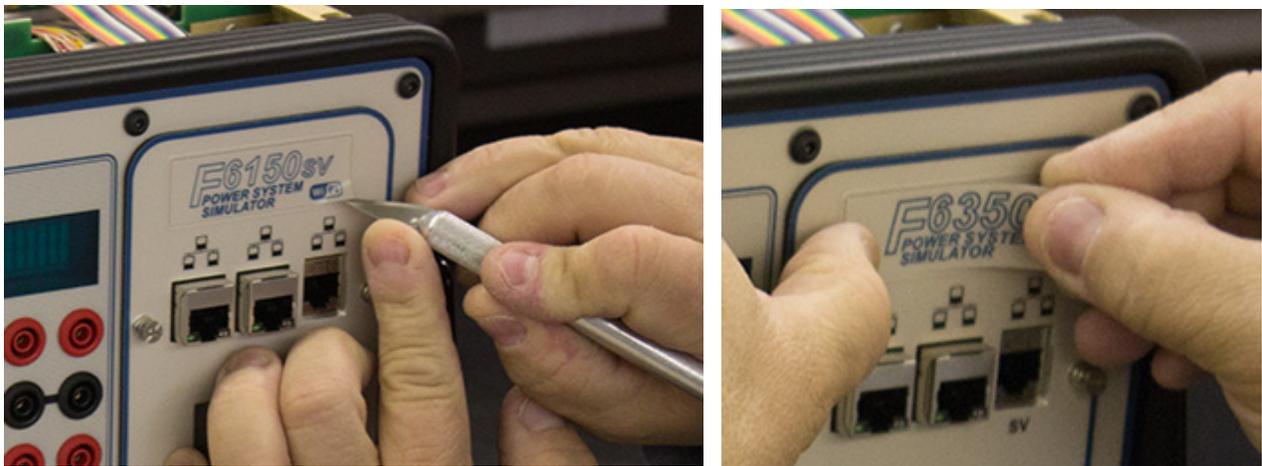
## Finishing the Hardware Procedures

### Saving the Old Board

Save the old Analog I/O board in the anti-static bag that the new board was in, in case you ever want to go back to an F6150sv configuration.

### Replacing Label

Replace the F6150sv label with the F6350E label in the kit.



**Figure 210 Replacing Instrument Label**

## Upgrading Firmware

Once you have replaced the printed circuit board:

1. Launch Protection Suite, ProTesT, F6TesT, or the F6ControlPanel to upgrade the instrument firmware. The firmware is included on the CD that is provided to you.

To install the firmware:

1. Double-click on **F6 Control Panel**.
2. Go into **Tools**.
3. Click **F6000 Flash loader**.
4. Click **Browse**.
5. Look on the F6350 Package disk provided.
6. Double-click on the Firmware folder.
7. Double-click on F6350-cpu2.pkg.
8. Click **Program**.
9. Wait for the Firmware to download.
10. When completed click **Close**.
11. Reboot the unit.
12. Check the display. You should see F6350 Version v5.1.1 build 1069 or higher on the display.

Once you install the firmware, the F6150sv is converted into F6350e.

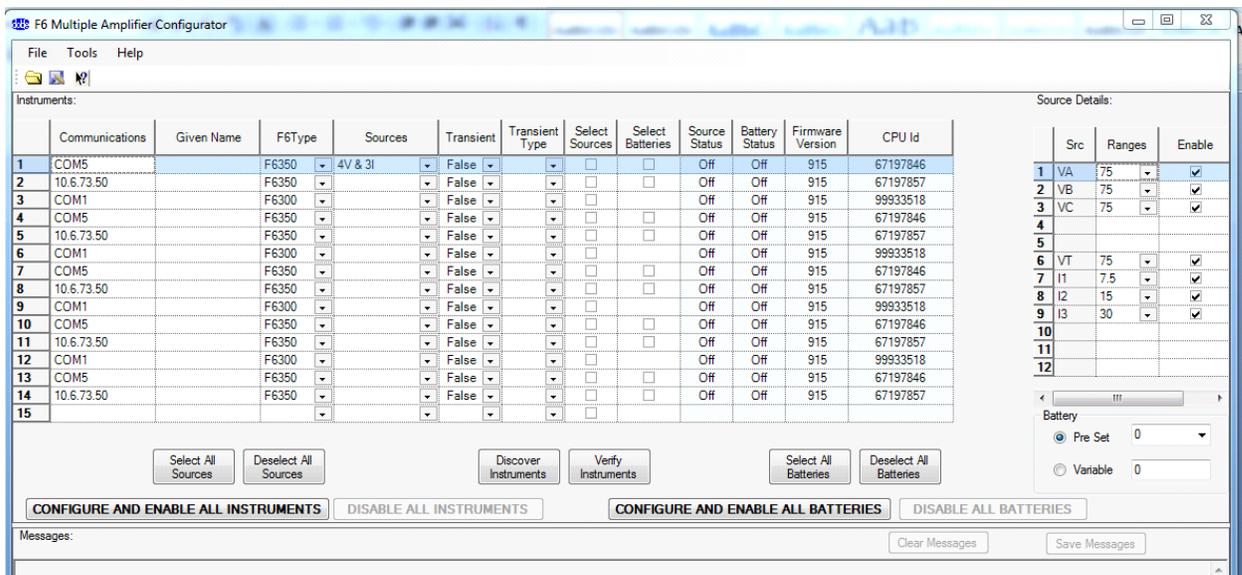
<b>!</b>	<b>NOTE:</b> If you purchase an F6350 dedicated amplifier, you do not need to replace the Analog I/O board. The F6350 comes equipped with the I/O board, along with the interface cable (for connecting the F6350 to the RTDS) and a CD.
----------	--

## Configuring the F6350e

This procedure uses the F6 Multiple Amplifier Configurator (F6MAC) PC application (v 2.0.5.4).

When using the F6350e with the F6MAC, the user has a wider range for the current outputs due to the presence of enhanced current amplifier boards. The current outputs increase by 16.66% compared to the standard current amplifier boards. Please note to compensate for the higher current outputs in your test plans as explained below.

The user interface in V 2.0.5.4 of the F6MAC will display the standard Current Ranges of 7.5, 15, or 30 Amps, as shown in the image below. Due to the greater gain of the enhanced current amplifiers, the 3.35V low level voltage signal (full-scale output) will produce output currents which are 16.66% higher i.e. 8.75A (for 7.5A range); 17.5A (for 15A range); 35A (for 30A range).



**Figure 211**

When using the F6350e with the F6MAC in Transient Mode by selecting “True” in the Transient column of the UI, as shown in [Figure 212 on page 350](#). The Source Details, in the right-hand window will permit the selection of 15, 30, or 60 Amps. Again, because of the greater gain of the enhanced current amplifiers, the 6.7V low level voltage signal (full-scale transient output) will produce output currents which are 16.66% higher, for example, 17.5A (for 15A range); 35A (for 30A range); 70A (for 60A range).

Please note that in an F6350e unit the transient range current can be maintained continuously, instead of being limited to 1.5 seconds in F6350 units with standard current amplifier boards..

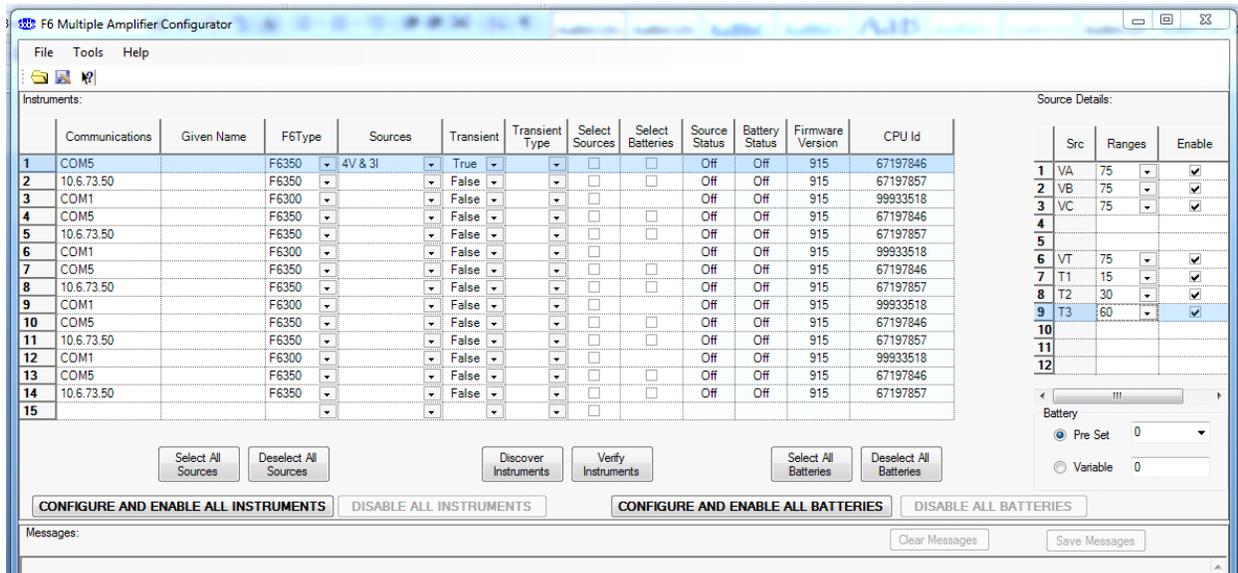


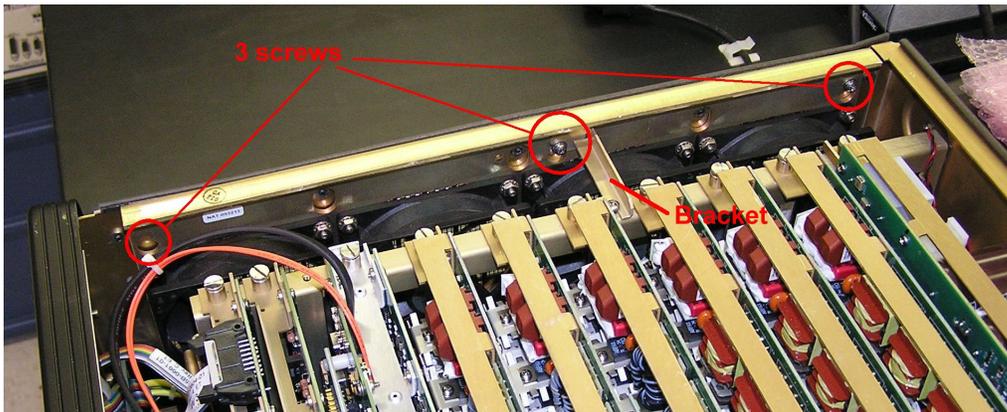
Figure 212

# 17. Upgrading Low Voltage Power Supply

This chapter covers replacement of the low-voltage power supply/fan assembly.

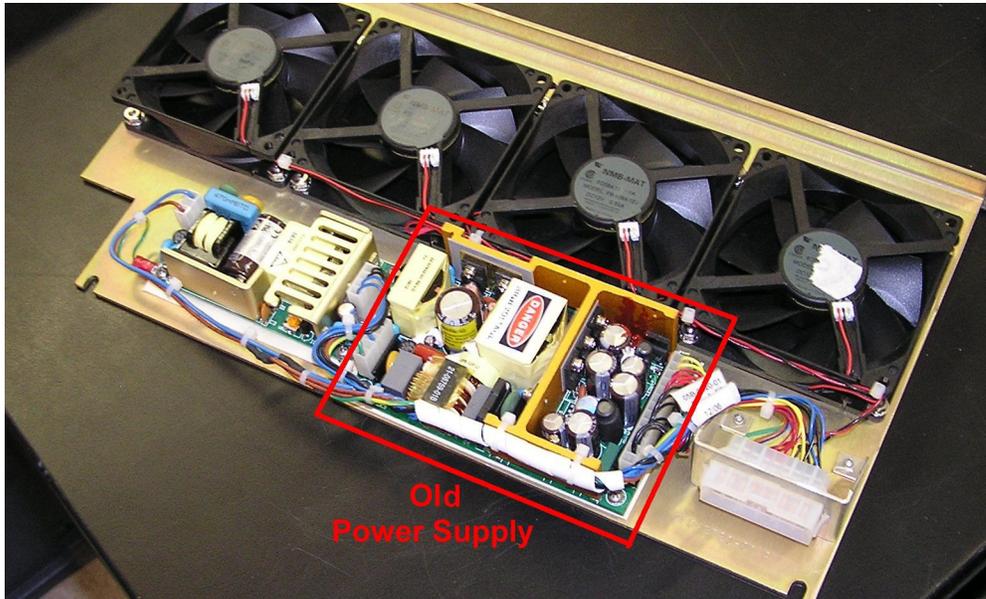
## Removing Old Power Supply/Fan Panel

1. Remove cover and chassis flange.
2. Loosen the 3 screws above the power supply/fan panel and remove bracket.



**Figure 213**

3. Lift the fan assembly, push it slightly toward the center line of the box, and lift it straight up.



**Figure 214**

## Running New Cable

1. Remove the power supply from the last slot.
2. Remove the 3 voltage amplifier boards from their slots. (You may wish to mark the boards before removal, so that you know which ones go into which slots.)
3. Run the new 2-wire cable through the small square hole in the plate, so that the white connector is toward the fan openings and the 2 bare leads are in the other direction.

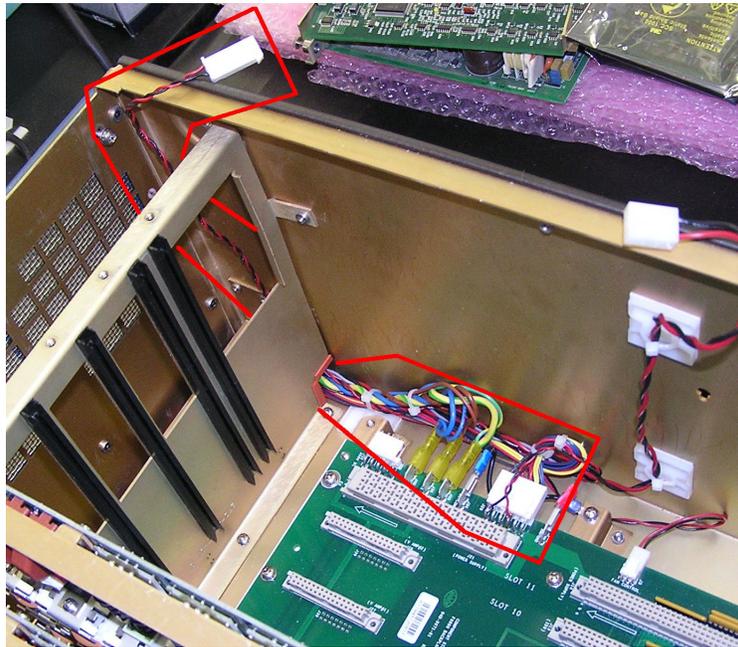


Figure 215

## Connecting New Cable

1. Solder the bare wires to the connector pins. The black wire goes to Pin 1. The red wire goes to Pin 4.

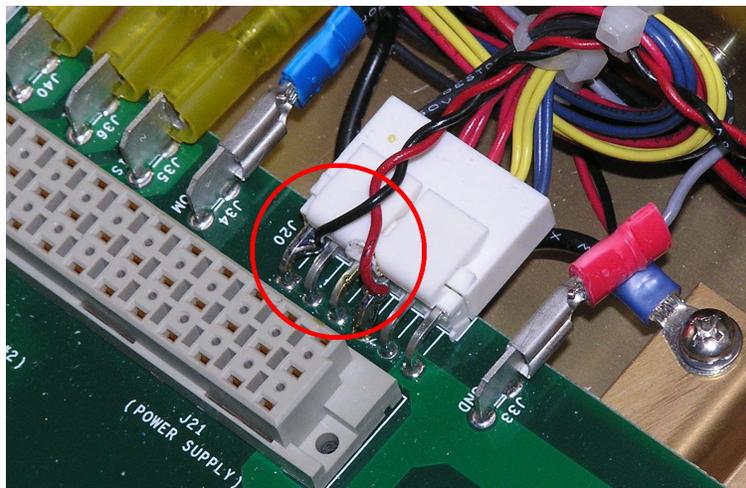
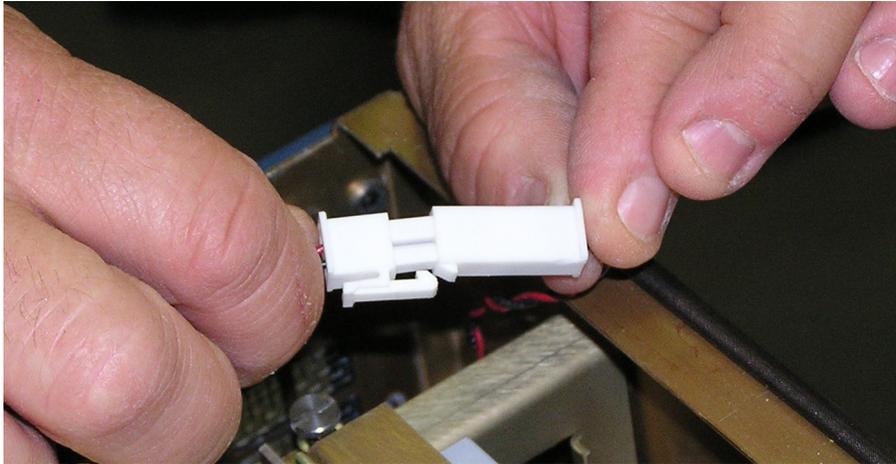


Figure 216

2. Add a tie wrap to secure that end of the cable.
3. Connect the white connector to the connector on the new fan assemble board.
4. Add a tie wrap to secure that end of the cable and keep the cable out of the fan.



**Figure 217**

## Return Boards

1. Re-install the 3 voltage amplifier boards into their slots. Tighten their screws.
2. Re-install the power supply board into the last slot. Tighten its screw.
3. Install the fan assembly board into its slot, being careful not to pinch any cables. Tighten the front and rear screws.
4. Re-install the small bracket. Tighten its screw.

## Complete

1. Reassemble the unit.

## 18. Corrections

This manual is designed to represent current versions of the F-series hardware, especially the F6150x and F63xx, as of the date on the cover. Use of the term "F6150" may refer to any of the current F6150 versions, F6150, F6150A, F6150e, or F6150sv, or their variants.

### Corrections

This file was created at Doble Engineering Company's Watertown, MA headquarters. Should you see any errors or omissions, please contact us.

### Copyright

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