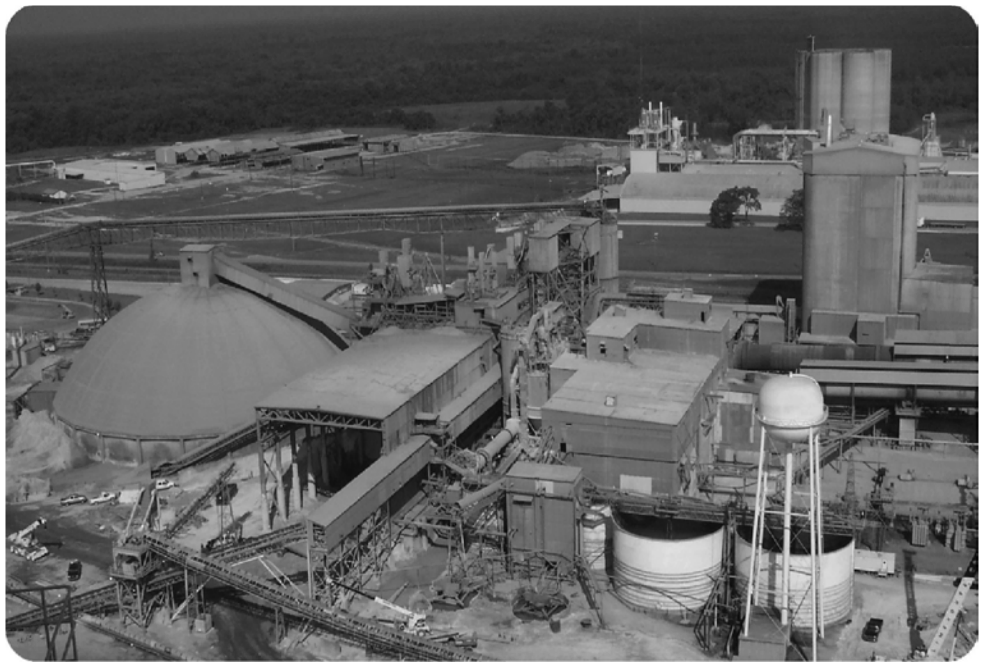
Bulletin 7000 Commissioning Manual

Allen-Bradley

PowerFlex® 7000 Medium Voltage AC Drive Air-Cooled ("B" Frame)—ForGe Control

(Using PanelView 550)

Publication 7000-IN006-EN-P



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Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

New and Updated Information

This table details the changes made to this revision.

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Important User Information

This document provides procedural information for commissioning the PowerFlex 7000 medium voltage "B" Frame drives (standard and heat pipe models).

Who Should Use This Manual

This manual is intended for use by personnel familiar with medium voltage and solid-state variable speed drive equipment. The manual contains material that enables Rockwell Automation field service engineers to commission the drive system.

What Is Not in this Manual

This manual provides information specific to commissioning PowerFlex 7000 "B" Frame drive. It does not include topics such as:

- Physically transporting or siting the drive cabinetry
- Installation and pre-commissioning procedures
- Meggering safety procedures.
- Dimensional and electrical drawings generated for each customer's order
- Spare parts lists compiled for each customer's order
- Trouble-shooting potential usage problems.

Please refer to the following documents for additional product detail or instruction relating to PowerFlex 7000 "B" Frame drives:

- Drive-specific Technical Specifications
- Transportation and Handling Procedures: receiving and handling instructions for Medium Voltage variable frequency drive and related equipment
- Installation Guide: detailed installation and pre-commissioning procedures and information
- Commissioning Guide: required procedures and checklists for Rockwell Automation field service engineers
- Drive-specific User Manual: instructions for daily and recurring drive usage or maintenance tasks
- Drive-specific Technical Data: additional troubleshooting, parameters, and specification information for MV variable frequency drives

Rockwell Automation provides the site- and installation-specific electrical and design information for each drive during the order process cycle. If they re not available on site with the drive, contact Rockwell Automation.

If you have multiple drive types or power ranges, ensure you have the correct documentation for each specific PowerFlex 7000 product:

- "A" Frame for lower power air-cooled configurations (up to approximately 1250 hp/933 kW)
- "B" Frame for higher-power, air-cooled configurations (standard or heat pipe models)
- "C" Frame for all liquid-cooled configurations

Manual Conventions

This manual uses a variety of symbols to indicate specific types of information.

WARNING	Warnings indicate where people may be hurt if users do not follow procedures properly.
ATTENTION	Cautions indicate where machinery damage or economic loss may occur if users do not follow procedures properly.

Both of the above symbols could indicate:

- A possible trouble spot
- Tell what causes the trouble spot
- Give the result of an improper action
- Tell the reader how to avoid trouble

SHOCK HAZARD	This symbol indicates a potential electrical shock hazard on a component or printed circuit board.

General Precautions

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference Allen-Bradley publication 8000-4.5.2, "Guarding Against Electrostatic Damage" or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: Only personnel familiar with the PowerFlex 7000 Adjustable Speed Drive (ASD) and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

Commissioning Support

After installation, Rockwell Automation Medium Voltage Support is responsible for commissioning support and activities in the PowerFlex7000 product line.

Contact Rockwell Automation commissioning services by phone at 519-740-4100; request the Medium Voltage Support – Project Manager.

Rockwell Automation support includes, but is not limited to:

- quoting and managing product on-site start-ups
- quoting and managing field modification projects
- quoting and managing customer in-house and on-site product training

PowerFlex 7000 Overview

The PowerFlex 7000 is a general purpose, stand-alone, medium voltage drive that controls speed, torque, direction, starting and stopping of standard asynchronous or synchronous AC motors. It works on numerous standard and specialty applications such as fans, pumps, compressors, mixers, conveyors, kilns, fan-pumps, and test stands in industries such as petrochemical, cement, mining and metals, forest products, power generation, and water/waste water.

The PowerFlex 7000 meets most common standards from NEC, IEC, NEMA, UL, and CSA. It is available with the world's most common supply voltages at medium voltage, from 2400-6600 volts.

The design focus is on high reliability, ease of use, and lower total cost of ownership.

Topology

The PowerFlex 7000 uses a Pulse Width Modulated (PWM) – Current Source Inverter (CSI) for the machine side converter as shown in Figure 2 on page 12. This topology applies to a wide voltage and power range. The power semiconductor switches used are easy-to-series for any medium voltage level. Semiconductor fuses are not required for the power structure due to the current limiting DC link inductor.

With 6500 volt PIV rated power semiconductor devices, the number of inverter components is minimal. For example, only six inverter switching devices are required at 2400V, 12 at 3300-4160V, and 18 at 6600V.

The PowerFlex 7000 also provides inherent regenerative braking for applications where the load is overhauling the motor (i.e. downhill conveyors, etc.), or where high inertia loads (i.e. fans, etc.) are slowed down quickly. The drive uses Symmetrical Gate Commutated Thyristors (SGCTs) for machine converter switches, and Silicon-controlled rectifiers (SCRs) (for 18 pulse rectifier configurations) or SGCTs (for AFE rectifier configurations) for the line converter switches.

Rectifier Designs

Active Front-end (AFE) Rectifier

An active front end (AFE rectifier) does not require an isolation transformer to meet IEEE 519-1992. Depending on the topology, an isolation transformer can have up to 15 sets of secondary windings.

The AFE rectifier requires a switching pattern that complies with similar rules as the inverter. The pattern, used for the example shown in Figure 2, is a 42-pulse selective harmonic elimination (SHE) pattern, which eliminates the 5th, 7th and 11th harmonics.

The filter resonant frequency is placed below 300 Hz (for a 60 Hz system) where no residual harmonics exist. This prevents the excitation of system harmonic frequencies. Other factors that are considered when designing the filter are the input power factor and the requirement on Total Harmonic Distortion (THD) of input current and voltage waveforms.

The small integral AC line reactor (see Figure 2) provides additional filtering and current limiting features to a line side short circuit fault. The line current and voltage waveforms are also shown in Figure 2. The line current THD is approximately 4.5%, while line-to-line voltage THD is approximately 1.5%. (THD of line voltage is a function of system impedance.) Input power factor with the AFE rectifier is near unity throughout a typical operating speed range for variable torque loads.

Use the AFE rectifier in conjunction with a rectifier duty isolation transformer or with an AC line reactor (as shown in Figure 2).

Available isolation transformer configurations:

- Integral to the drive ("A" Frame only)
- Remote indoor dry type,
- Outdoor oil-filled type

This allows for maximum flexibility in dealing with floor space, installation cost and control room air conditioner loading.

Motor Compatibility

The PowerFlex 7000 achieves near-sinusoidal current and voltage waveforms to the motor, resulting in no significant additional heating or insulation stress. Temperature rise in the motor connected to the VFD is typically 3 °C (5.5 °F) higher compared to across-the-line operation. Voltage waveform has dv/dt of less than 10 volts per microsecond. The peak voltage across the motor insulation is the rated motor RMS voltage divided by 0.707.

Reflected wave and dv/dt issues often associated with voltage source inverter (VSI) drives are a non-issue with the PowerFlex 7000. Figure 1 shows typical motor waveforms. The drive uses a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, plus a small output capacitor (integral to the drive) to eliminate harmonics at higher speeds.

Standard motors are compatible without de-rating, even on retrofit applications.

Motor cable distance is virtually unlimited. Rockwell Automation has tested this technology for controlling motors up to 15 km (9.3 miles) away from the drive.

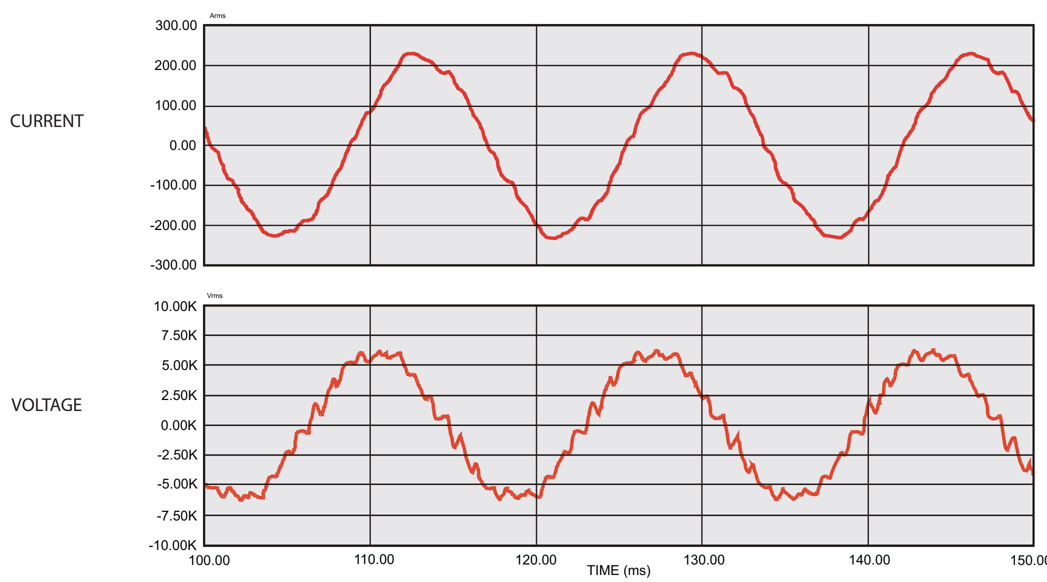


Figure 1 - Motor waveforms @ full load, full speed

Simplified Electrical Diagrams

2400V with AFE Rectifier

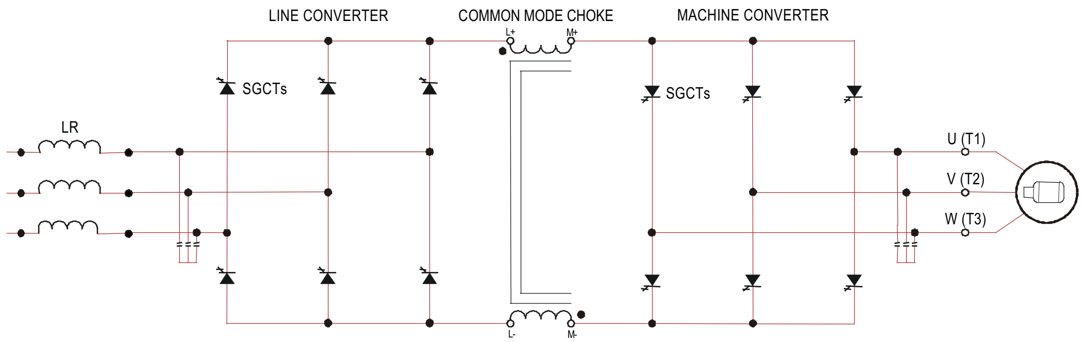


Figure 2 - 2400 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive

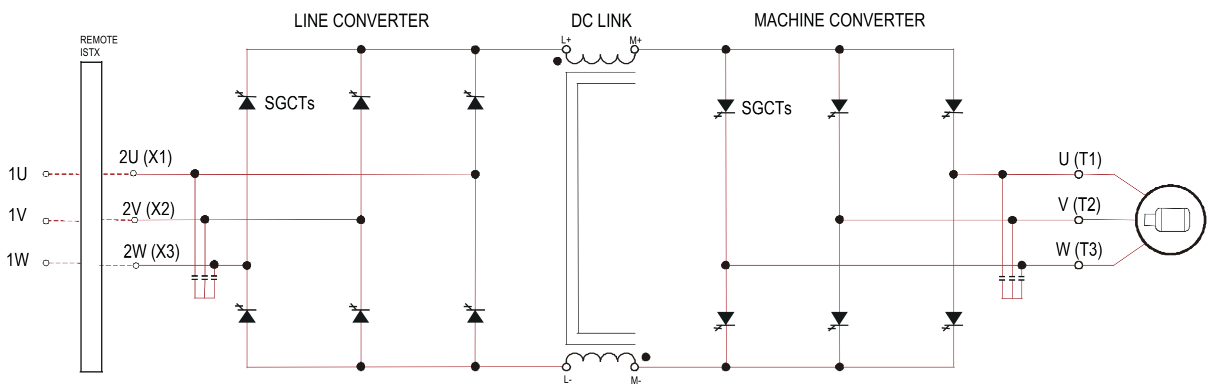


Figure 3 - 2400 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

3300/4160V with AFE Rectifier

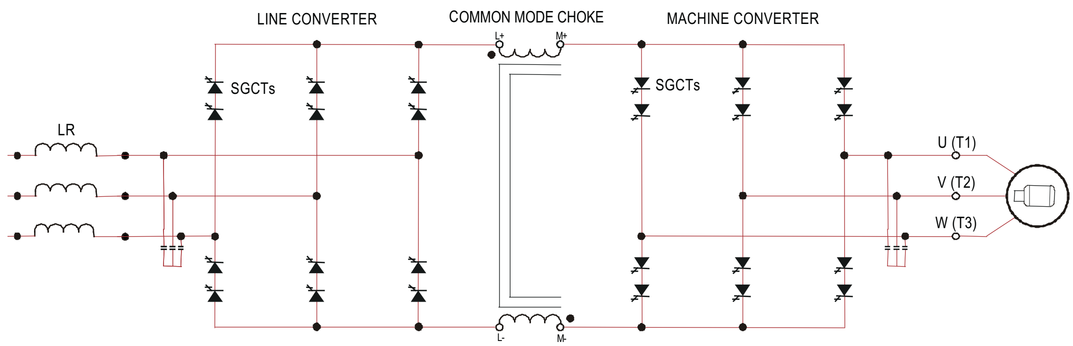


Figure 4 - 3300/4160 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive

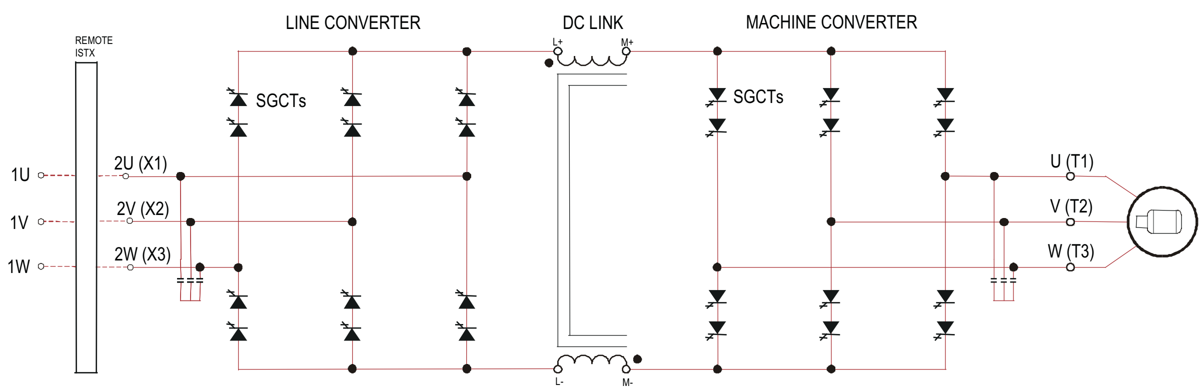


Figure 5 - 3300/4160 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

6600 V with AFE Rectifier

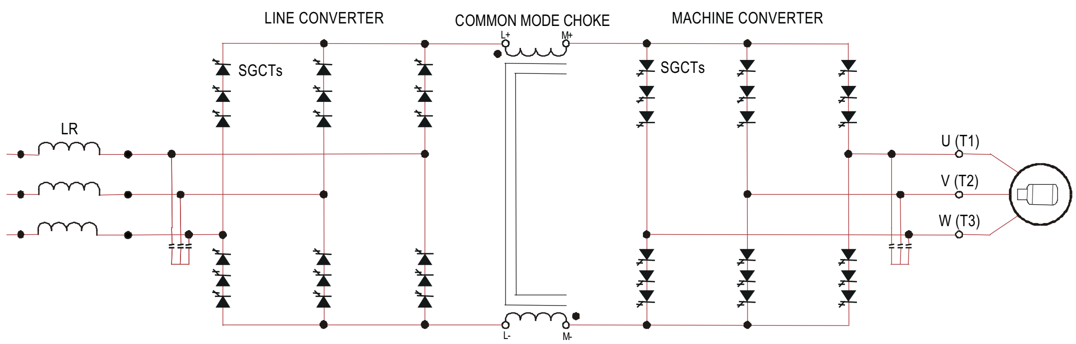


Figure 6 - 6600 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive

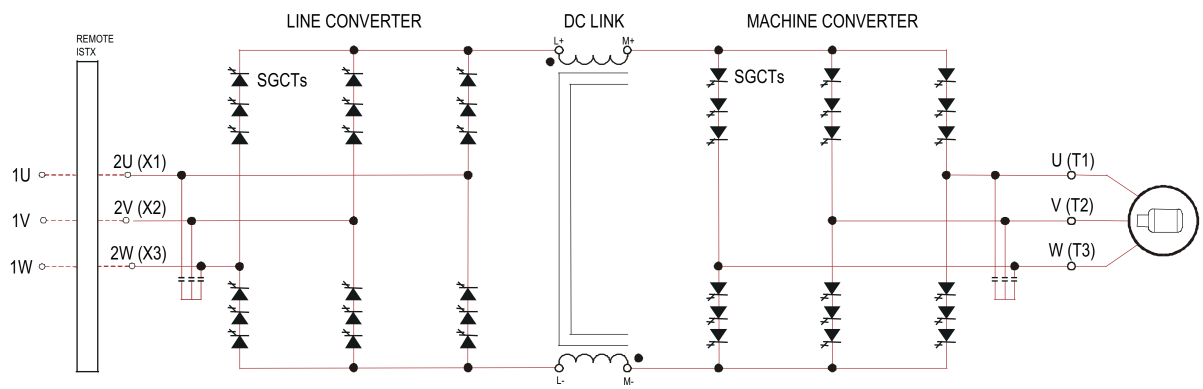


Figure 7 - 6600 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

Operator Interface

The operator interface terminal features a 16-line, 40-character, pixel-based LCD display. The bar chart meters are configurable for common process variables including speed, voltage, and load.

Figure 8 - Operator interface

The terminal provides access to drive control during start-up, monitoring, and troubleshooting. The setup wizard enables you to configure required parameter menus, using questions or prompts for desired operation. Warnings and comments include help text to assist you. The setup wizard, combined with the auto-tuning feature, enables you to tune the drive to the motor and load as quickly and accurately as possible, resulting in fast start-ups, smooth operation, and less down time.

Available test modes include low voltage gate check, and running at full current without motor connected.

Available enhanced diagnostic functions include separate fault and warning queues in non-volatile RAM (NVRAM), extended fault text strings, on-line help, and trend buffers for 16 variables.

Refer to for information regarding the operator interface and procedures for loading and editing drive parameters through the interface.

Initial Operator Interface Configuration

The PowerFlex 7000 "B" Frame medium voltage drive uses the PanelView 550 terminal as the operator interface (Figure 9 on page 18). The medium voltage drive terminal only uses the PanelView interface hardware, incorporating unique software with a modified faceplate.

This chapter describes how to configure the operator interface. To complete initial drive programming, see Drive Programming and Parameters on page 189. Specific references to a particular parameter are only for illustrative purposes. Refer to the PowerFlex 7000 Medium Voltage AC Drive Technical Data for further information regarding drive parameters.

The interface limits user access to specific configuration features on the basis of defined security levels. For more information on defining these levels, see Configuring Access Levels on page 194.

Terminology

Editing field – An area of a screen in which you can type data via the keypad.

Flash – A type of memory that indefinitely stores information and is unaffected by power loss. The drive uses this format for firmware, parameters, and data file storage.

NVRAM – Non-Volatile Random Access Memory is unaffected by power loss. The drive uses this format for long term data storage (for example, parameters and alarm queues).

Parameter – A memory location at which the drive reads or writes data. You must configure operational parameters before using the drive. Configuring a parameter changes the drive behavior. You may add additional parameters or change them while the drive is in use, in order to adjust its operation, (i.e. editing a speed parameter).

Operation – Tasks that the drive performs, or that you must do with the drive. Completing a task may involve multiple screens; for example, modifying a parameter is an operation requiring two or more screens.

PanelView 550 – The PanelView 550 integrates a hardware terminal and a software package into a single operator interface. The medium voltage drive uses the hardware portion of the product with different software than default PanelView software.

PCMCIA – Personal Computer Memory Card International Association is a standard for flash memory cards.

PowerFlex operator interface – The PanelView 550 interface hardware and the unique software contained within it, enabling the unit to function with the medium voltage drive.

Read-only parameter – A memory location that is readable but not writable. A read-only parameter contains real-time data that the operating system uses to read the current drive conditions, such as running speed.

Tag – A generic reference to either a parameter or a read-only parameter.

XIO – the eXternal Inputs and Output adapters that transmit hard-wired signals to the drive.

Keypad

The keypad of the operator interface consists of two rows of five function keys (item 1 of Figure 9) located below the operator interface display area (item 4 of Figure 9). In the lower right corner of the operator interface are the four cursor keys, indicated as ▲ or ▼ ◀ or ▶ (item 2 of Figure 9). Above the cursor keys are data entry keys consisting of the numeric values 0-9, a decimal point (.), a negative (-), a backspace key, and a data entry key (item 3 of Figure 9).

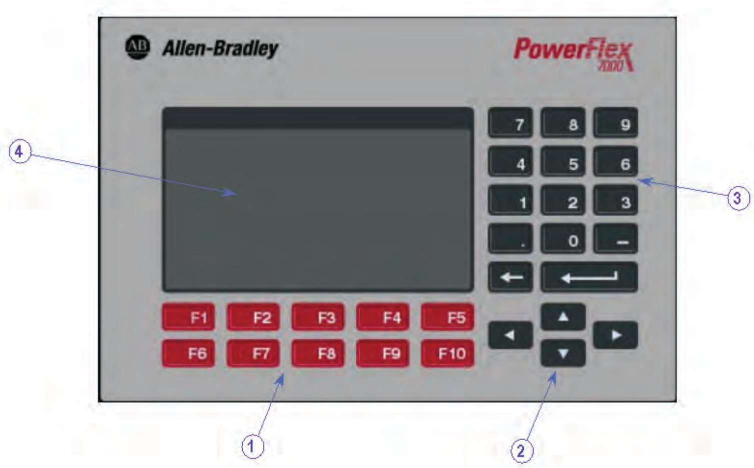


Figure 9 - PowerFlex 7000 "B" Frame Operator Interface Terminal

All keys are of a membrane type. The key function activates when you release the key.

Function (Softkeys) Keys

Along the bottom of the display area are the 'softkeys'. These are the physical function keys. Each key's function will vary between displays. The bottom row of keys (i.e. [F6]-[F10]) is always visible. The upper row appears only if necessary. A single row of 'Softkeys' always refers to the keys [F6]-[F10].

Even though the upper row of Softkeys (i.e. [F1]-[F5]) may not be visible on some displays, the [F1]-HELP key is always active. ([F2]-[F5]) are only active if visible.

Cursor (Selection) Keys

Use the cursor keys to select an item on the display. When you select an item, that item appears highlighted. To change the selection, press the key in the desired direction. If there are multiple pages to a screen, moving the highlight will automatically scroll to the next page.

Some displays, such as the Utility screen, use these keys to modify the data value. Pressing ▲ or ▼ changes the value by a single unit at a time. Pressing ◀ or ▶ changes the value by a course amount (i.e. 10 units).

For entries requiring a HEX value, use ▲ or ▼ to scroll to the desired HEX value.

For parameters containing an enumeration string, use ▲ or ▼ to scroll the options list. When you make a selection, press [Enter]. A triangle symbol or inverted triangle to the right of the list indicates more selections than will fit on the screen. Use the cursor keys to scroll to additional selections.

For parameters comprised of bit fields, use ◀ or ▶ to move to the required field. Use ▲ or ▼ to toggle the bit between possible states.

All four cursor keys have a "hold" feature. If you hold a key for 2 seconds, the related function repeats at a rate of 5 'presses' per second, as if you were pressing the key.

Data Entry Keys

Use these keys to enter data. Pressing [0] to [9] types the corresponding value in the editing field. Pressing [-] changes the value to a negative number. Pressing [.] enables you to enter a fractional value.

Edit field values using the ⟵ [Backspace] key. This key deletes characters from right to left. The help screen uses this key to return to the previous level of help.

The [Enter] key function varies depending on the screen. During a selection operation, the [Enter] key accepts the selection and proceeds to the next screen in the operation. If you are in the process of entering data, press [Enter] to accept the field data.

Screen Components

The operator interface combines a menu screen with the data drive to provide user access to configurable drive operations. Some operations require multiple screens to complete; scroll or navigate between the menus and screens that contain longer pages than the terminal interface can display.

Although the data displayed on any particular screen will vary, the general composition of a screen is similar for all. Figure 10 shows a typical screen and its components.

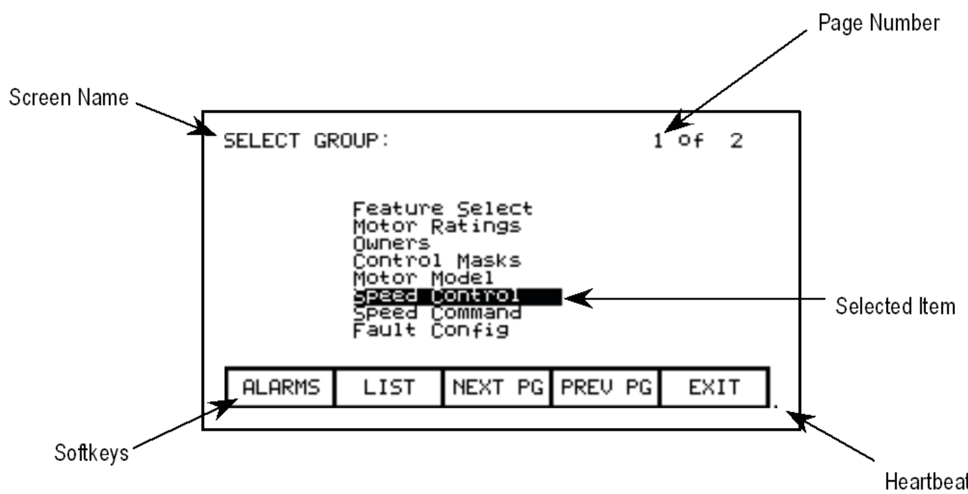


Figure 10 - Screen Components

The screen name appears in the upper left corner, as shown in Figure 10, and helps provide menu orientation. Some screens display the selected item from the previous screen to the right of the current screen name.

For screens with multiple pages, both the current page number and the total pages for this screen appear in the upper right corner. Pressing [F8] displays the next page of data.

In the lower right corner is a small dot, shown in Figure 10 as the "heartbeat". This dot indicates the healthy state of the operator interface, and in normal conditions flashes at a rate of .5 Hz. During communication errors, the dot flashes at a rate of .1 Hz.

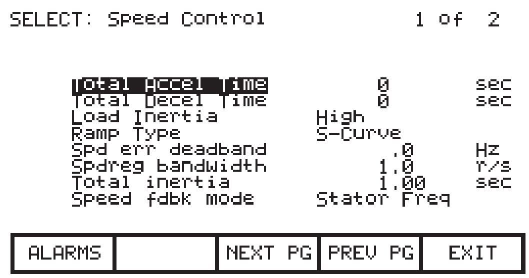


Figure 11 - Screen name and selected item

The remainder of the screen displays drive data related to the selected menu options. Screens that include item selection highlight the default or current selection, as shown in Figure 11.

Interface Operations

Security: Access Levels

Secure access levels protect the drive from unauthorized parameter changes, and filter accessible information. Each access level includes the access permissions of all lower access levels.

Monitor: The default access level; access to a small subset of the parameter database. No change access to any configuration information.

Basic: Permits changes to any viewable parameter.; sufficient for configuring and maintaining the drive for the majority of applications.

Advanced: Permits configuration access to the entire drive.

Two additional secured levels for trained service personal are only accessible for making physical hardware changes to the drive.

Individual PIN security protects all levels, except the first. Use the ▲ or ▼ keys to select the access level. Enter the PIN for the relevant access and press [Enter] to change the access level.

Refer to the User Manual for complete information on the use of Access Levels.

Information Windows

Certain operations communicate directly with the drive, which may cause a performance lag. The interface will display status messages relating to the ongoing operation.

Accessing/Writing to Drive

On initial start-up, the interface knows little about the drive. At each screen, the interface receives and stores information from the drive, and displays the message, "Accessing Drive...". The interface will not accept user input until it completes the access task. Using the same screen for the same data will then be faster, since the interface can access locally-stored data.

Optionally, you can download the complete database to the interface to eliminate the initial access delays. If uninterrupted, the interface automatically downloads the database on power-up, or during periods of inactivity.

Some operations must write information to the drive, during which the interface displays, "Writing to Drive..." The interface does not accept user input until the task finishes.

Communication Errors

Many things might disrupt interface communication with the drive. In the event of a disruption, the interface provides a status window, and will not accept further user input until it completes the current task.

The "Communication Error" message has two forms. If the interface is already "Accessing Drive" or "Writing to Drive", then the error message appears in the current window. For screens displaying real-time data from the drive, such as the 'Top Level Menu", a new window displays the "Communication Error". Two examples appear in Figure 12.

In both cases, once the interface reconnects to the drive, the message closes and the operation finishes.

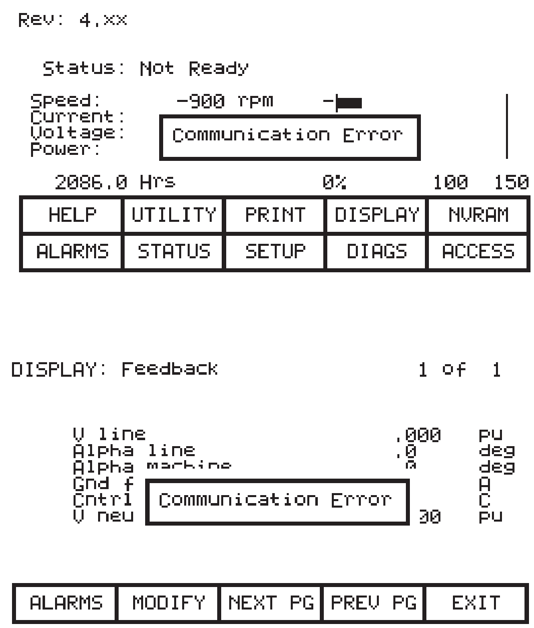


Figure 12 - Communication Errors

Operator Interface Menu

Hierarchy Chart

The interface screens provide menu-driven access to the drive operations. Figure 13 on page 25 and Figure 14 on page 26 illustrate the menu hierarchy, and show the relationship between screens and a particular operation. They also illustrate the path to a particular screen.

This chart does not cover usage of the operator interface, but is useful reference for both initial configuration and further parameter programming.

Reading the Chart

Each box represents a screen, and shows the screen name. From a particular screen, a downward arrow indicates other screens that are accessible from the current screen, and the function key required to call each screen. Pressing [F10] on any screen returns exits and returns to the preceding screen.

A lateral arrow indicates screens accessible by pressing [Enter] while making a selection. Pressing [F10] exits and returns to the preceding screen.

Some operations share common screens, shown only once on the chart and indicated by symbols inserted into a circle. For example: the ACCESS screen is available from the MAINMENU by pressing [F10]. In this location (marked by an *), the ACCESS and PASSWORD CHANGE screens appear in their entirety. These operations are also available from the MODIFY PARAMETER and SETUP screens by pressing [F8]. At these locations, screen operation is represented by the symbol 'P', representing the same flow as previously defined.

The soft function keys that calls the HELP and ALARMS screens are not shown. All screens can call either function using [F1] and [F6] respectively.

As an example of using the chart, we will modify a parameter while displaying it, starting from the top-level menu referred to in the chart as the MAINMENU screen. This example concentrates more on the flow of screens and how it relates to the chart, rather then the actual function of each screen. The symbols refer to those of the chart. Descriptions of movement, i.e. lateral, refer to flow depicted on the chart.

From the MAINMENU, press [F4] to open the DISPLAY GROUP screen. Scroll to a parameter group and press [Enter]. This laterally moves us to the DISPLAY screen. Since you selected a parameter group, pressing [F7] opens a selection operation (symbol 'D') in which the SELECT screen appears, enabling you to use the cursor keys to select a parameter.

Pressing [Enter] laterally moves us to the symbol T. ending the selection process. For this example, the symbol T laterally moves to the symbol M that defines a new parameter modification process. The MODIFY PARAMETER screen appears.

To modify the parameter, you must have the correct access to it. Press [F8] to call the ACCESS screen, represented by the symbol P. Select the correct access level on this screen and press [F10] to exit. This returns to the MODIFY PARAMETER screen. When you are finished editing the parameter, press [F10] to return to the SELECT screen (via symbols M and T). Pressing [F10] again returns to the DISPLAY screen (via the symbol D). Pressing [F10] again will return you to the DISPLAY GROUP and finally to either the MAINMENU or the MESSAGE screens.

If you have modified any drive data, pressing [F10] calls the MESSAGE screen with a prompt to save changes permanently to NVRAM. To leave changes as temporary, press [F9] for 'No' and continue to the MAINMENU. If you press [F8] for 'Yes', the NVRAM screen appears, and you can save the data. Exiting the NVRAM screen returns to the MAINMENU. Pressing [F10] key on the MESSAGE screen will returns to the DISPLAY GROUP screen.

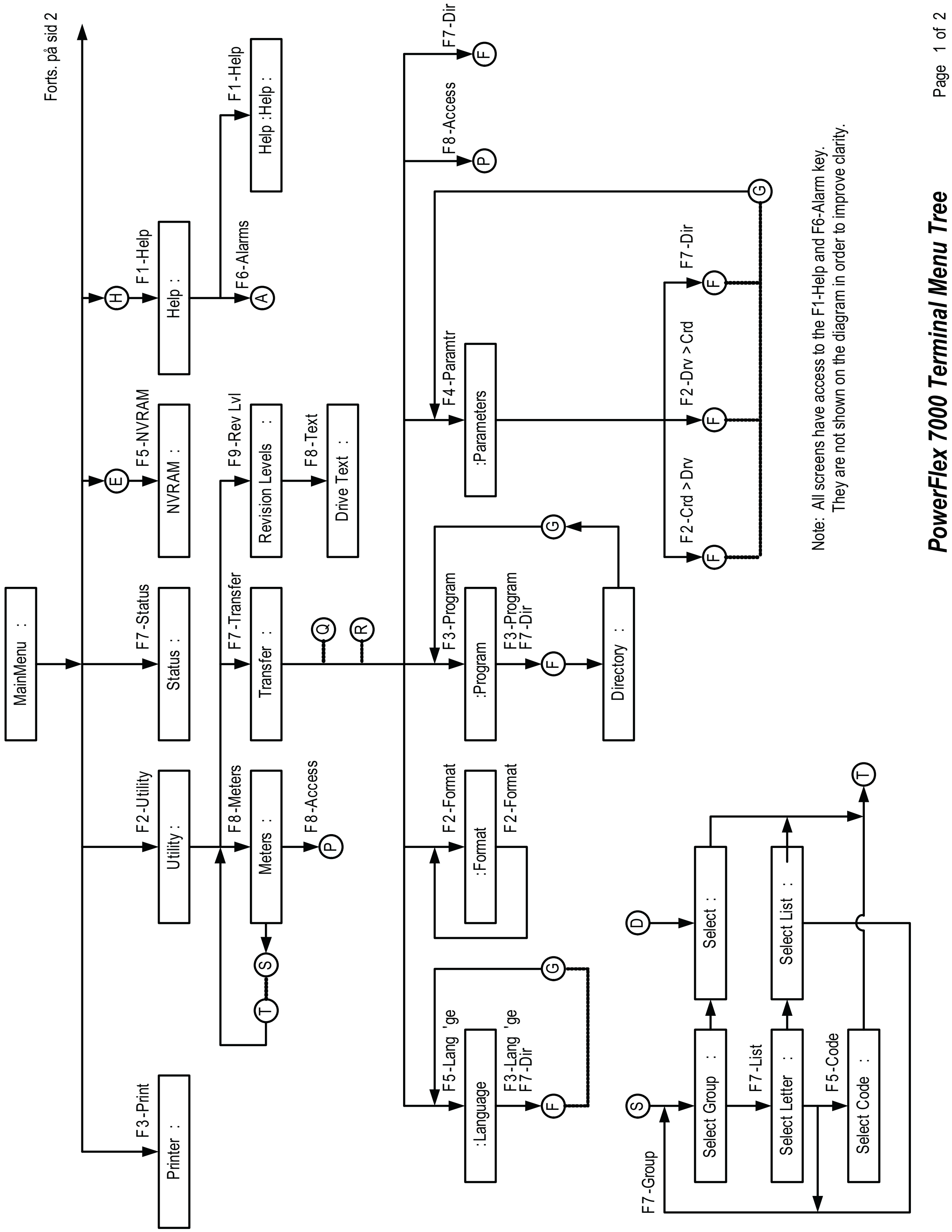


Figure 13 - Menu hierarchy

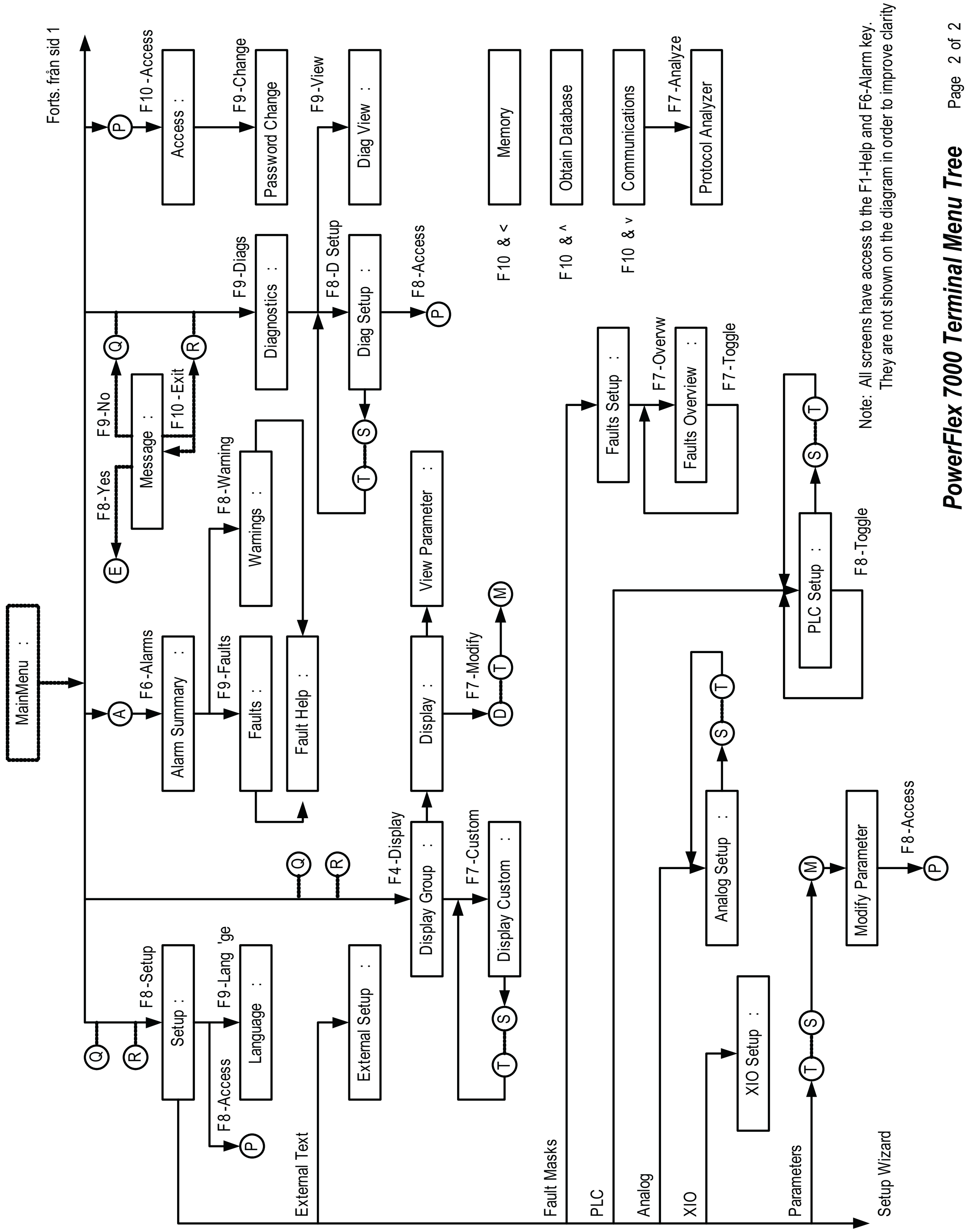


Figure 14 - Menu hierarchy, cont'd

Configuring the Interface

General Operation

Screen contents vary depending on the operation. You can access most operations using the function keys on the bottom of the screen. Function keys generally change from one screen to the next, although some functions are consistent across multiple screens:

- F1 - Help: This operation is available on every screen, even if the softkey is not available. Help is context-sensitive, providing content specific to the current screen.
- F6 - Alarms: Always displays the Alarm Summary screen. A new alarm will cause this key to flash.
- F8 - Next Page: Navigates screens containing multiple pages.
- F9 - Previous Page: Navigates screens containing multiple pages.
- F10 - Exit: Returns to the previous screen.

Operator Interface Power-up Sequence

When you start or reset the operator interface, it performs two operations:

- Linking to Drive: The interface establishes communications with the drive communications board. The screen shows information about the software product contained in the PowerFlex operator interface, such as:
  – - software part number and revision level
  – - date and time stamp of program creation
- Obtaining Drive Database: the interface is downloading the drive database. This process is optional; abort the process by pressing any key on the interface. Obtaining the entire database does speed up subsequent operations, since relevant portions of the database are available in flash memory. (Otherwise, the interface continues to access the drive database directly, which significantly slows the first operation requiring that data. Subsequent operations requiring the same data are not affected). Aborting the download will not affect portions of the database already obtained.

Once the interface downloads the database, it will boot in one of two modes, depending on how the current drive configuration:

a) On an unconfigured drive, the operator interface boots in 'Setup Wizard' mode. Until you complete the configuration, this is the default start-up mode. You can cancel the wizard at any time by pressing the appropriate softkey.

b) On a configured drive, the top-level menu appears after start-up. You can access the Setup Wizard at any time from the Setup menu.

Top-Level Menu

This screen (Figure 15) provides menu access to all other operations. To select an operation, press the corresponding softkey.

The menu screen identifies the drive and its overall operative state. Four digital meters track selected drive parameters. A Hobbs meter displays the drive's current up-time.

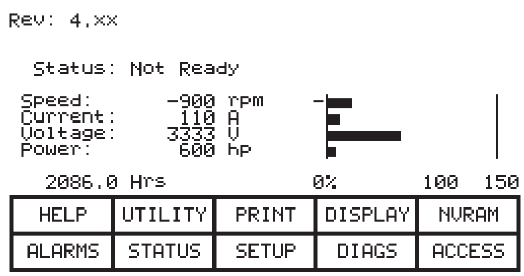


Figure 15 - Top-level menu

Status indicates one of the following:
- NOT READY—drive is not ready to start
- READY—drive will start on command
- FORWARD RN—drive is running in the forward direction
- REVERSE RN—drive is running in the reverse direction
- WARNING — drive has a warning
- FAULTED—the drive is faulted
- DISCHARGING—waiting for the input filter capacitor to discharge on an Active Front End drive before re-start

Accessing the Help Function

Access the Help from any screen by pressing [F1]. After the screen name is the name of the screen from which you called the Help function; in sample show in Figure 15, the Help call originated from the "REV" screen. If the Help screen contains multiple pages, use [F8]and [F9] to navigate between the pages.

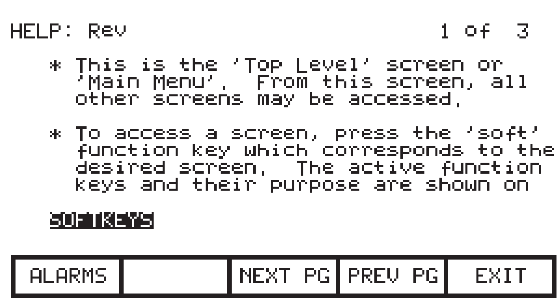


Figure 16 - Typical Help screen

Exit the Help and return to the original screen at any time by pressing [F10].

Related Topics

The Help system provides additional information relating to the current topic as links highlighted above the softkeys. Select an additional topic via the ◀ or ▶ keys. Figure 16 shows the additional topic of "SOFTKEYS". To view this information, press [Enter].

The help for the additional topic appears as shown in Figure 17. Related help topics may also have additional related topics.

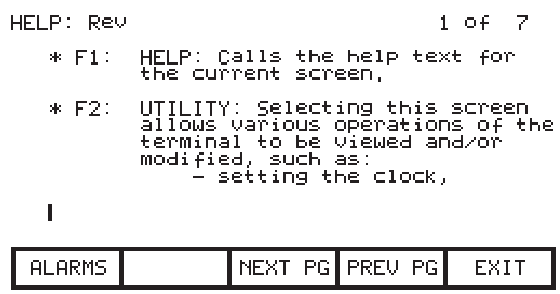
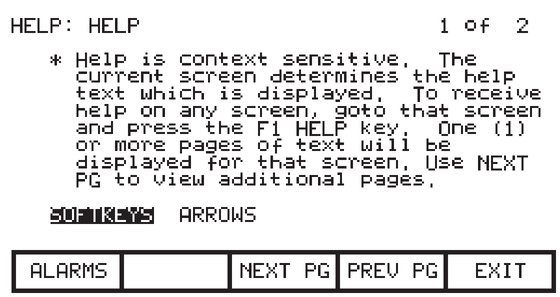


Figure 17 - Help—Related Topics screen

Pressing [F1] from a help screen provides instructions for using the help system.



To return to the previous help screen, press [Backspace]. To exit the Help completely and return to the screen from which you originally requested help, press [F10]. Press [Backspace] to return to the previous help topic.

Using the Interface Configuration Utility

Use the Utility mode to configure the operator interface, including:

- setting the clock and calendar
- changing the delay for the display backlight shutoff
- changing the contrast of the display
- defining the meters that will be displayed on the Top Level Menu

- viewing the revision levels of all software in the drive line-up.
- transferring data between the operator interface 'flash' memory, 'flash' memory card and the drive.
- loading a new language module.

Access the Utility mode from the top-level menu by pressing [F2].

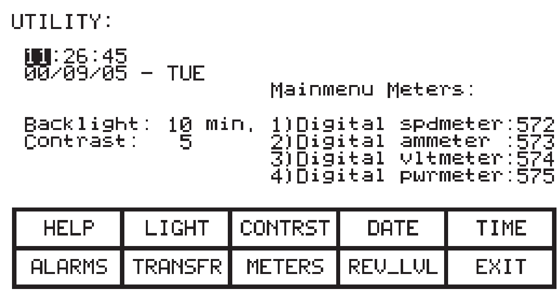


Figure 18 - Utility Operation (configuration) screen

During configuration, the selected value appears highlighted as shown in Figure 18. Select a value to edit it.

IMPORTANT	You can abort configuration from any screen by pressing any of the assigned function keys (other than F1).

Changing Backlight Delay

The interface display is backlit. To preserve the life of the lamp, backlighting automatically shuts off after a period of inactivity on the keypad. Restore the backlight by pressing any key, which has no other affect on the interface when pressed with the backlight off.

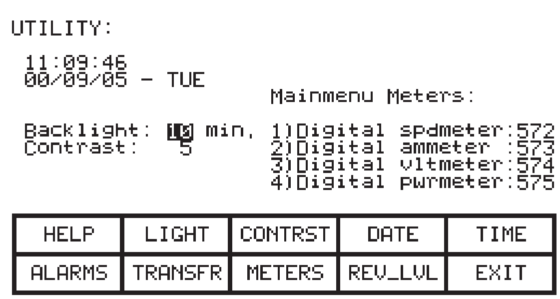


Figure 19 - Configuring display backlight

To change the duration of the delay, press [F2]. The current backlight delay is highlighted. Adjust for values between 0 to 60 minutes. Zero (0) disables the delay, keeping the light on indefinitely. Press ▲ or ▼ to change the value by 1-minute increments. Press ◀ or ▶ to change the value by 10-minute increments. Press [Backspace] to abort the edit. Press [Enter] to save the changes.

Changing Contrast

Press [F3] to access contrast configuration (Figure 20). Press ▲ or ▼ to change the contrast value. To abort the change, press [Backspace]. Press [Enter] to save the changes.

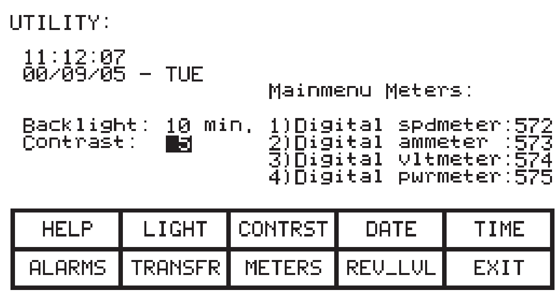


Figure 20 - Configuring display contrast

Setting Time

The clock controls the time stamp on drive information appearing on the alarm summary screen.

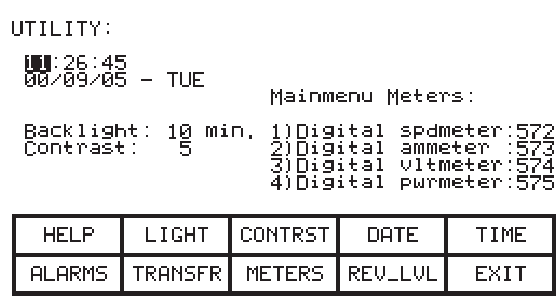


Figure 21 - Setting the clock

To change the hour, press [F5]. Press ▲ or ▼ to increment the clock by 1 unit. Press ◀ or ▶ to increment the clock by ten units.

To change the minutes press [F5] again and repeat the procedure (repeat again to change the seconds).

To abort the change, press [Backspace]. Press [Enter] to save the changes.

Setting Date

Like the clock, the calendar affects the date stamp on drive information appearing on the alarm summary screen.

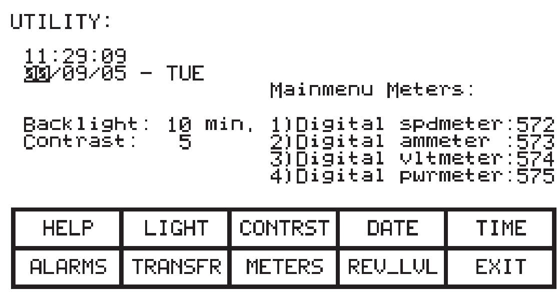


Figure 22 - Setting the calendar

The calendar uses the MM/DD/YY format.

To change the month, press [F4]. Press ▲ or ▼ to increment the calendar by 1 month. Press ◀ or ▶ to increment the calendar by 10 months.

To change the day press [F4] again and repeat the procedure (repeat again to change the year).

To abort the change, press [Backspace]. Press [Enter] to save the changes.

You can not set the day of the week. The interface determines the day of the week based on your date selection.

Selecting Meters

The utility screen (Figure 18) shows tags assigned to four meters on the top-level menu. You can change these meters by pressing [F8] to configure meter selection, as shown below.

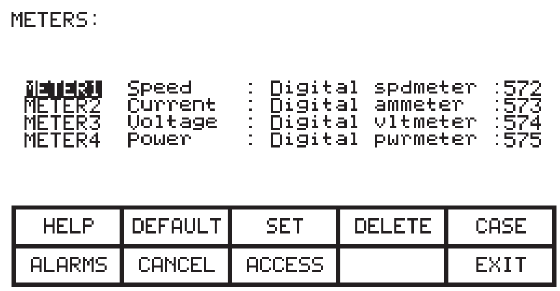


Figure 23 - Configuring meter displays

To change a meter, press ▲ or ▼ to select a meter and press [Enter]. If nothing happens, you do not have access to this feature. Refer to Configuring Access Levels on page 194.Correct the access issues, and press [F8] to continue on this screen.

See also Selecting a Parameter on page 189 for more information on tag selection. Complete the selection process to assign the tag to the meter. The meter name changes to a default string (i.e. V Line) as shown in Figure 24 for meter 2.

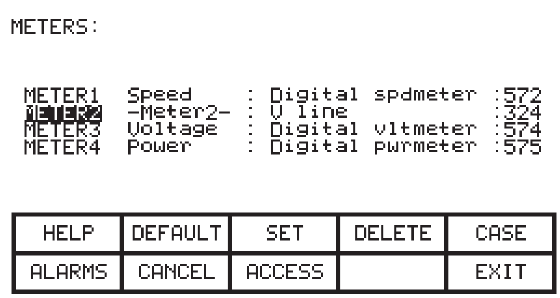


Figure 24 - Configuring meter tags

The text consists of 8 characters and appears on the top level menu with tag value and units.

To change a meter, press ▲ or ▼ to select a meter and press [Enter]. To modify the text, press ▶. If nothing happens, you do not have access to this feature. Refer to Configuring Access Levels on page 194.Correct the access issues, and press [F8] to continue on this screen.

The cursor highlights the first character position of the string as shown in Figure 25. Refer to the section entitled "Edit Text".

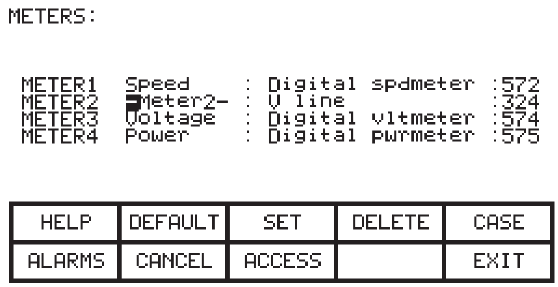


Figure 25 - Editing text

When editing is complete, the screen will appear as in Figure 26.

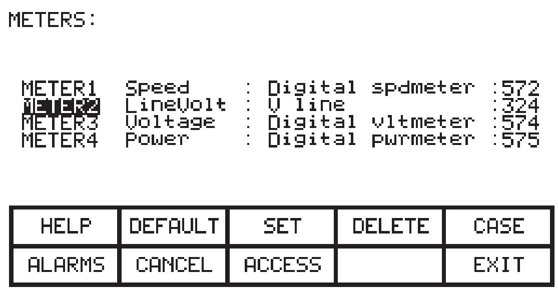


Figure 26 - Editing complete

The operator interface contains a default set of meters. Select the default set by pressing [F2] from the 'Meters' screen to view default text and tags as shown in Figure 23 on page 33.

Edits do not take affect until you press [F10] and exit the screen. Cancel any edits prior to exiting the screen by pressing [F7].

Figure 27 shows the results of the edits as they appear in the top-level meter display.

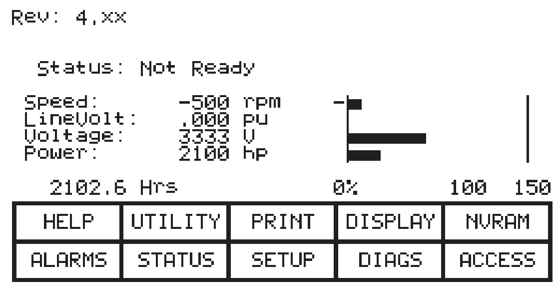
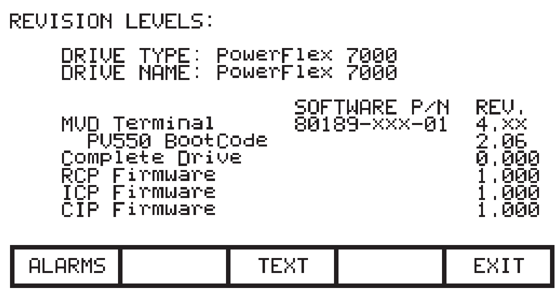


Figure 27 - Modified top-level meter display

Software Revision Levels

You will need to know the software revision level for your interface, for maintenance and upgrade purposes. To see this information, press [F9].



The revision screen typically shows:

- the type of drive
- a unique, 16-character, user-definable string as drive identifier
- terminal software revision level and its part number
- terminal bootcode revision level
- various drive board revision levels

These are identified by name.

To edit the drive identifier text string, press [F8]. If nothing happens, you do not have access to this feature. Refer to Configuring Access Levels on page 194.Correct the access issues, and return to this screen to continue.

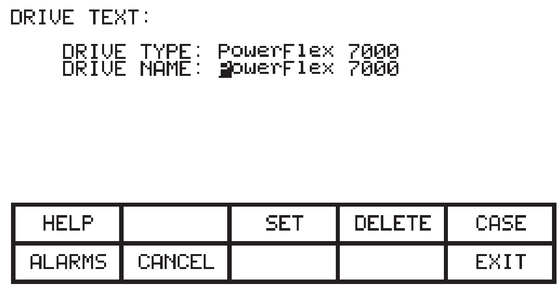


Figure 28 - Editing the drive name

To modify the text in the edit screen as show in Figure 28, refer to the section entitled “Edit Text”, noting the following exception. When you finish typing text (as in Figure 29) the [Enter] key has no effect. Press [F10] to accept the edited string.

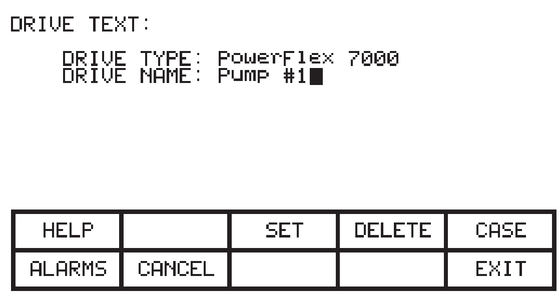


Figure 29 - Editing complete

If necessary, cancel the edits before exiting this screen by pressing [F7].

Transfer Data in Memory

The operator interface contains long term storage in two forms. Flash memory contained in the operator interface stores the firmware, optional language modules, and the drive parameters. This information can also reside on a removable flash card that you can transfer to another drive.

To transfer information from the two forms of memory, press [F7]. This displays flash memory operations screen. For more information on programming the drive (including configuring operational parameters), refer to Drive Programming and Parameters on page 189.

Changing Language

When the drive language changes (through the interface or an external device), the interface updates invalidated database strings and the server character set, and links all strings to the new language. During this process, the interface displays a "Language Changing..." message.

For more information on programming the drive (including configuring operational parameters), refer to Drive Programming and Parameters on page 189.

Commissioning Preparations

This chapter provides important reference material for commissioning a PowerFlex air-cooled medium voltage AC drive, including:

- recommended tools and equipment
- safety checks
- drive line-up data sheets
- pre-power checks
- control power checks

Use this document in conjunction with the most recent version of the Rockwell Automation "Commissioning Guidelines for MV PF7000 [A/B/C] Frame Drives with ForGe Control" document, available to field service engineers on the Intranet at http://rain.ra.rockwell.com/mvb.

Review this information before commissioning the drive line-up. Record all the information requested in the data sheets, which will be useful during future maintenance and troubleshooting exercises.

Perform the commissioning checks in the order listed. Failure to do so may result in equipment failure or personal injury.

Start-up occurs at the customer's site. Rockwell Automation requests a minimum of four (4) weeks' notice to schedule each start-up.

The standard Rockwell Automation work hours are between 9:00 AM to 5:00 PM EST, (8 hr/day) Monday through Friday, not including observed holidays. Additional working hours are available on a time and material basis.

Before Commissioning

Before commissioning the drive, Rockwell Automation recommends the following:

1. Meet with the customer before installation to review:
   a. the Rockwell Automation start-up plan
   b. the start-up schedule
   c. the drive(s) installation requirements
2. Inspect the drive's mechanical and electrical devices.
3. Perform a tug test on all internal connections within the drive and verify wiring.

4. Verify critical mechanical connections for proper torque requirements.
5. Verify and adjust mechanical interlocks for permanent location.
6. Confirm all inter-sectional wiring connections.
7. Re-verify control wiring from any external control devices such as PLCs, etc.
8. Confirm cooling system is operational.
9. Verify proper phasing from isolation transformer to drive.
10. Confirm drive cabling to motor, isolation transformer, and line feed.
11. Confirm test reports indicating megger / hipot test is complete on line and motor cables.
12. Control power checks to verify all system inputs such as starts/stops, faults, and other remote inputs.

Applying power and tuning or performance-testing the drive are part of the actual commissioning process, not part of the preparation.

Note: Appropriate customer operations staff must be on-site with Rockwell Automation commissioning personnel to participate in the system start-up procedures.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the OFF position. Rockwell Automation recommends that you disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, follow the safety related work practices of NFPA 70E, Electrical Safety Requirements for Employee Work Places.

Notwithstanding the safety references here, follow all local codes and safety practices when working on this product.

ATTENTION: The CMOS devices used on the control circuit boards are susceptible to damage or destruction by static charges. Personnel working near static sensitive devices must be appropriately grounded.

Pre-Commissioning Responsibilities

Ensure that the customer has completed the pre-commissioning checklist; refer to the PowerFlex 7000 'B' Frame Installation Guide for the customer's full pre-commissioning checklist, as well as sign-off dates and signatures indicating completion of the required tasks.

Commissioning Preparation

The following section identifies all the tools and resources required to successfully commission a PowerFlex 7000 'B' Frame drive line-up. In addition, it identifies how to obtain the required equipment in the event that it is not readily available prior to commissioning the drive. It is recommended that all items listed below be obtained prior to attempting to commission the drive. Ensure that the contents of this section are reviewed and that the uses of the equipment described within are understood prior to commencing commissioning of the drive. If further support or additional information is required, contact your local Rockwell Automation service office or Medium Voltage Support at (519) 740-4790.

Recommended Tools and Equipment

Hand Tools

- Metric and Imperial wrenches, sockets, and Hex keys
- Torque wrench
- Assortment of screw drivers
- Assortment of electrical tools (wire strippers, electrical tape, crimpers, etc.)

Electrical Equipment

- High voltage gloves – 10 kV insulation rating (minimum)
- Approved high voltage potential tester – 10 kV rating (minimum)
- Anti-static strap

Test Equipment

- 100 MHz oscilloscope with at least 2 channels and memory
- 600-Volt (1000V rating) digital multimeter with assorted clip leads
- 5000 Volt megohmmeter

Computer Requirements and Software

- Laptop computer (486 or higher installed with Microsoft (MS) Windows)
- Microsoft HyperTerminal (Provided with MS Windows)
- Rockwell Automation Software (RS) drive tools (Optional)
- RS Logix [2]
- Required computer cables

– 9-Pin Null Modem[3]
– 9-Pin Serial[3]
– Remote I/O (SCANport DeviceNet…) [1]
– PLC Communications Cable [2]

[1]Only required when Remote I/O has been provided with the drive.
[2] Only required when PLC has been provided with the drive
[3] Refer to Publication 7000-UM151_-EN-P, Chapter 5 – Component Definition and Maintenance.

Additional Required Resources

Prior to scheduling your drive commission, ensure you have the following:

- Functional specifications for the drive to be commissioned (generally available from the online MV Literature Library).
- Any commissioning notes for this customer/installation, available from the Rockwell Automation Application Specialist or Project Manager.
- Self-powered gate driver board test power cable wire harness (Part no. 80018-298-51) supplied with SCR rectifier drives only.
- Rockwell Automation electrical and mechanical diagrams for each drive (also available through ShopView/SAP).
- PLC program (if supplied with a PLC; materials available from teh MV website using the order number as a reference).
- Commissioning data sheets.
- All required manuals (see below for list).

If any of the above information is not available prior to the time of commissioning, please contact the Rockwell Automation Project Manager or the factory.

Technical Publications and Manuals

Each drive ships with a service binder containing all technical publications required to install, use, and troubleshoot the drive line-up. This section describes how to determine what technical publications are required and how to obtain them in the event that the service binder is not available when pre-commissioning, or when you require additional information:

- Commissioning Guide lines for Rockwell Automation MV PF7000 Frame drives (available internally at http://rain.ra.rockwell.com/mvb).
- The PowerFlex 7000 “B” Frame Installation Guide: This is a Rockwell Automation-internal document for commissioning engineers conducting commissioning procedures. Customers can request copies of the manual from their local Rockwell Automation Office.

- The PowerFlex 7000 "B" Frame Commissioning Guide: This is a Rockwell Automation-internal document for commissioning engineers conducting commissioning procedures. Customers can request copies of the manual from their local Rockwell Automation Office.
- The PowerFlex 7000 Medium Voltage AC Drive Parameters (Technical Data publication 7000-TD001_-EN-P): Use this document for parameter details and programming during commissioning or troubleshooting. Refer to 7000-TD002_-EN-P for the latest firmware revision.
- The PowerFlex 7000 "B" Frame User Manual: Use this document for general information regarding the usage and programming of the operator interface after installation (before or after commissioning.)
- Additional Manuals: The electrical schematics that ship with the drive should list any additional manual necessary for configuring the drive line-up. The schematic titled "General Notes" identifies all required Rockwell Automation publications by publication number.

IMPORTANT	Ensure you also have the latest technical and release notes for the relevent drive firmware before proceeding with commissioning. Check the most recent version of the Commissioning Guide for a list of updated Tech Notes.

Important Note for the Commissioning Engineer

The commissioning engineer should review this commissioning package and follow the defined steps to commission PF7000 drive(s). It is the responsibility of the commissioning engineer to complete all datasheets included in this package and collect any other relevant information that may not have been included in the package. Important guidelines for capturing waveforms are also included in the package for quick reference. These must be reviewed and followed properly by the commissioning engineer. Anything that is not clear, please contact MV Tech Support for assistance:

Phone: 519-740-4790
Option 1 for technical and option 4 for commissioning questions

MVSupport_technical@ra.rockwell.com or
MVSupport_services@ra.rockwell.com

After successful commissioning of the drive, the commissioning engineer is required to return the completed commissioning package along with his field service reports to the project manager within one week after completion of job. If job is not completed and some data collected it must be sent to project manager within one week after leaving the site. The items listed below MUST be included when submitting the commissioning package.

1. All checklists and tables in this document (commissioning checklist, customer data, motor data, daily service summary, etc.)
2. Harmonics waveforms must be captured on AFE drives under drive-not-running and full-load conditions.

3. DC current test waveforms (dc voltage and dc current) and variables while running DC test
4. Load Test waveforms (line and load voltage and current waveforms at 50% and 100% load or whatever maximum load and speed allowed by the customer)
5. Final drive parameter settings and variables (running motor at max speed and load) captured at SERVICE LEVEL ACCESS.
6. Modified PLC program (if applicable)
7. Synchronous transfer waveforms (for synchronous transfer applications)
8. Marked-up drawings
9. Summary of issues/failures encountered during commissioning

Ensure that all documents and data files (waveforms, parameter settings, variables, trend data, etc.) intended fopr submission are properly named, labeled and organized.

IMPORTANT If the commissioning datasheets submitted by the commissioning engineer are incomplete and/or the required commissioning data, such as harmonic waveforms, dc test waveforms, sync xfer waveforms etc, are not captured correctly or the required data is missing, then it can delay the processing of expense invoices submitted by the engineer.

IMPORTANT While the Field Service Engineer (FSE) is still at the site, he MUST send the following information to MV Tech Support for review via e-mail at mvsupport_service@ra.rockwell:

- Drive setup after completing the auto-tuning
- Drive variables captured in running condition (at load or no load or uncoupled or with load)
- Line voltage and line current waveforms for harmonics on AFE drives when drive is energized
- Black Box Data before leaving the site, followed by instructions on relevant Tech Note.

Commissioning the Drive

Key Steps to Commission a PF7000 Drive

As a guide for a commissioning engineer, the major steps involved in the commissioning of medium voltage PF7000 drives are outlined below in a sequential order. For detailed instructions, always refer to the relevant PowerFlex 7000 drive's user manual.

- Review the drawings and identify all sources of energy that apply to the drive system and get better understanding of the application to which the drive system is applied.
- Follow safety procedures and apply LOTO before working on the equipment.
- Complete all power off checks and note down motor and drive nameplate data.
- Apply control power and perform power on checks.
- Perform gating test.
- Program the drive after verifying the information on EDs and DDs against the equipment nameplate data.
- Ensure the drive hardware and parameters are correct, such as HECS/CT ratio and burden resistors installed in the drive are accurately programmed in drive parameter settings
- Perform system test and verify operation of the drive and the associated controls.
- Remove any jumpers used during system test.
- Inspect the drive line-up and ensure that no tools are left inside the cabinets before closing them.
- Apply medium voltage and complete incoming line phasing checks and take harmonic measurements.
- Perform DC test. Ensure that the Diagnostic Trend is setup and ready before attempting the DC test.
- Perform Stationary Autotune tests (first 2 autotune tests).
- Bump the motor for rotation check.
- Complete Rotating Autotune tests (last autotune test) .
- Save the parameters in NVRAM and also transfer them from drive to memory and also print the drive setup to your laptop.
- Start the drive in normal operation, print variables and capture waveforms.
- Complete commissioning documentation.

Medium Voltage Product Support MUST complete and return the commissioning datasheets to the Rockwell Automation Canada, Cambridge office immediately upon completion of the drive system commissioning.

The most recent datasheets are available in the Commissioning Guidelines for MV PF7000 [A/B/C] Frame Drives" document, available to field service engineers on the Intranet at http://rain.ra.rockwell.com/mvb.

ROCKWELL AUTOMATION CANADA
135 Dundas Street
Cambridge, Ontario, N1R 5X1
Canada

MV Support Contact Info:
Office Hours: 9:00am - 5:00pm EST, Monday to Friday
Phone: 1-519-740-4790, (Option 1 for Tech Support, Option 2 for MV Parts)
After Hours Support: 5:00pm – 9:00am EST, 365 days
Digital Pager: 1-519-654-5616

Drive Application Review

To ensure trouble-free commissioning, it is necessary for all involved in the start-up to familiarize themselves with the drive line-up and application. Do not service the equipment without a clear understanding of the equipment's functional design, and the equipment's particular application. If questions arise that are not addressed within this manual, contact your local GMS office or Medium Voltage Support directly.

Rockwell Automation Drive Line-up Drawings

Prior to performing any service work on the drive line-up, study and understand the electrical and dimensional drawings provided with the equipment. These drawings contain detailed information and instructions required for commissioning and installation of the equipment including the following:

Dimensional Drawings

- Power cable termination locations
- Ground bus locations
- Shipping split locations
- Control and medium voltage power ratings
- Drive options
- Remote I/O protocol
- PLC options
- Motor and load specifications
- Drive power component selection ratings
- Heat exchanger ratings, connections

Electrical Drawings

- Contactor locations (electrically)
- Drive topology
- General notes
- Cable isolation ratings
- Symbol table
- Component designations

Device Designations	Color Designations	Wire No. Designations	SGCT Designations
Ribbon Cable Designations	Location of Relay and Contactor Contacts	Location of Relays	Drawing Location References

- Customer power and control wiring locations (electrically)
- Control and medium voltage power ratings
- Fuse ratings and locations (electrically)

If the dimensional and electrical prints are not available, request copies from the factory. In addition, if the drawings require changes to accurately suit the installation and application of the system, please fax or e-mail them to the factory for revision.

Electrical System One-line Diagram

After reviewing the Rockwell Automation electrical and dimensional drawings, obtain a copy of the electrical system one-line drawing to help identify all relevant equipment tag identification names and numbers. Study the system for power sources and parallel paths of medium voltage power to the drive. Retain a copy of the one-line diagram for the drive commissioning and, if possible, send a copy to the Medium Voltage division for archiving and use in the event of future customer assistance requests.

Verify One-line Diagram on Site

After reviewing all documentation, perform an on site inspection of the drive. While referencing the one-line diagram and Rockwell Automation prints, identify all the locations of the components within the drive line-up by their tag identification name or number. Trace the power cables from point to point while following the electrical diagrams. Note and review any discrepancy between the physical installation and the electrical prints prior to commissioning the drive.

Inspection Process

Before commissioning the drive line-up, you must inspect the process to which the drive is applied. This step is not only important as a means of identifying and understanding how the equipment design adapts to the customer's application, but also to identify any potential hazards. Review the process and identify any necessary measures to ensure that commissioning the equipment will not expose anyone to hazardous situations, or in any way do damage to the equipment involved in the application.

ATTENTION: Verify that the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being serviced. Take all action necessary to ensure that motor regeneration into the drive does not occur while the equipment is being serviced.

Safety Tests

Complete this section of the commissioning chapter to ensure that the commissioning continues in an environment safe to all those involved in servicing the drive line-up. Complete every point in this section prior to continuing with the drive commissioning. Ensure that you perform the drive commissioning in accordance with local safety standards.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.

ATTENTION: Before attempting any work, verify the system has been locked out and tested to have no potential.

Lockout Tagout

Prior to opening the doors to the drive line-up cabinets, ensure you use proper lockout tagout procedures to ensure that the working environment is safe. In addition, test the equipment for potential prior to servicing the equipment. Even though the input to the drive may be open, it is still possible for potential to be present.

ATTENTION: Live capacitors in circuit. Before touching anything, ensure that the drive is isolated from medium voltage and wait five minutes for the capacitors to discharge. Test the circuit for potential before servicing the equipment. Failure to do so can result in severe injury or death.

ATTENTION: Ensure that the motor is not spinning due to a driven load. A spinning motor can generate a high potential into the drive's motor filter capacitors, which can result in severe injury or death.

Refer to local safety guidelines for detailed procedures on how to safely isolate the equipment from hazards.

Only open the door to the medium voltage cabinets after you successfully complete the lockout and tagout.

Step Down Transformer Fusing

The drive uses transformers to step down medium voltage to low voltage. With all sources of power removed from the drive (Medium Voltage and Control Power), remove the step down transformer fuses from the fuse clips and place them in a safe place outside of the drive cabinet. Removing the control power fuses will prevent a separate source of control power from being stepped up to Medium Voltage in the event that the safety interlocks fail to function.

Fuse and O/L Protection

While referencing the electrical diagrams, locate all fuses and overload relays within the drive line-up. Verify that all installed fuses and overload are the same as indicated by Rockwell Automation. Fuses and overload settings are also identified by stickers located on the cabinet structure in close proximity to the fuse or overload. Ensure the settings match the rating identified on the sticker.

Replacement fuses have been shipped with the drive in the event that a fuse opens during commissioning.

Installation Review

Prior to commencing the commissioning of the drive line-up it, Rockwell Automation recommends re-inspecting the equipment installation. Identifying errors in the drive installation prior to commencing the commissioning rather than mid way through the process greatly reduces the time required to commission the drive line-up.

Inspect for Shipping Damage

Prior to continuing verifying the installation of the equipment, open the cabinets to all equipment supplied by Rockwell Automation and inspect each component installed for signs of damage. Make any damage claims to the Medium Voltage Business as soon as possible in order to replace the damaged components as quickly as possible.

Inspect Cabinets for Debris

Once you complete the safety checks and successfully isolated the drive line-up, inspect all cabinets in the drive line-up for foreign material left behind during the installation. Ensure that no tools, hardware or wiring debris remain in the drive. Note that some electric components used within the drive create magnetic fields that may attract residual metal shavings if the customer required any drilling or metal cutting during the installation process.

Clear all metal shavings from the cabinet and take care not to get shavings into the cabinets if you do any further drilling or cutting.

Protective Barriers

In confined spaces, installation electricians often remove protective barriers to create more space within the cabinets. Ensure that you re-install all protective barriers removed during installation. Failure to re-install a protective barrier may result in equipment damage or personal injury.

Component Grounding

Verify that the drive and all its associated equipment have system power ground cabling installed and that the cables are terminated at both ends. Terminate power cable shield grounds at both ends. Ensure that all grounding hardware is sufficiently torqued (see Torque Requirements for Threaded Fasteners on page 119). Ground all drive line-up components (drives, switcher, motors, transformers and reactors) to the installation's ground grid.

In drive line-ups supplied with isolation transformers, leave the secondary of the isolation transformer floating so the drive line-up can reference system ground from the upstream distribution transformer. Failure to do so may result in unreliable drive operation.

Information on Splice Kits

If the drive line-up was shipped in sections, verify that the bus splice kits provided in this circumstance are properly installed and torqued at shipping split locations.

Power Cabling

Ensure that all customer power and control wiring required for drive line-up installation are identified on the electrical drawings by a dashed line (see your electrical drawing's General Notes for additional information).

ATTENTION: Power cabling should be installed in accordance with local codes and guidelines. The information in this section is to be used as reference only and is not intended to replace practices outlined in the electrical code.

Trace the power cabling from termination point to termination point while examining the cable and its routing for mechanical damage, sharp bend radiuses and sources of induced noise and heat. Ensure that the power cabling is sufficiently braced so as to contain the cabling in the event of a ground fault situation.

Verify that all cables are terminated on each end and are sufficiently torqued (see Torque Requirements for Threaded Fasteners on page 119).

Verify that the cable installed meets the recommended power rating outlined in the electrical drawings and installation section of the manual. Ensure that the cable terminations are stress-coned, if required.

Verify that the customer power cables have been Hi-Potted or meggered and read a sufficient insulation value.

Control Wiring

Identify all customer-required control wiring detailed on the electrical diagram, and locate it within the terminal blocks in the drive. Examine it to verify that the cable insulation has not been tightened into the terminal. Verify that all connections have proper continuity.

Ensure factory jumpers installed and marked with notes "to remove if remote equipment installed" have been removed.

Inspect the control cable routing to ensure that DC control wiring and AC control wiring are separated from each other. Routing them together in the same bundle, wire-way or conduit may induce unwanted noise in the drive control. In the overhead cable tray provided at the front of the drive, ensure that the AC control, DC control and fiber optic cables remain isolated from each other by the available dividers.

Inspect for additional control not shown on the electrical diagram. Determine its purpose, mark the changes on the electrical diagram, and send the prints to the factory for future reference.

Perform a tug test on all control cables to ensure that they are securely fastened, and check each plug and connector to ensure it is properly seated in its socket.

ATTENTION: Ensure that there is sufficient clearance between the installed control wiring to the control cabinet and components carrying medium voltage. Verify that closing the low voltage door does not swing the low voltage cables into the medium voltage cabling section.

Service Data

The Commissioning Guidelines document must include all of the system nameplate data and variable set points as commissioning proceeds.

Why this Information is Needed

When you commission a PowerFlex 7000 'B' Frame medium voltage AC drive, the start-up sometimes occurs in an artificial environment. There's usually no actual process in operation, and no load, at least not a full load. Therefore, the application situation is artificial and this isn't an ideal time to establish parameter baselines to signature the drive. After commissioning is complete, the drive is at full capacity and realistic load conditions occur; parameters such as speed regulation may begin to drift and the drive will not perform as designed to meet processing requirements.

It is important that you complete the service data in a detailed and accurate manner, and that immediately after their completion, you submit the data sheets to both the customer and the factory. This data is necessary for further modifications on the drive line-up once production commences.

It is common to make modifications to the drive's program some time during the two-month period following the drive commissioning. This ensures that speed control, direction, starting and stopping functions are all performing with precision.

In addition to system modifications, the factory will use the data sheet as an indication that the system is running. The date on the commissioning data sheets indicates to the factory the date that the system started up, and will be used to commence the product warranty.

In the unlikely event the system is not operating as designed, it will be possible to trend performance between similar applications and topologies. In the event a product notification or recall is required, the factory uses the datasheets to identify if the customer falls under the definition for an update.

The factory archives data sheets for future reference.

Control Power Off Tests

Perform the following checks before applying control power to the drive. Rockwell Automation recommends that you complete these checks in the sequence they are presented here.

Interlocking

When the input contactor option is purchased a key interlock is provided to prevent access to the medium voltage compartments of the drive unless the input isolation switch is locked in the open position.

Where the input switching device is provided by others, Rockwell Automation will provide a key interlock on the medium voltage compartment of the drive, and a matching interlock for installation by others on the upstream device. The interlock shall be installed in a manner that ensures the power to the drive is off and the drive is electrically isolated whenever the key is freed.

Although Key interlocks shipped with all medium voltage equipment are aligned in the factory, they often move out of position during shipping or are often misaligned when the cabinet is set down on an uneven floor. The following instructions will assist the field engineers in quickly and accurately aligning the deadbolt key interlock with its counterpart.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.

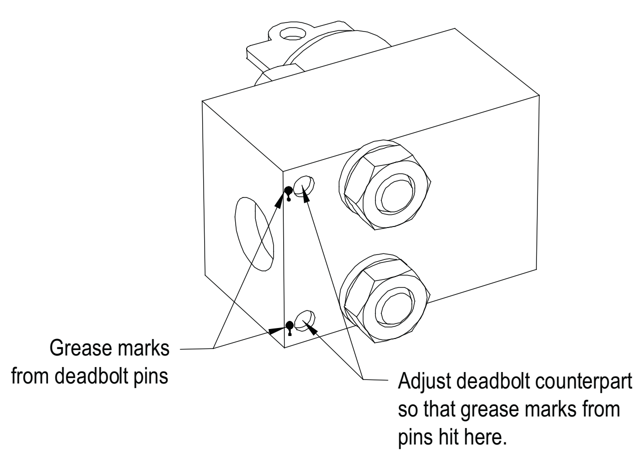


Figure 30 - Deadbolt assembly mounted to door

1. Lock out and isolate the drive from medium voltage. Verify with a hot stick that there is no medium voltage present.
2. Determine that the key interlock is correctly aligned by securely bolting the medium voltage doors of the cabinet closed and removing the key from the lock. The key should turn easily; if any force is required to turn the key, the deadbolt alignment requires adjustment.
3. Open the doors of the cabinet and inspect the key assembly. Place high visibility grease on the pins of the deadbolt counterpart. The factory recommends using yellow torque sealant, however if it is unavailable almost any grease will do. (See Figure 31)

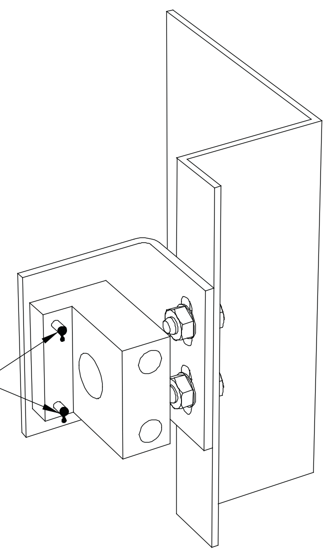


Figure 31 - Deadbolt counterpart mounted to cabinet

4. Bolt the cabinet door closed so the pins on the dead bolt counterpart make contact with the deadbolt assembly. Doing so should leave two marks of torque sealant or grease on the assembly where the pins made contact (see Figure 30 on page 54).
5. Slightly loosen the adjustment bolts on the counterpart and make the necessary movements on the counterpart to ensure that the pins align with the landing plates on the deadbolt assembly. As the amount of counterpart movement required is an estimate, it may take a couple attempts to properly align the assembly.
6. Clean the torque seal/grease from the key interlock once finished aligning the counterpart.

Once properly aligned, the key should turn freely when the cabinet door is fully bolted shut. If the key does not function when the door is tightly bolted closed, adjustments will have to be made to the depth of the counterpart. This can be done by adding shims on the landing plate where the counterpart is mounted.

Resistance Checks

Prior to applying control power to the drive, power semiconductor and snubber circuit resistance measurements must be taken. Doing so will ensure that no damage has occurred to the converter section during shipment. The instructions provided below detail how to test the following components:

- Inverter or AFE Rectifier Bridge
  - Anode-to-Cathode Resistance Test (Sharing Resistor and SGCT)
  - Snubber Resistance Test (Snubber Resistor)
  - Snubber Capacitance Test (Snubber Capacitor)
- SCR Rectifier Bridge
  - Anode-to-Cathode Resistance Test (Sharing Resistor and SCR)
  - Gate-to-Cathode Resistance Test (SCR)
  - Snubber Resistance Test (Snubber Resistor)
  - Snubber Capacitance Test (Snubber Capacitor)

ATTENTION: Before attempting any work, verify that the system has been locked out and tested to have no potential.

SGCT Testing

The following steps outline how to verify SGCT semiconductors and all associated snubber components. A quick reference to the expected resistance and capacitance values as well as a simple schematic diagram is located in the table below. A simple schematic diagram in Figure 32 on page 57 shows how the snubber components are connected across a SGCT.

SGCT Rating	Sharing Resistor[1]	Snubber Resistor	Snubber Capacitor
1500 Amp	80Ω	6Ω (AFE Rectifier)	0.2µf
1500 Amp	80Ω	7.5Ω (Inverter)	0.2µf
800 Amp	80Ω	10Ω	0.1µf
400 Amp	80Ω	15Ω (AFE Rectifier)	0.1µf
400 Amp	80Ω	17.5Ω (Inverter)	0.1µf

[1]— 2300V drives will not have a sharing resistor on devices.

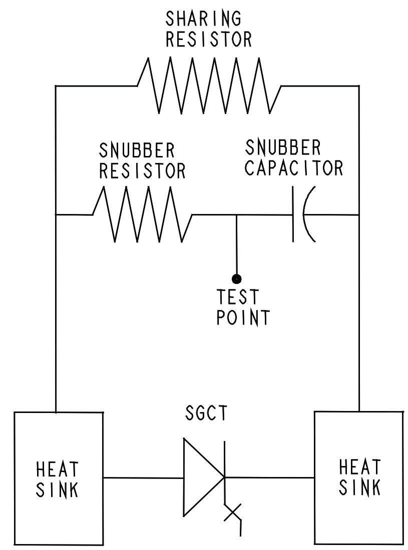


Figure 32 - SGCT Snubber Circuit Connections

If a device or snubber component is damaged, replace it following the detailed procedures in the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section.

SGCT Anode-to-Cathode Resistance

Performing an Anode-to-Cathode resistance test not only tests the integrity of the SGCT but also the integrity of the sharing resistor. An abnormal device resistance measurement will indicate either a shorted device or damaged sharing resistor.

Using an ohmmeter, measure the anode-to-cathode resistance of each SGCT in the inverter bridge, looking for similar resistance values across each device. Easy access from the anode-to-cathode is available by going from heatsink-to-heatsink as shown in Figure 33:

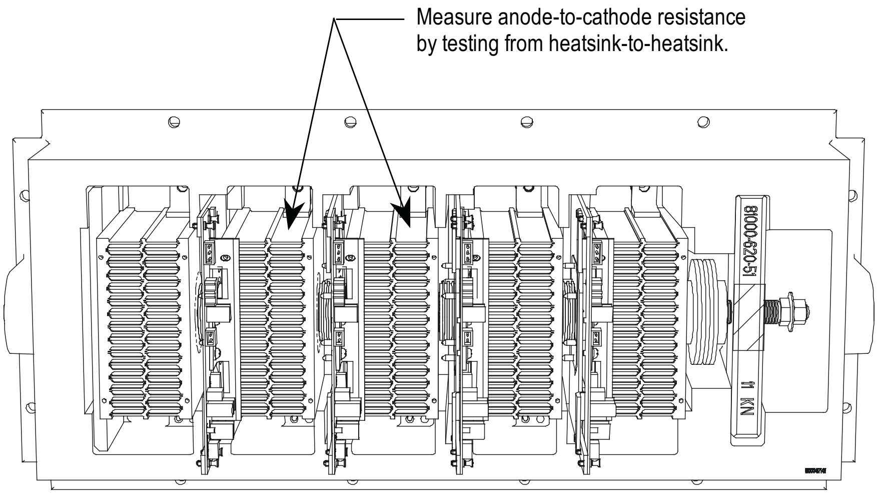


Figure 33 - Anode-to-Cathode resistance test points

An SGCT when not gated on is an open circuit. A healthy device resistance value should be close to the value of the sharing resistor, however due to parallel resistances in the firing card, the resistance value will be slightly lower.

Example: The resistance across the anode-to-cathode of a 800 amp device may be 57 kΩ even though the sharing resistor is 80 kΩ.

You can detect SGCT failures by measuring a lower than normal resistance value; one device in the converter may read 15 kΩ whereas the rest of the devices in the converter measure close to 60 kΩ. This indicates a partially shorted device. A fully shorted device will read closer to 0 Ω and is easily identified. If the SGCT is out of tolerance, refer to the PowerFlex 7000 ‘B’ Frame User Manual’s “Component Definition and Maintenance” section for detailed instructions on how to replace the SGCT assembly.

Damage to a sharing resistor is detectable if the SGCT is replaced and the anode-to-cathode resistance remains abnormal. If the resistor is found to be out of tolerance, refer to the PowerFlex 7000 ‘B’ Frame User Manual’s “Component Definition and Maintenance” section for detailed instructions on how to replace the snubber/sharing resistor assembly.

Snubber Resistance (SGCT Device)

Access to the snubber resistor is not required to test the resistance.   The snubber circuit test point is located within the PowerCage under the heatsinks. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the heatsink above.

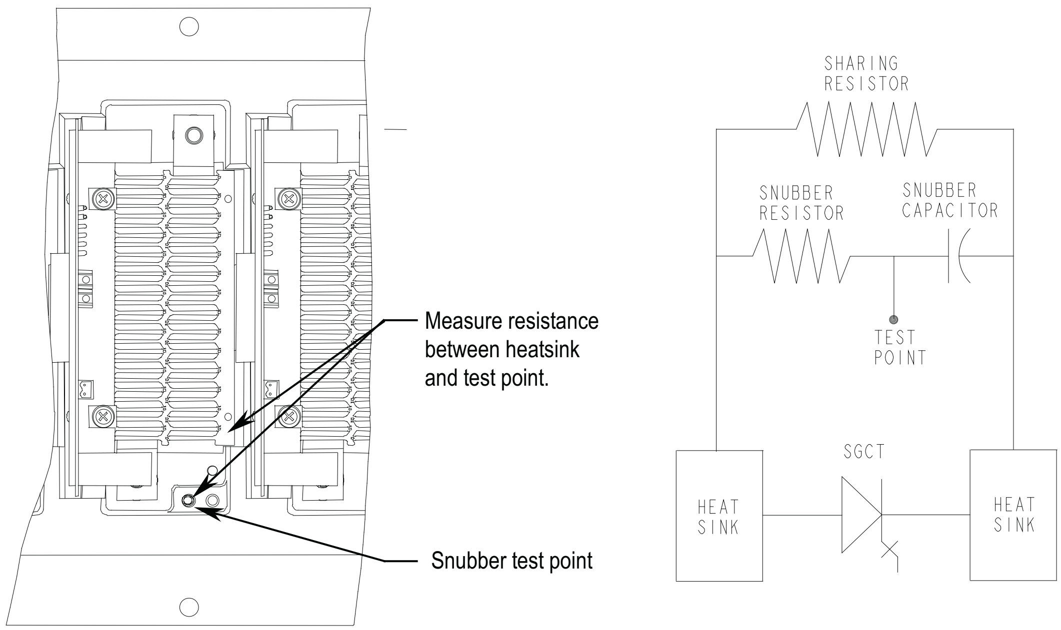


Figure 34 - Snubber resistor test

If the resistor is found to be out of tolerance, refer to tthe PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for detailed instructions on replacing the snubber resistor assembly.

Snubber Capacitance (SGCT Device)

Turn the multimeter from the resistance to capacitance measurement mode. Proceed to verify the snubber capacitor by measuring from the test point to the heatsink adjacent to the right.

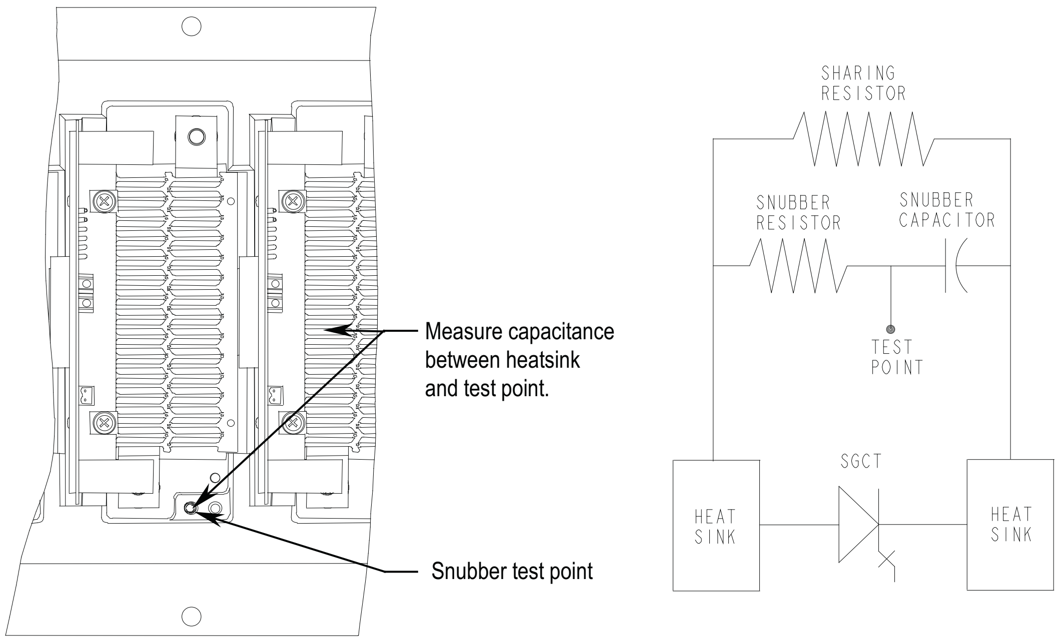


Figure 35 - Subber capacitor test

The capacitance measured is actually affected by the snubber capacitor and other capacitance in the circuit, including capacitance from the gate driver circuit. You are actually looking for a consistent reading for all devices.

If the capacitor is found to be out of tolerance, refer to the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for detailed instructions on how to replace the snubber capacitor.

SCR Testing

The following steps outline how to verify SCR semiconductors and all associated snubber components. For quick reference to the expected resistance and capacitance values, refer to the following table. Figure 36 shows the snubber component connections across an SGCT.

SCR Rating	Sharing Resistance	Snubber Resistance	Snubber Capacitance
350, 400, 815 Amp	80Ω	60Ω	0.5 µf

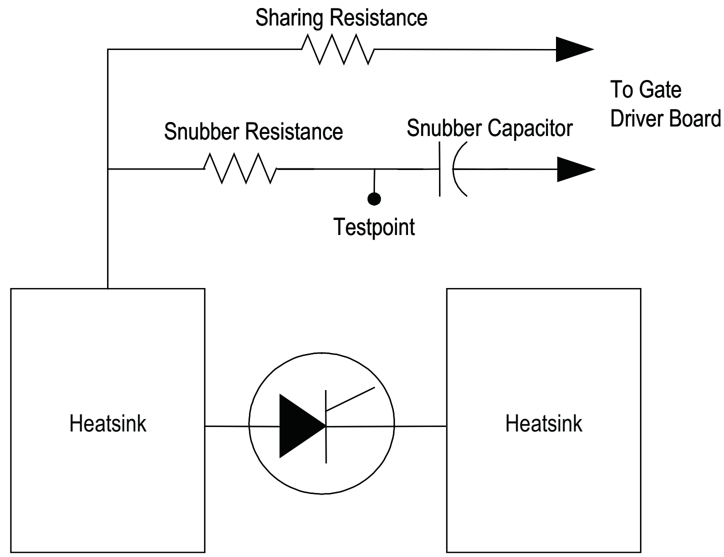


Figure 36 - SCR snubber circuit connections

If you find a damaged device or snubber component, follow the detailed replacement procedure located in the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section.

SCR Anode-to-Cathode Resistance

Performing an Anode-to-Cathode resistance test verifies the integrity of the SCR. Unlike the SGCT, the SCR uses the snubber circuit to power the self-powered gate driver boards. The resistance measurement taken across each SCR should be constant; an inconsistent value may indicate a damaged sharing resistor, self-powered gate driver board or SCR.

Using an ohmmeter, measure the anode-to-cathode resistance across each SCR in the rectifier bridge, while looking for similar resistance values across each device.

Easy access from the anode-to-cathode is available by going from heatsink-to-heatsink as shown in the diagram below:

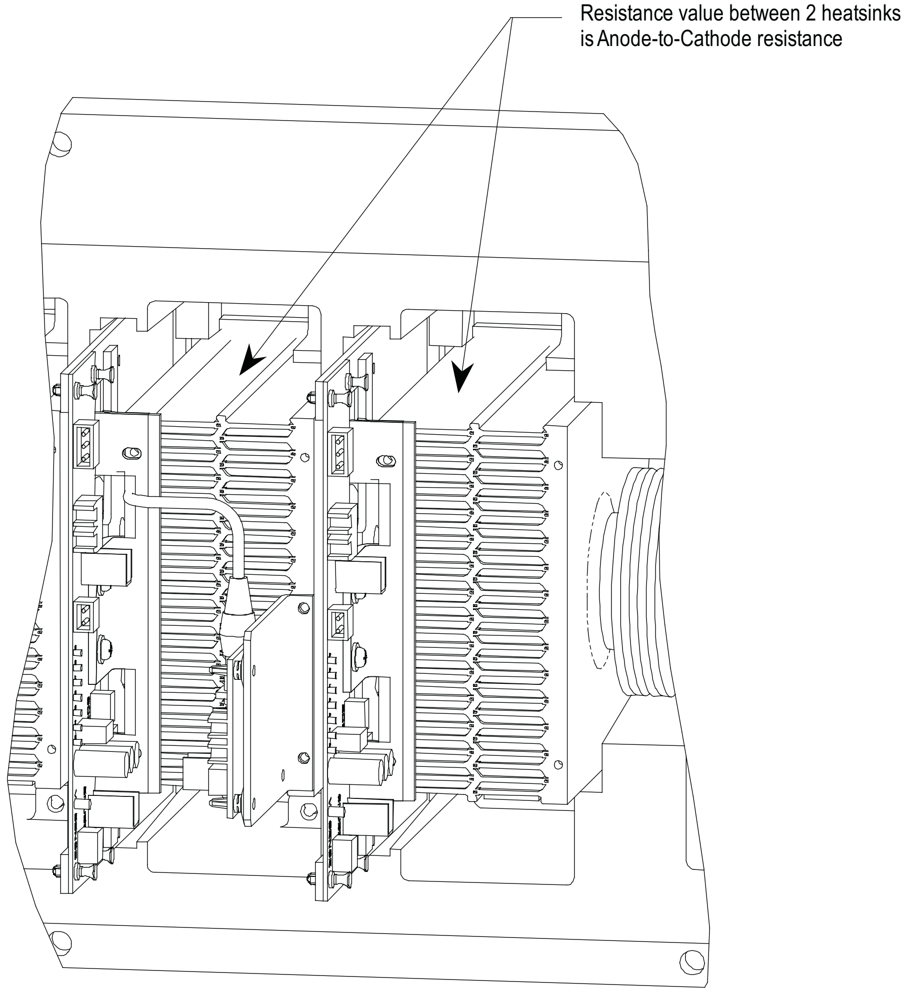


Figure 37 - Anode-to-cathode test

A good SCR and circuit should read between 22 and 24 kΩ.

An SCR that has failed from anode-to-cathode will commonly produce a resistance value of 0 for a shorted device or ∞Ω for an opened device. Unlike the SGCT, it is highly irregular for an SCR to have a partially shorted device. If an SCR is found to be out of tolerance, refer to the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for detailed instructions on how to replace the SCR assembly.

SCR Sharing Resistance Test

To test the sharing resistor of an SCR module, disconnect the 2-pole plug of the self-powered gate driver board labeled SHARING and SNUBBER on the circuit board. The red wire of the plug is the sharing resistor. Measure the resistance between the red wire of the plug and the heatsink to the left. A value of 80 k-ohms indicates a healthy sharing resistor.

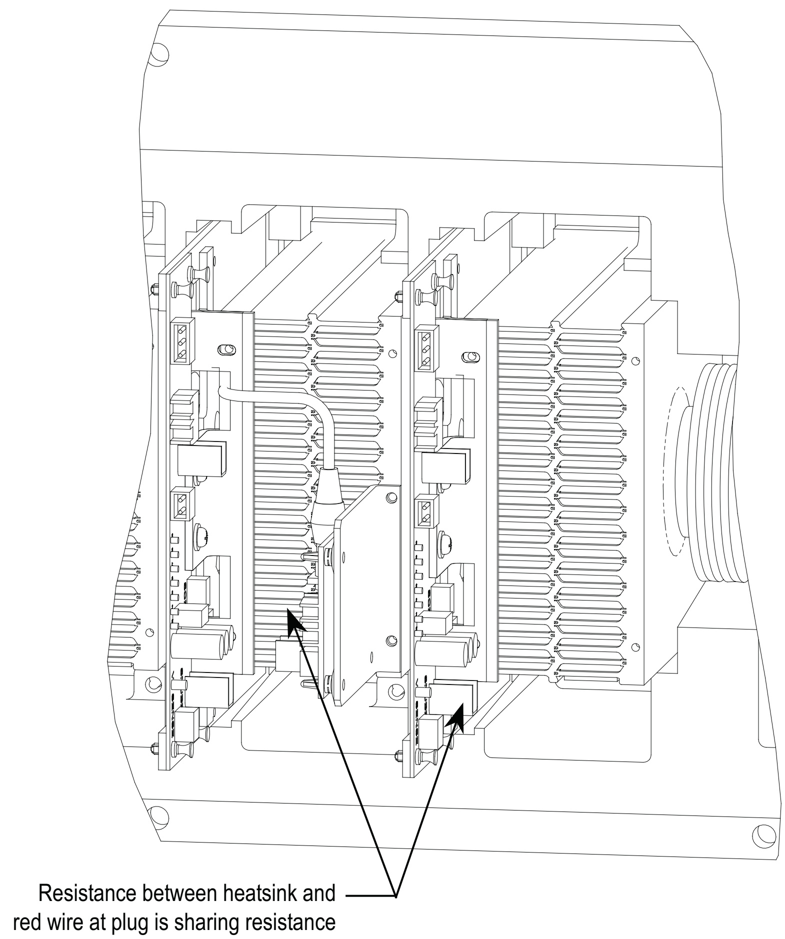


Figure 38 - SCR sharing resistance test

Gate-to-Cathode Resistance

One test that can be performed on SCRs that cannot be performed on SGCTs is a Gate-to-Cathode Resistance Test. Performing a Gate-to- Cathode resistance measurement will identify damage to an SCR by revealing either an open or shorted gate to cathode connection. To test an SCR from gate-to-cathode, disconnect the SCR gate leads from the self powered gate driver board and measure the gate-to-cathode resistance on the SCR firing card Phoenix connector as shown below:

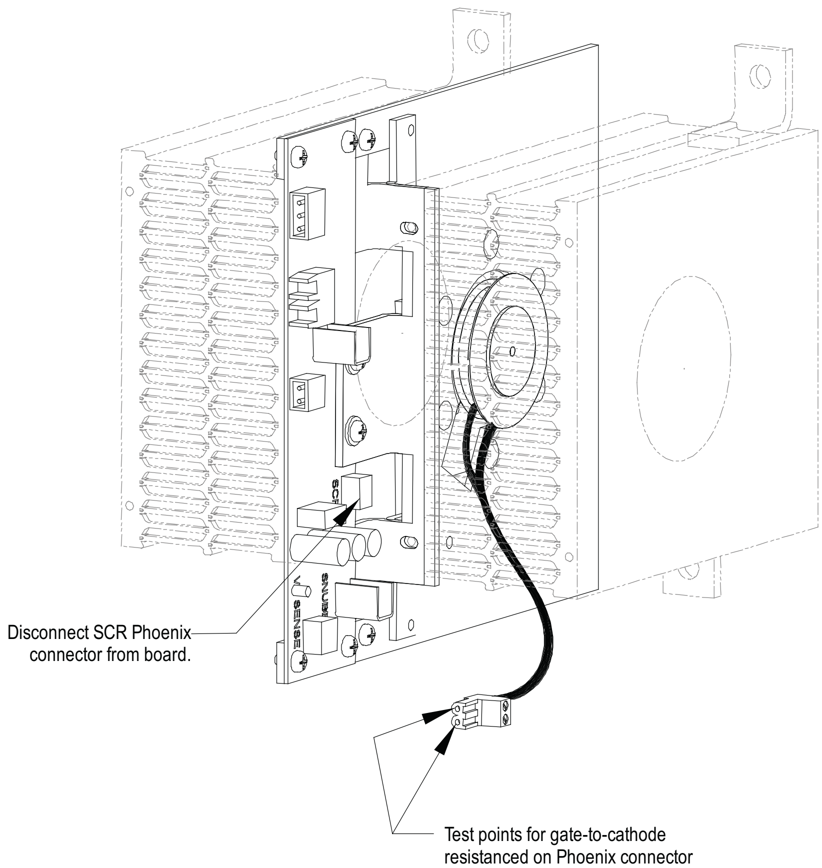


Figure 39 - SCR gate-to-cathode test

The resistance value from gate-to-cathode should be between 10 Ω to 20 Ω. A value close to 0 Ω indicates that there is an internal short in the SCR. An extremely high value indicates that the gate connection in the device has broken.

If a Gate-to-Cathode test reveals a damaged SCR, a detailed replacement procedure is located the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section.

Snubber Resistance (SCR Device)

Access to the snubber resistor is not required to test the resistance. The snubber circuit test point is located within the PowerCage under the heatsinks. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the heatsink above.

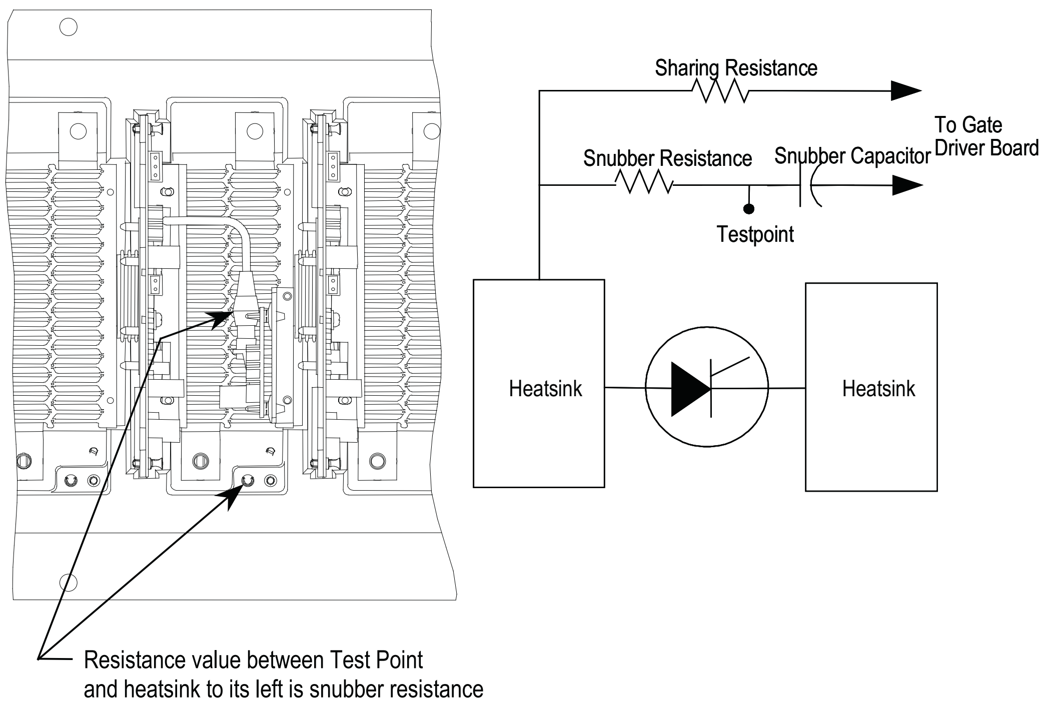


Figure 40 - Snubber resistance test

If the resistor is found to be out of tolerance, refer to the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for detailed instructions on how to replace the snubber resistor assembly.

Snubber Capacitance (SCR Device)

Turn the multimeter from the resistance to capacitance measurement mode. Proceed to verify the snubber capacitor by measuring from the test point and the white wire at the 2-pole device snubber plug (labeled snubber).

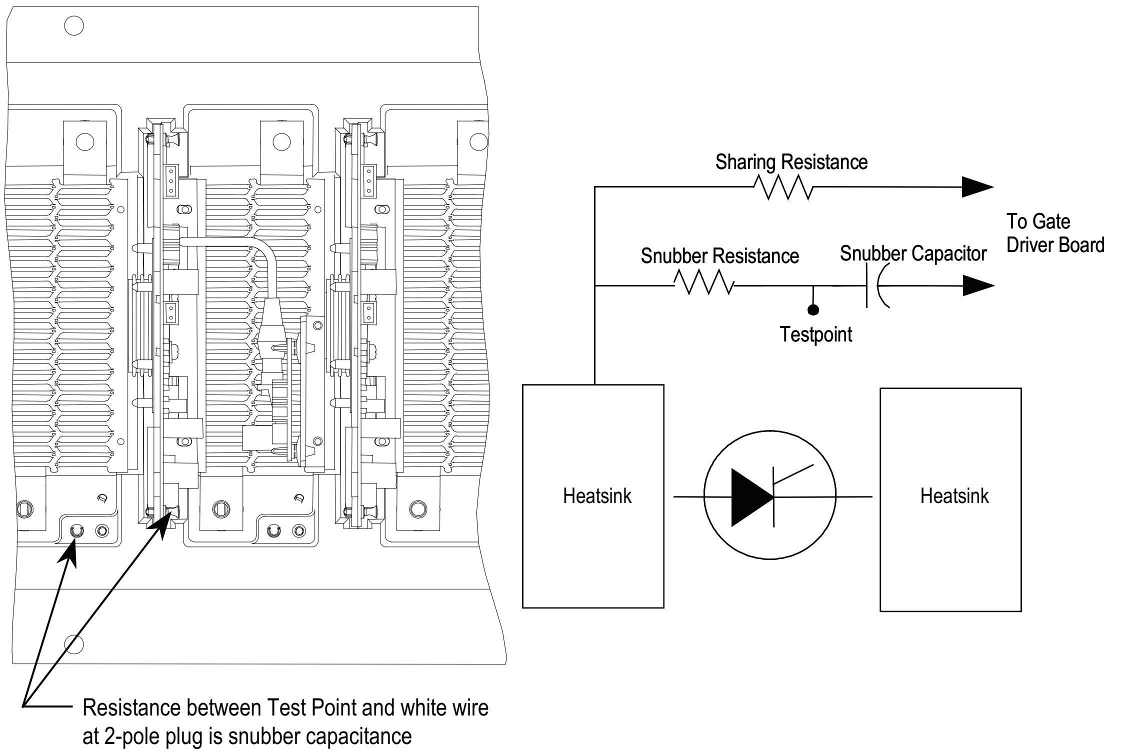


Figure 41 - Snubber capacitance test

To test the snubber capacitance, disconnect the plug of the self-powered gate driver board labeled SHARING and SNUBBER. The resistance between the white wire of the plug and the Test Point to its left is the snubber capacitance.

If the capacitor is found to be out of tolerance, refer to the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for detailed instructions on how to replace the snubber capacitor.

Control Power Tests

Although there are a variety of options available to customers that will effect the control power distribution within the drive, the input will always be as illustrated below:

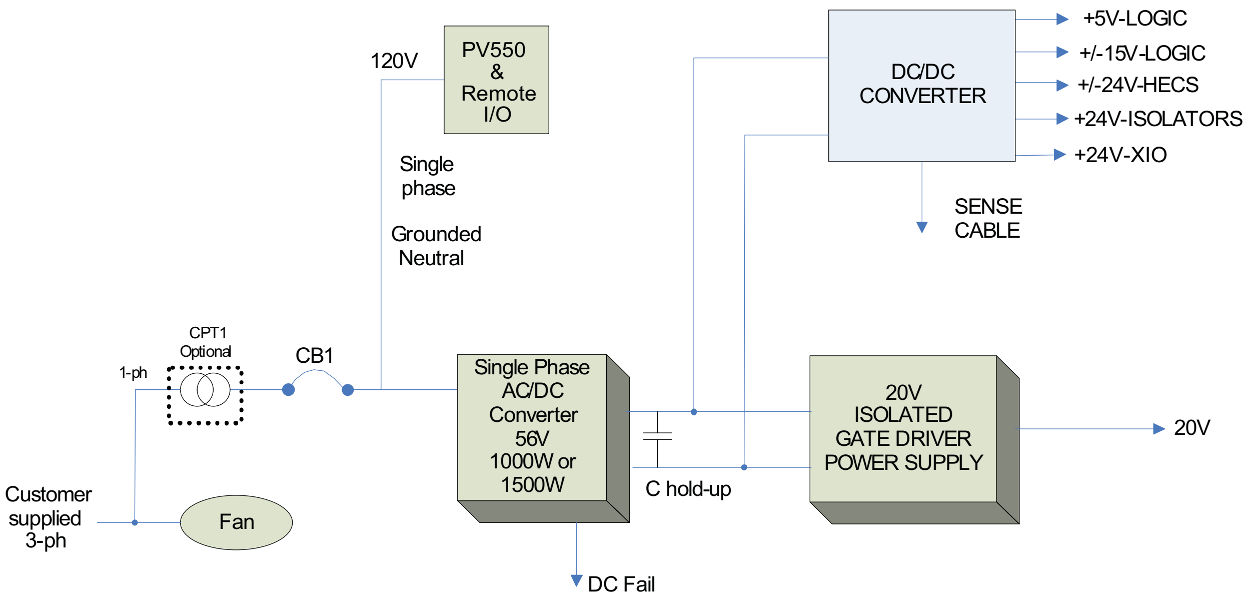


Figure 42 - Control power distribution

IMPORTANT	Prior to energizing the drive, verify that the control power feeding into the input breakers is rated as designated on the electrical diagram.

Three-Phase Input

In the 3-phase input configuration, the customer supplies 3-phase control power into the disconnect switch (Labeled DS1 on the Electrical Schematics). From that point, the power is distributed to the 3-phase fan and to the power supplies through a single phase CPT. The output of the single phase CPT powers all the power supplies and controls within the drive. The 3-phase control should be measured at the input to DS1. If the rating matches the designation on the electrical schematic, it is acceptable to apply control power to the drive. Take necessary measures to rectify the control power level in the event that it does not meet the design specifications.

Three-Phase Input / Single Phase Input

This configuration has one source of control power:

- Three-phase control power for fan operation which is also converted to single-phase control power to operate the Interface, power supplies, I/O and additional auxiliaries.

Similar to the three-phase configuration, the input power for the fan and control must be verified at the primary of DS1.

If the ratings match the designation on the electrical schematic, it is acceptable to apply control power to the drive by closing CB1 and DS1. Take necessary measures to rectify the control power levels in the event that they do not meet the design specifications.

Power Supply Tests

The variety of components installed within the PowerFlex 7000 'B' Frame requires a versatile control distribution design. As a result there are many power supplies incorporated within the drive design. The following section describes how to verify that all power supplies installed within the drive are functioning as designed.

Circuit Board Healthy Lights

Once all sources of control power have been verified and proven to be within specified levels, close the low voltage input breaker (CB1) and Disconnect Switch (DIS); doing so will apply control power to the drive.

Observe the healthy lights on all drive control boards to ensure that the unit has passed all power-up self-tests. The following table identifies the LEDs that should be illuminated, assuming the drive passes all self-tests and is in a ready state:

Component	LED Activities
AC/DC Converter Power Supply	No Healthy LEDs Provided
DC/DC Converter Power Supply	No Healthy LEDs provided
SGCT Power Supplies[1]	1 Green LED per section of Power Supply (No Label)
SGCT Integrated Firing Card	LED 4 (Green) LED 3 (Green) LED 1 (Red)
Analog Control Board (ACB)	2 Green LEDs – Healthy
DPM	LED 6 (Green) LED 9 (Green) LED 7 (Green) LED 11 (Green)

Component	LED Activities
External I/O	Various YELLOW Surface Mounted LEDs based on I/O status
Remote I/O Adapter	LED configuration will change based on adapter. Refer to the adapter user's manual to identify the state the adapter is in.
Operator Interface Terminal	Displays Boot Sequence. Communications Error will occur in a fault situation. A small flashing indicator in bottom right corner indicates good communication.

[1]—Number of supplies varies based on drive configuration.

Failure of LED to illuminate indicates a problem with the power-up self-test. Refer to Publication 7000-TD002_-EN-P for information on troubleshooting.

Control Power Transformer (CPT) ("B" Frame only)

A control power transformer is supplied only in certain drive configurations. If there is no control transformer supplied in the drive being commissioned, please disregard the following information on setting the control voltage output level.

Measure the control voltage level at the secondary of the control power transformer located in the DC link low voltage cabinet of the drive. Ensure that the output of the transformer matches the specification on the electrical schematics.

You can adjust the value of the output by changing the taps on the control transformer. Disconnect the power at the disconnect switch prior to attempting to change the control transformer tap setting.

AC/DC Converter (PS1)

Every PowerFlex 7000 "A" or "B" Frame drive has at least one AC/DC power supply. As the number of devices increases, or to provide a redundant power supply, the number of installed AC/DC power supplies may increase. The electrical schematics provided by Rockwell Automation identify thenumber of AC/DC power supplies in the drive being commissioned.

Ensure the output of the AC/DC power supply is 56V DC. To make adjustments, refer to the PowerFlex 7000 'B' Frame User Manual's "Component

Definition and Maintenance" section.

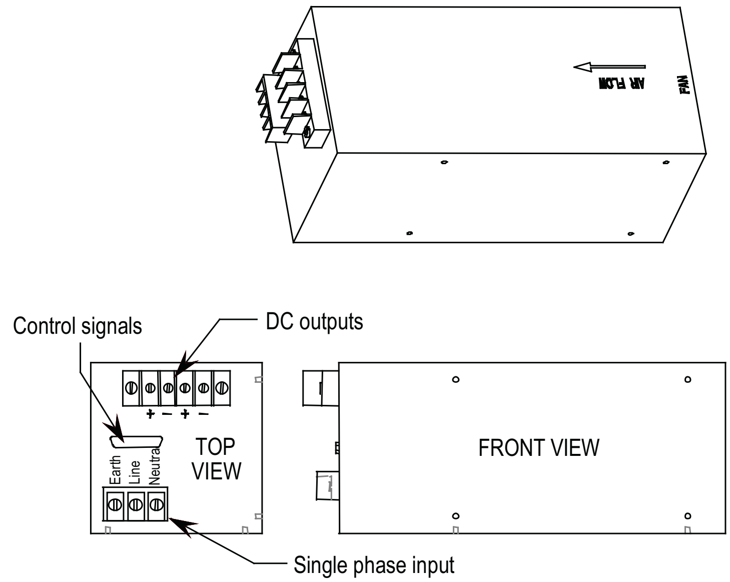


Figure 43 - Location of AC/DC power supply on low voltage panel

DC/DC Converter (PS2)

The DC/DC converter has no provision for output power adjustments. A green LED on front case of the power supply indicates that the power supply is functioning properly. Using a Digital Multimeter, measure each of the outputs of the DC/DC converter to ensure that they meet the values specified on the electrical schematics. Compare these measured values to those displayed on the Operator Terminal under the Metering group.

Record all plug values on the relevant Commissioning Guide data sheet.

If any values are out of the expected range, a bad DC/DC converter is suspect. For additional information on how to troubleshoot the DC/DC converter, refer to the troubleshooting section, Chapter 3 of the Technical Data manual, publication 7000-TD002_-EN-P.

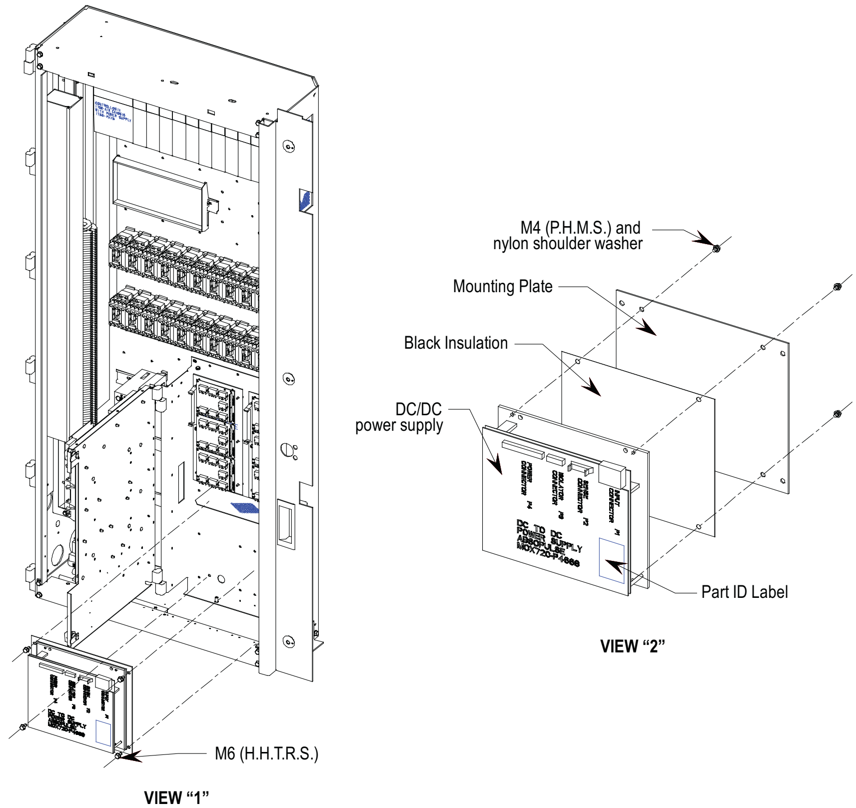


Figure 44 - DC/DC converter (PS2)

SGCT Power Supplies (IGDPS)

Note: Refer to Figure 45 below for location of IGDPS.

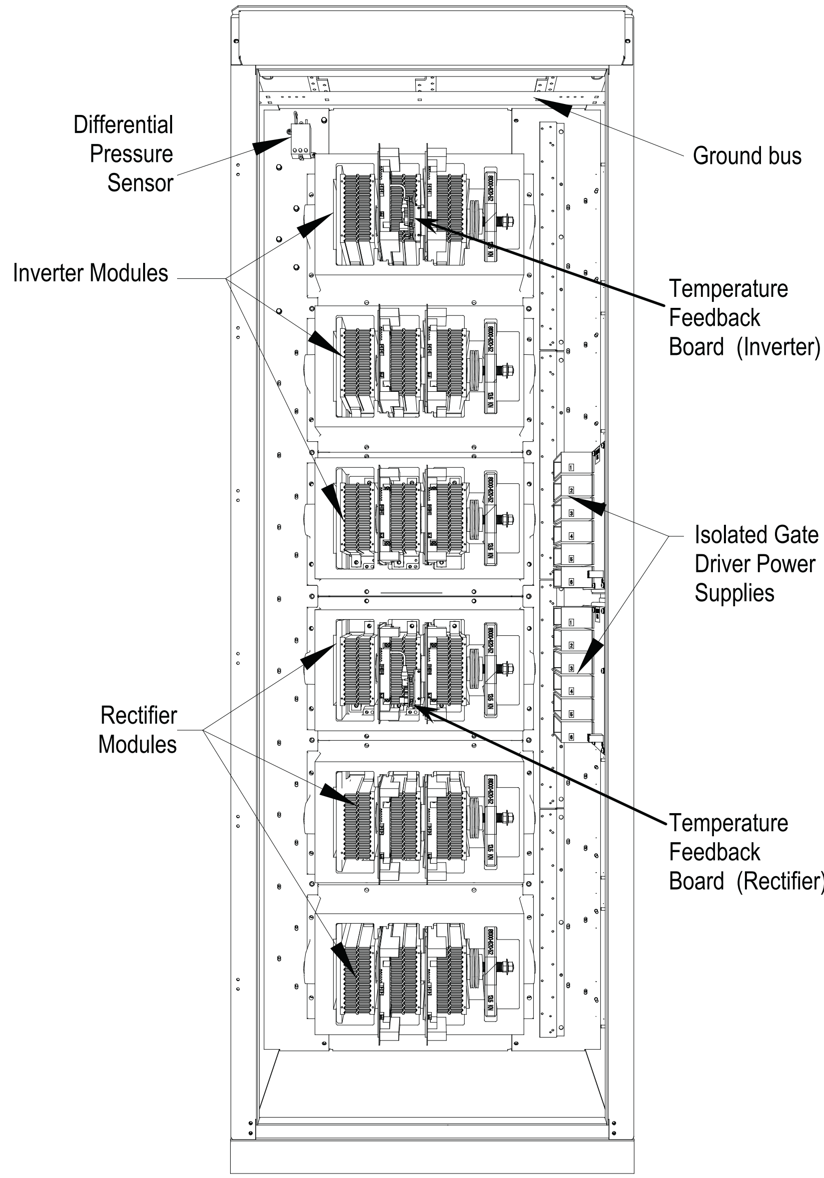


Figure 45 - Converter Cabinet Components (2400V)

Note: For variations in drive cabinetry (such as the heat pipe B Frame or Marine liquid-cooled drives) please refer to the appropriate Installation Manual for that drive.)

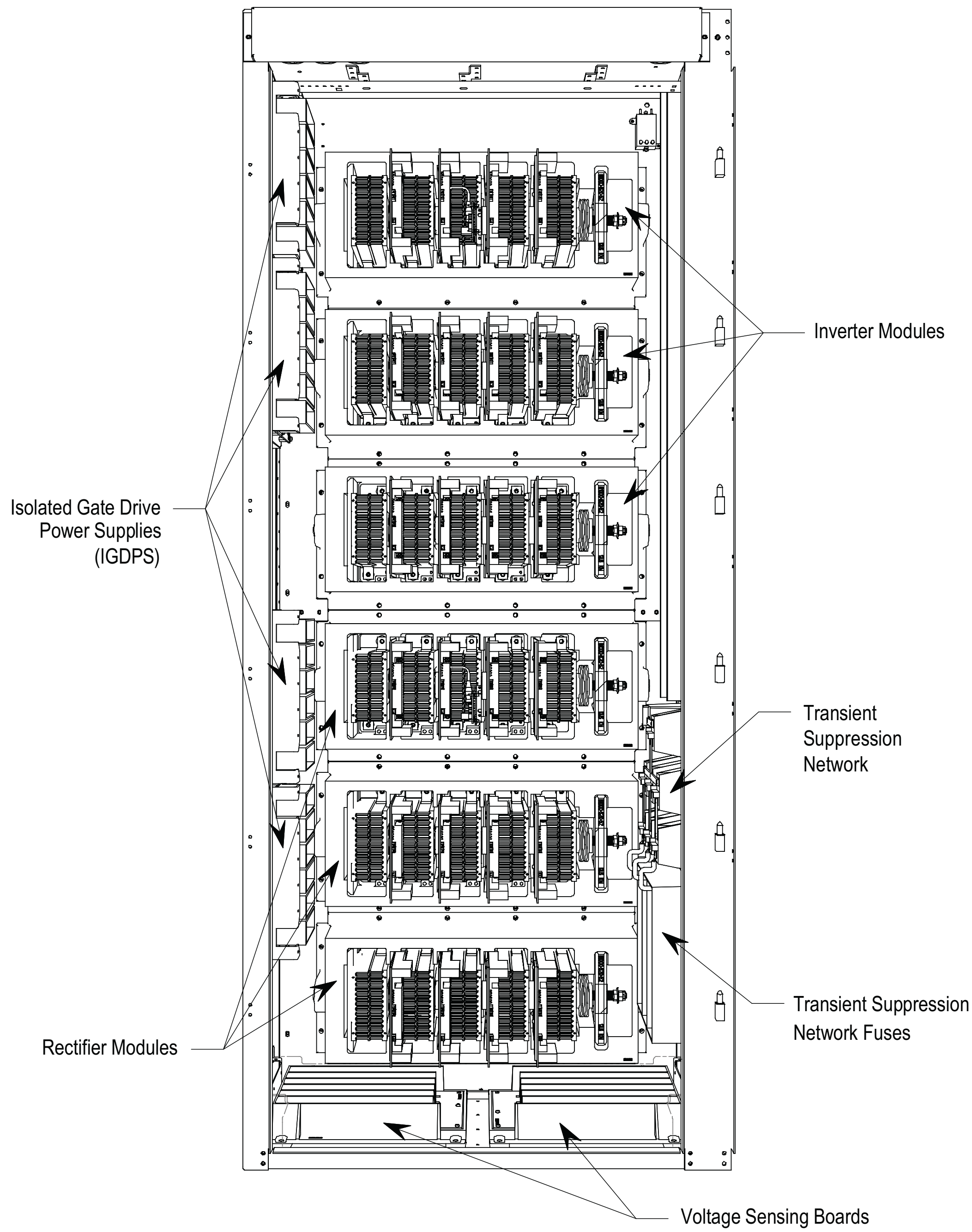


Figure 46 - Converter Cabinet Components (3300V-4160V)

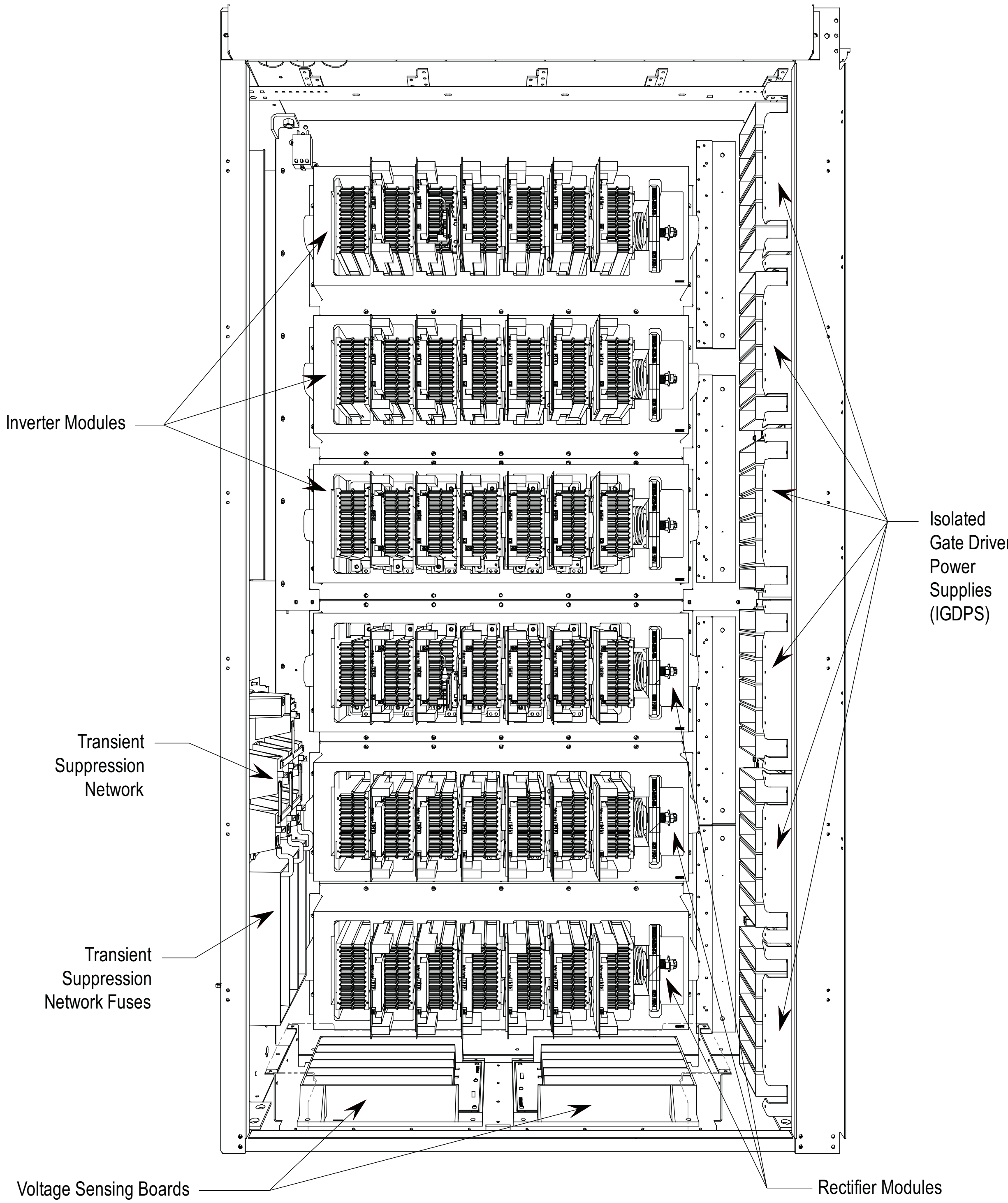


Figure 47 - Converter Cabinet Components (6600V)

The circuitry for the IGDPS is encapsulated in epoxy. As a result the module cannot be field-repaired and there are no test points or adjustments available on this board. If one of the six isolated 20 V output fails, you must replace the entire board.

IGDPS Board LEDs

There is one green LED on each of the 6 output channels of IGDPS. If the IGDPS is healthy, then all six LEDs are active. If any of the LEDs in not ON then the IGDPS might be defective; replace it immediately.

Record the output measurements in the relvant Commissioning Guide data sheet to ensure all 6 outputs in each IGDPS are functioning. The output voltage should be within 20V + 2%. There may be more than one IGDPS in the drive.

If a channel fails, refer to the troubleshooting section of the manual for a replacement procedure.

Gating Tests

After testing the drive converters without Medium Voltage and verifying the power supply output values, test the SCRs and SGCTs under low voltage control power.

The following procedures describe the next level of device testing:

- Gating Test Mode
- SCR Firing Test
- SGCT Firing Test

If the results of the tests are not as described in the section below, refer to the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for troubleshooting in the converter section of the drive.

Gating Test Mode

The following procedure explains how to enter gating test mode, and simulate drive operation by applying gate signals to the SCRs and SGCTs while isolated from medium voltage. Prior to starting the drive for the first time, perform a gating test to ensure that each device is functional.

Some drive status I/O are active while performing tests in gating test mode. If monitoring the drive I/O monitored remotely, notify process control in advance to avoid confusion.

ATTENTION: Isolate the drive from medium voltage prior to starting this test.

1. From the operator interface screen, press [F10], then ▼ to scroll to ADVANCED and press [Enter]. Press [F10] to exit this screen.
2. Press SETUP [F8], then [Enter]. The PARAMETERS screen defaults to Feature Select, the first group listed.
3. Press [Enter] then ▼ to scroll to Operating Mode.
4. Press [Enter] then ▼ to scroll to Gating Test. Press [Enter] to enter gating test mode.

ATTENTION: Ensure that the drive is no longer running in test mode prior to applying medium voltage to the drive line-up. Failure to do so may result in equipment damage.

SCR Firing Test

In normal operation, the SCR firing cards derive their power from a voltage divider network that steps down the medium voltage to 20 V DC maximum. As it is necessary to perform this test while isolated from medium voltage, you need a secondary power source for firing cards.

Each drive has a power cable that supplies 15 V DC from an AC/DC power supply to the firing cards (SPGDB). This cable has one input you can connect to an AC source (120/240V, 50/60 Hz) and 18 sets of outputs you can connect to the SCR self-powered gate driver boards.

Use the following procedure:

Plug the AC power connector on the test cable into an appropriate AC source. The other eighteen 3-pin connectors plug into the SCR SPGDB board terminals labeled TB3 – Test Power (see Figure 48). The number of eighteen 3-pin connectors used depends on the voltage and configuration of the drive rectifier section.

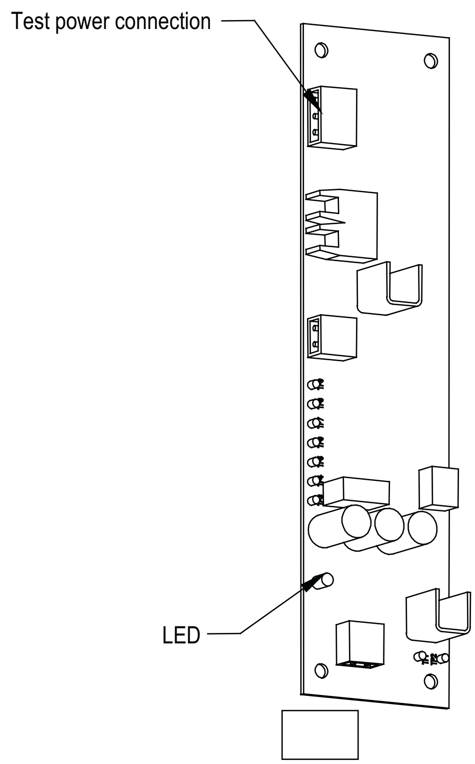


Figure 48 - Self-Powered Gate Driver Board Test Power Terminal

Put the drive in Gating Test Mode and the rectifier automatically enters Test Pattern gating mode. LED 1 – Gate Pulse (Yellow) should light up and pulsate at the same device firing frequency. The other LEDs light up as the firmware sends a gating signal to every SCR.

There is also a Gating Test that fires the individual devices one at a time, in what is described as a Z-pattern. For each section, the Top Left device turns on for 2 seconds, then turns off. The next device to the right turns on for 2 seconds, and the pattern continues.

At the end of the first stack of devices, the right device in the middle stack down fires, and the pattern continues right to left until reaching the end of the middle stack. Then the left device in the bottom stack fires and the pattern continues to the last device, when it returns to the top. This tests for correct fiber optic cables connected to the corresponding devices.

During commissioning, it is not necessary to use an oscilloscope for SCR firing tests, although it is required if SCR firing problems occur.

ATTENTION: Ensure that the test cable is removed from the drive and that it is taken out of Test Mode prior to applying Medium Voltage. Failure to do so may result in personal injury or equipment damage.

SGCT Firing Test

Unlike the SCR Self-powered gate driver board, the SGCT has an integrated firing circuit mounted on the device. This circuit derives power from the SGCT Power Supplies (IGDPS), and you can monitor the lights on the firing circuit without putting the drive into gating test mode. There are 4 LEDs on the firing card, illustrated in the following diagram:

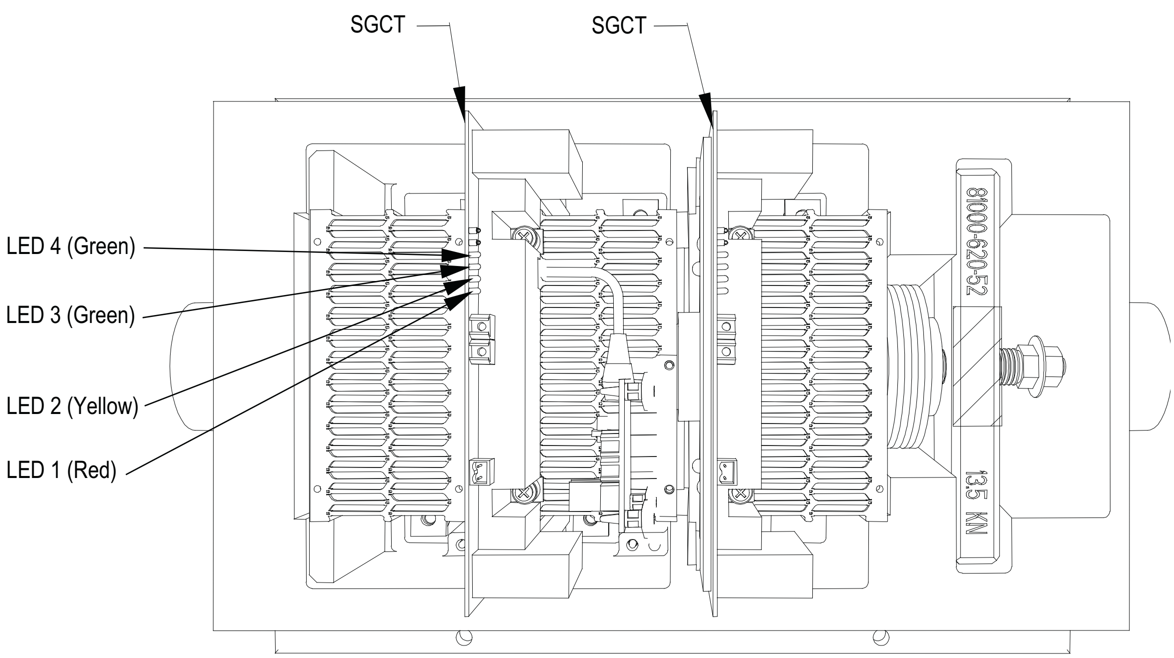


Figure 49 - SGCT healthy LEDs

While the drive is idle without gating, LEDs 4 (Green), 3 (Green), and 1 (RED) should be on while LED 2 (Yellow) is off. If any other combinations of LEDs are illuminated, refer to the the PowerFlex 7000 'B' Frame User Manual's "Component Definition and Maintenance" section for instructions on troubleshooting the SGCT firing cards.

When you put the drive into gating test mode, the inverter automatically enters the test pattern gating mode.

Monitor the SGCT LEDs and ensure that LEDs 4 (Green) and 3 (Green) remain on, while LEDs 1 (Red) and 2 (Yellow) toggle on and off alternately at the converter's operating frequency.

There is also a gating test that fires the individual devices one at a time, in what is described as a Z-pattern. For each section, the top left device turns on for 2 seconds, then turns off. The next device to the right turns on for 2 seconds, and the pattern continues. At the end of the first stack of devices, the right device in the middle stack down fires, and the pattern continues right to left until reaching the end of the middle stack. Then the left device in the bottom stack fires and the pattern continues to the last device, then returns to the top.

This tests for correct fiber optic cables connected to the corresponding devices.

Normal gating test mode fires the inverter at the output frequency corresponding to the active reference (speed) command.

System Test

Prior to applying medium voltage, verify the entire low voltage control circuit to ensure the drive operates as expected. Failure to perform this test may result in damage to the drive or process in the event that the control does not operate as expected. This section of the manual provides instruction for the following five tests:

- System Test Mode
- Start/Stop Contactor Control
- Status Indicators
- Analog I/O
- Configurable Alarms

System Test Mode

This test mode enables the drive to operate the drive's low voltage control circuit without medium voltage present.

Drive status I/O is active while performing tests in this mode. If monitoring the drive I/O remotely, notify process control in advance to avoid confusion.

ATTENTION: Isolate the drive from medium voltage prior to starting this test.

ATTENTION: You must have advanced access permissions on the drive to perform this operation.

From the main screen on the operator interface, press SETUP [F8] to open the Parameters menu, and press [Enter].

The screen highlights the first group, Feature Select. Press [Enter].

The Feature Select screen highlights the first option, Operating Mode. Press [Enter].

On the Operating Mode screen, use t ▼ to scroll down to System Test. Press [Enter], then EXIT to enter System Test mode.

You can check the entire system without medium voltage. As long as you have test power to all your contactors, you can start, stop, E-Stop, trigger faults, check remote IO, check PLC inputs, and verify other functionality.

ATTENTION: Ensure that the drive is no longer running in system test mode prior to applying medium voltage to the drive line-up. Failure to do so may result in equipment damage.

Start/Stop Control Circuit

Once the drive is in System Test mode, ensure that the stop/start circuit functions as desired. If necessary, review the electrical schematic drawings prior to performing this test to better understand the control circuit.

Start the drive in local control while observing the system vacuum contactors or customer supplied circuit breakers. If you must troubleshoot Rockwell Automation medium voltage switchgear, refer to the following publications:

- Publication 1500-UM055_-EN-P, Medium Voltage Controller, Bulletin 1512B, Two-High Cabinet, 400 Amp • User Manual
- Publication 1503-IN050_-EN-P, OEM Starter Frame and Components • Installation Manual
- Publication 1502-UM050_-EN-P, Medium Voltage Contactor, Bulletin 1502, 400 Amp (Series D) • User Manual
- Publication 1502-UM052_-EN-P, Medium Voltage Contactor, Bulletin 1502, 400 Amp (Series E) • User Manual
- Publication 1502-UM051_-EN-P, Medium Voltage Contactor, Bulletin 1502, 800 Amp • User Manual

If the Medium Voltage contactors or circuit breakers perform as desired, stop the drive and perform the same test while operating in remote control.

Start the drive again and verify that all emergency stops installed in the system function as desired. Ensure that all electrical interlocks installed in the system function as desired. Make any necessary control wiring modifications at this time and re-test the system if necessary.

Status Indicators

Drive status is often feedback to a plant's process control either digitally through the PLC input/output feature (refer to the relevant PowerFlex 7000 Installation Guides or user Manuals for PLC programming details) or through relay logic. The following relays are provided with the drive as standard:

Relay Name	Relay Designation
Run Contact	RUN
Fault Contact	FLT
Warning Contact	WRN
Ready Contact	RDY

It is necessary to activate each status indicator used by the customer to ensure that they have connected their control to the drive correctly. This can be achieved by changing the drive status (ready, faulted, warning etc.).

Analog I/O

It is possible to configure all of the drive's analog inputs and outputs without running the motor. The following information describes how to set up the following drive features:

- Analog Inputs
  - Analog Reference Command Input Scaling (Local, Remote)
  - Minimum Setting
  - Maximum Setting
  - Digital Reference Command Input Scaling (Digital)
- Analog Outputs

All of the Analog I/O connections occur on the ACB.

Analog Inputs

- Analog Command Input Scaling
  - Prior to commencing the reference command input scaling it is necessary to ensure that the reference command input selection has been configured as desired. This requires setting Reference Select [P7] to the appropriate input source.

- Set the utilized Reference Command minimum (SpdCmd Pot(L), SpdCmd Anlg Inp(R) and SpdCmd DPI (D) to the desired value. The minimum reference command input setting on a drive without a tachometer is 6 Hz. Without tachometer control, do not set the reference command minimum parameter below 6 Hz. A control with tachometer feedback will allow a minimum speed of 1 Hz. With tachometer control, do not set the reference command minimum parameter below 1 Hz.
- Set the utilized Reference command (L, R and D) Maximum parameters so that with full reference command inputs, the associated Reference command Variables read the desired maximum value.
- The various reference command maximums usually have to be increased above the desired maximum value to compensate for the loading down of their 10 volt input rails by the attached potentiometer or isolator.

Example: SpdCmd Anlg Inp (4-20mA) Reference command Input Scaling

The customer 4-20 mA speed input is coming to the Current Loop Receiver on the ACB, and they want the maximum input to represent 60 Hz.

1. Set Reference Command Remote Maximum (Ref Cmd R Max) for 60 Hz.
2. Set the Reference Select parameter to 'Remote 4-20 mA'.
3. Have the source supply 20 mA to the drive. Verify this with a multimeter connected in series with the current source. Ensure that you are in Remote mode with the selector switch, and look at the parameter Speed Command In, which will represent that 20 mA signal.
4. Ensure that it reads 60 Hz. If it does not, increase the Ref Cmd R Max value until this parameter reads 60 Hz.

Example: SpdCmd DPI (Digital) Reference command Input Scaling

The maximum value for a digital reference command is 32767; the minimum value is 0. Values that are negative or out of bounds will result in the drive slowing down to minimum speed.

Analog Outputs

Review the electrical schematics to understand which meters or signals the user expects out of the analog output ports on the ACB Board.

1. To assign a parameter to an analog output, ensure that you have Advanced access to drive operations. From the main screen, press SETUP [F8], and ▼ to scroll to Analog. Press [Enter].
2. Press ▼ to scroll to the output to assign. Press [Enter] to open the parameters list in the Select Group screen. Use the arrow keys to scroll to the parameter to assign, and press [Enter]. This returns you to the Analog screen. Confirm the new parameter name beside your selected output.

3. Press EXIT [F10] to return to Parameters. Press [Enter] and scroll down the list to Analog Outputs. Press [Enter] to see a similar list of available ports and the assigned parameter number.
4. Scroll down to the scaling factors for the 4 Meter Port and the 3 ACB Port outputs. All parameters are scaled to 0-10V, with 0 representing the minimum value, and 10V representing the maximum value. These Scaling parameters (i.e. Anlg Port2 Scle) can be used to change the scaling. (Refer to the Installation or Technical Data Guides for more information on programming parameters.)

IMPORTANT	There are certain parameters whose minimum value is a negative number. In that case, the minimum value of the parameter (-10V) is scaled to 0V output, and the maximum value is scaled to 10V output.

5. Highlight the appropriate Analog Scale parameter and press [Enter]. Type the new value, press [Enter] then EXIT [F10]. Ensure you save to NVRAM when you are finished.

The analog outputs from the customer interface boards are stated as 0 to 10 volts, but in actual fact their outputs are typically 0.025 to 9.8 or 9.9 V. This is due to the rails being loaded down by an attached speed potentiometer or signal conditioner impedance. Incorporated signal conditioners usually have 0 to 10-volt inputs and 4 to 20 mA outputs. An additional error is incorporated in the signal conditioners, so if they are calibrated for 0 to 10 volts input, there will not be exactly 4 to 20 mA out.

Next, calibrate the external 4 to 20 mA signal conditioners.

1. Set a digital multimeter to mA and place it in line with the signal conditioners. If the output of the conditioner is terminated, use the meter as a load.
2. Assign a parameter to the Analog Output port you are calibrating. This parameter must be configurable from minimum to maximum for test purposes only, for example: IDC Command Test. See previous page on assigning an output.
3. Set IDC Command Test to 0.000 pu. This is the minimum. Adjust the Zero adjustment screw on the isolator to read 4 mA.
4. Set IDC Command Test to 1.500 pu. This is the maximum. Adjust the Span adjustment screw on the isolator to read 20 mA.
5. Repeat the process until you complete the adjustments.
6. Set IDC Command Test to 0.750 pu to ensure you read 12 mA (Half-scale). Set IDC Command Test to 0.000 pu.
7. Assign the required parameter to the Analog Output port we have calibrated.
8. Save all changes to NVRAM.

Configurable Alarms

Ensure that the configurable alarms have been programmed in the drive control. Instructions on where to locate the following External Fault related tasks in the manual are listed below:

- Setting Fault Masks: Installation Guide or User Manual, Operator Interface, Fault Masks.
- Setting External Fault Text: Installation Guide or User Manual, User Definable External Text 3-42
- Setting Fault Classes: this document (Commissioning Guide)

Test the external faults by lifting the wires to all external warning / fault inputs while running in system test mode. These wires terminate at the Digital I/O boards. Opening the circuit at any point will verify the external fault's configuration and functionality. However, it is preferable to actually force the trips from the source. If that is not possible, then lift the wire at the protective device.

ATTENTION: Do not short the lifted wire to ground when testing the circuit or damage will occur to the Digital I/O board and possibly weld the equipment's trip contact.

18-Pulse Phasing Test

Prior to applying medium voltage and running the drive, it is important to verify the phase rotation on the input of all 18-pulse drives. The following tests do not need to be performed on AFE rectifier drives unless they incorporate synchronous transfer:

- Line Terminal Resistance Measurements
- Application of Medium Voltage Power
  - Compare the voltage feedback from all 9 test points in the ACB board to ensure proper phasing.

Failure to perform the recommended tests will result in poor drive performance and may result in drive converter damage.

Line Terminal Resistance Measurements

Measuring the resistance between the drive line cable terminals will quickly identify if there is inter-wiring between the 0º, +20º, and -20º bridges in the isolation transformer.

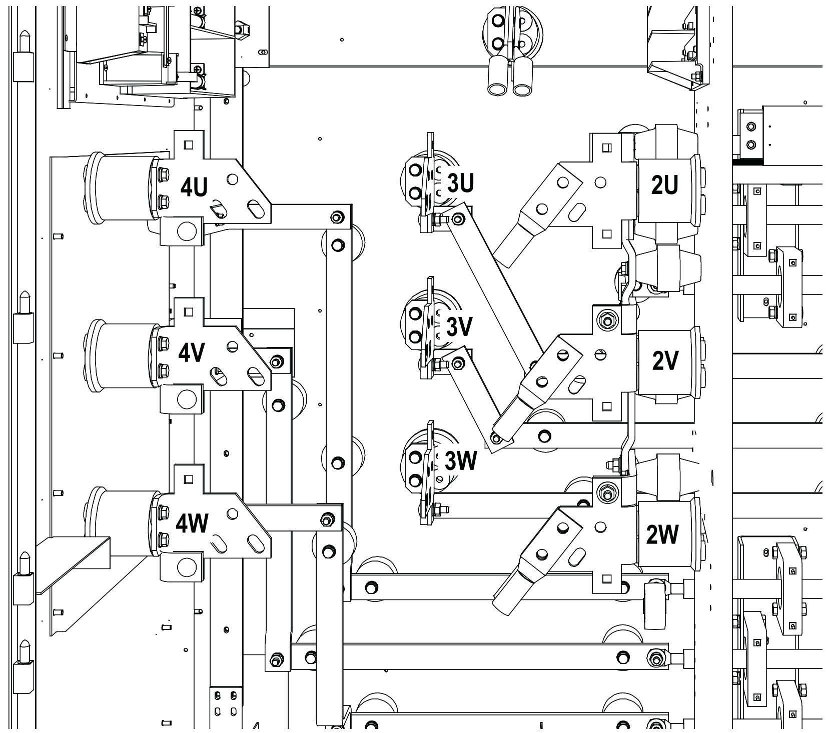


Figure 50 - Line terminal designations

There are low resistances between phases through a transformer winding and a high resistance between transformer windings. Therefore, the expected resistance measurements are listed in the table below:

Terminal Measurement Points	Expected Resistance
2U -> 2V -> 2W	Approximately 0 Ω
3U -> 3V -> 3W	Approximately 0 Ω
4U -> 4V -> 4W	Approximately 0 Ω
#U -> #V -> #W	Approximately ∞ Ω

If the measurement results are not as described above, the inter-wiring between the isolation transformer and drive needs to be re-inspected.

Application of Medium Voltage

Before running the drive on Medium Voltage, configure the diagnostic trending feature to capture information in case of fault during commissioning.

ATTENTION: Remember to reset the trending before leaving the drive in production.

The diagnostic trending operation of the drive allows you to capture the relationships of 8 parameters over a period of time. Trending is a valuable tool for trouble shooting the drive.

The length of the trend buffer is 100 samples.

From the main menu, press the Diagnostics Key (Diags [F9]). This key enters the user into the Diagnostics Menu. The Options within the Diagnostics Menu are listed as follows:

- RE-ARM
- D_SETUP
- VIEW

Re-Arm

The re-arm function clears the memory buffer, which contains the data stored from the previous trend. It is necessary to reset the trending feature in order for a second trigger to occur, unless you have continuous trigger enabled.

Diagnostic Setup

The diagnostic setup is used to define the source of the diagnostic trigger. Information that has to be programmed in the diagnostic setup is listed below:

Rate	The time delay between sample periods. Set any value between 0 and 20,000 msec. Use numeric keypad to enter the value and press [Enter] to accept.
Post	The percentage of the list which will occur after the trigger point. Set any value between 0 and 100%.
Trace	The Read-Only Parameter assigned to a particular list. The item linked to Trace 1 is the trigger value. There are 16 possible traces, although not all have to be active.

Trigger	Defines whether you want a continuous or a single-shot trigger. Pressing this key will place an S or a C in front of the trigger parameter. You will almost always want a Single-Shot (S) trigger. S = Single shot>>the trigger occurs once and stops, trigger must be manually re-armed C = Continuous capture>>auto re-arm enabled to collect new trends until stopped by viewing contents of captured data
Cond	Defines the Condition that will cause the trigger. The possible options are: = (Equal to) N= (Not Equal to) > (Greater than) < (Less than) + (Boolean OR) N+ (Boolean NOR) & (Boolean AND) N& (Boolean NAND)
Data	Defines the trigger value with respect to the Read-Only Parameter in Trace 1.

View

Use the View feature to observe the samples recorded during the last diagnostic trend.

Configuring Trending

The trending setup is best illustrated through an example:

Trend Read-Only Parameters—Trend Data:

16) Line Current pu:	122
15) Alpha Rectifier:	327
14) Idc Fbk Sampled:	329
13) Idc Reference:	321
12) Line Voltage pu:	135
11) Motor Current pu:	555
10) Motor Voltage pu:	554
9) StatFrqVoltModel:	485
8) Flux Feedback:	306
7) Torque Reference:	291
6) Speed Feedback:	289
5) Speed Reference:	278
4) RecControl Flag2:	160

3) RecControl Flag1:	264
2) InvControl Flag1:	265
1) DrvStatus Flag1:	569

The sample rate is to be set at 5 msec. This will default to the fastest sample rate. 10% of the samples should be recorded after the trigger. The single trigger should occur when any fault occurs.

1. Press the Diagnostic Soft Key (DIAGS [F9]).
2. Press the Diagnostic Setup Soft Key (D_SETUP [F8]) to begin programming the diagnostic settings.
3. Cursor the backlit section to Trace 1 and press the enter key to begin programming. Scroll through the parameter list until Diagnostics – DrvStatus Flag1 (569) is located. Select this as Trace 1.
4. Select Trace 2 through 16 as described in the step above. Note that when you finish Trace 4, just press the down arrow and you will get to the screen showing traces 5-8, 9-12, and 13-16.
5. Press the TRIGGER Soft Key until the letter S appears in front of the Trigger parameter.
6. Press the RATE Soft Key to program the trending sampling rate. This will be set to 0 msec in this example.
7. Press the DATA Soft Key to set the trigger level for the fault. This should be set to 8. If trigger needs to be set either on warning or fault, then set to 18.
8. Press the COND Soft Key to program the logic for the trigger level. In this example the COND will be set as an OR condition "+"
9. Press the POST Soft Key to set up how many samples will be recorded after the trigger. In this example the POST value will be set to 20%. The remaining 80% of the samples will be recorded prior to the trigger.

When you finish programming these settings, the drive is ready to trend data at the next fault.

The next test required to test phase rotation requires that medium voltage be applied to the drive input. Ensure that the drive is thoroughly inspected for debris and tools prior to energizing the drive. Furthermore, ensure that all protective barriers have been re-installed before continuing. Ensure that you have taken the drive out of System Test mode, and have returned to Normal operating mode.

Input Phasing Check

There are 9 voltage test points on the ACB board that will allow you to look at each voltage level individually.

These test points are labeled as follows:

Table 1 - ACB Test Points and Associated Voltage Signals

Test Point Description	Isolation Transformer: Secondary Phasing and Bridge		Phase Relationship with respect to V2uv (2U)
V2uv	2u	Master	0°
V2vw	2v	Master	-120°
V2wu	2w	Master	-240°
V3uv	3u	Slave 1	-20°
V3vw	3v	Slave 1	-140°
V3wu	3w	Slave 1	-260°
V4uv	4u	Slave 2	+20°
V4vw	4v	Slave 2	-100°
V4wu	4w	Slave 2	-220°

All of these test points can be measured to either the Analog Ground (AGND) on the board or the TE ground in the low voltage section. You can use V2uv as your reference (trigger on this waveform) and verify all the other test points using the table above. It is easier to use zero crossings on your oscilloscope as the reference points when checking the phase shifts.

Verify the following relationships:

1. V and W in each bridge should be lagging U by 120° and 240°, respectively.
2. 3U, 3V, and 3W should be lagging 2U, 2V, and 2W by 20° (-20°), respectively.

3. 4U, 4V, and 4W should be leading 2U, 2V, and 2W by 20° (+20°), respectively.

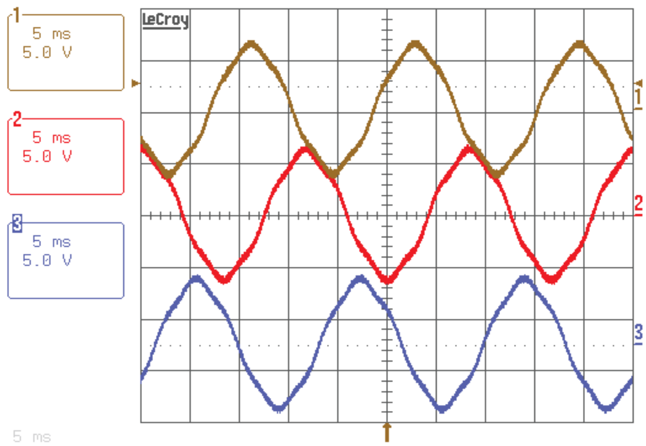


Figure 51 - CH1 is 2Vuv, CH2 is 2Vvw, CH3 is 2Vwu

For 60 Hz systems, 360° = 16.7 ms.

For 50 Hz systems, 360° = 20 ms.

Refer to Figure 52 for a visual representation of the phasing checks.

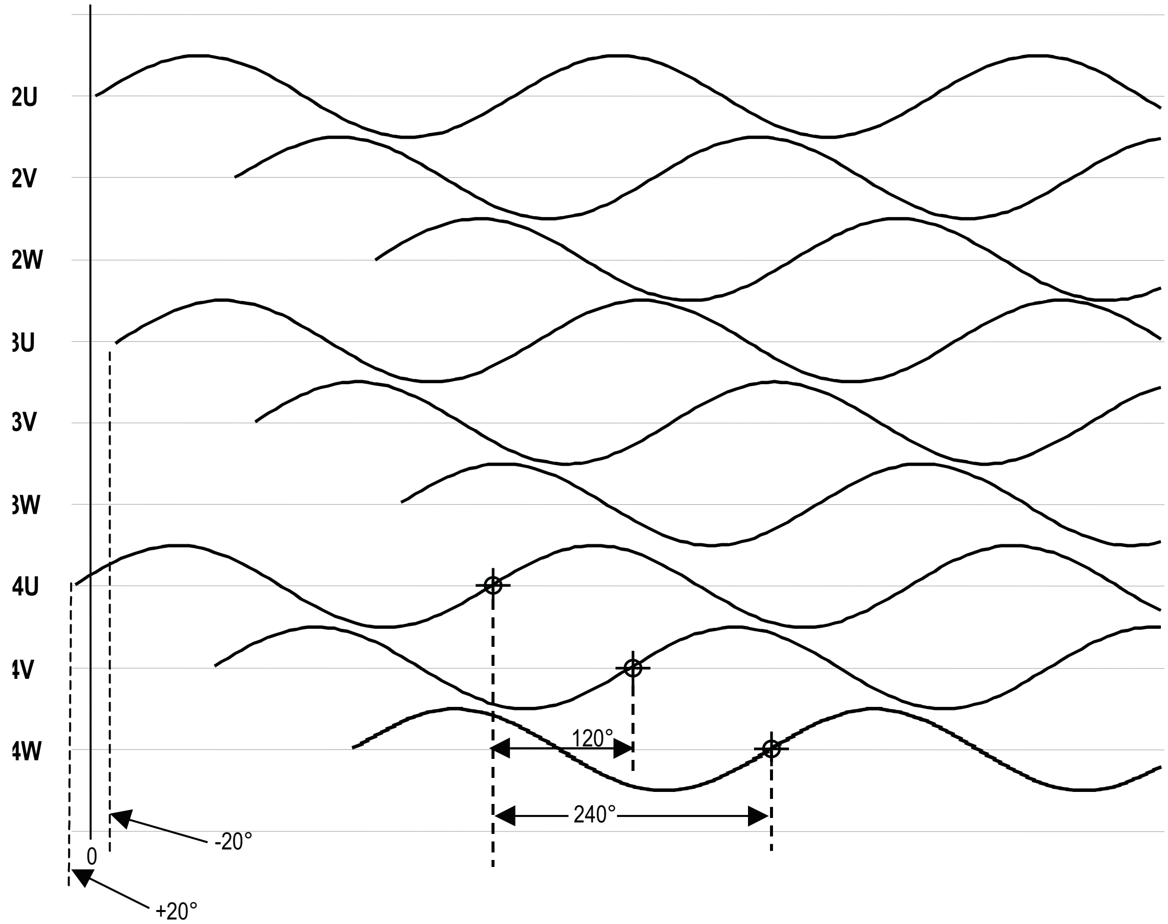


Figure 52 - 18-pulse phase sequence

DC Current Test

Use this test to verify the isolation transformer phasing and DC Link connections. Put the drive in DC Current Test and monitor variable Alpha Line and Idc feedback while increasing the DC current through the drive rectifier.

IMPORTANT	To modify the drive you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to the relevant drive Installation Guide for more information on access security.

1. From the main screen press SETUP [F8] then press [Enter]. Press [Enter] again to access the Feature Select parameter group.
2. Press [Enter] to select Operating Mode on the first line. Scroll down to select DC Current and press [Enter]. Then press EXIT [F10] to return to the main screen. There is no need to save to NVRAM when the prompt appears.

3. Press DISPLAY [F4]. Scroll down to Current Control and press [Enter], then MODIFY [F7]. Scroll down to Idc Test Command and press [Enter]. Enter the number 0.1 pu and press [Enter]. Press EXIT [F10] twice and press PREV PG. The value of Alpha Rectifier appears on this screen.
4. Press the drive START button. The drive should start pumping 0.1 pu (10%) of rated current through the DC link. Alpha Rectifier should be approximately 90°-92°.

   We can also check the Idc Reference and Idc Feedback on this same screen. Idc reference should be at 0.100 pu and Idc Feedback should be around that same number. Ensure that Idc error stays around 0.

   The Idc waveform can be observed from T21 (Idc1) on the ACB board. The waveform should have an offset of 0.5V for each 0.1pu of Idc Test Command. The waveform should also never have any of the low points between ripples go to 0V. This would indicate a problem with the DC Link cabling. See the troubleshooting section for sample waveforms.
5. Press MODIFY [F7], and increase Idc to .2 pu, and repeat the process. Increase to 0.7 pu in 0.1pu steps for 18P, and 0.3 pu in 0.1pu steps for AFE, verifying each level as you increase the current. For AFER, the Idc test is limited to 0.3 Idc reference. If there is a current meter somewhere on the input to the transformer/drive, check the current to ensure that it matches expectations for drive performance.
6. When ready, decrease the IDC current in increments of .1 pu to 0, then stop the drive. Return to the Feature Select parameter group and reset Operating Mode to Normal.

Tuning Procedure

Tune the PowerFlex 7000 'B' Frame medium voltage drive to the connected motor and load. There are three drive functions that require tuning. These are listed below in the typical tuning order:

1. Rectifier
2. Mtr Impedance
3. FluxSpeedReg

Tune the first two functions with the motor stationary, but third function requires the motor to rotate. In case the drive cannot complete the tuning, you must tune it manually.

NOTE:

1. You require a minimum of SERVICE level access to complete manual tuning. If you do not have SERVICE level access, please contact the factory.
2. Confirm the following tuning parameter default values:
   - Input Impedance (P#140)

- T DC Link (P#115)
- R Stator (P#129)
- L Total Leakage (P#130)
- Lm Rated (P#131)
- T rotor (P#132)
- Total Inertia (P#82)
- Lmd (P#418)

Rectifier

The Rectifier tuning function calculates parameter Input Impedance (140) and T DC Link (115) in Current Control group.

Input Impedance

Input Impedance is used in the software reconstruction of the line voltage to compensate for the drop in the line impedance. It is also used in the calculation of the line converter retard limit (for SCR rectifiers) to ensure proper operation under all conditions of line voltage and load current. If the Input Impedance parameter is not correctly adjusted, the resulting error in the reconstructed line voltage may cause line synchronization faults and incorrect reading of the incoming line voltage.

The Input Impedance parameter is tuned with the drive operating in the dc current test mode. Although the Input Impedance was tuned during factory test, it must be retuned during commissioning because its value is determined by the impedance of the input transformer and harmonic filter (if present).

T DC Link

Three parameters control current regulator tuning – two in the Current Control group, and one in the Drive Hardware group:

- Current regulator bandwidth CurReg Bandwidth
- DC Link time constant T DC Link
- DC Link inductance in per unit DCLnk Induct pu

Inductance DCLnk Induct pu is calculated from its nameplate rating, the current regulator bandwidth should be set to its default value of 200 rad/sec, and only T DC link is unknown and must be measured. Although the current regulator was tuned during factory test, it should be retuned during commissioning because the dc link time constant is affected by the impedance of the drive input transformer.

The following auto-tune procedure is used to complete the rectifier side tuning:

1. Ensure that the parameters in the Drive Hardware and Motor Ratings groups have been set to the correct values.

2. Set parameter Autotune Select in the Autotuning parameter group to Rectifier. The drive will go into DC Current test mode. The current regulator bandwidth is set to Autotune Idc BW (212).

3. Start the drive. The dc current will increase to 0.2pu and stay at that level for couple of seconds. The drive records the data under this condition and then ramps up to approximately rated current. After staying at the level for couple of seconds, the drive will again record the measured data and then ramp the current to zero. The current regulator bandwidth is set back to the original value. From the recorded data, the drive will calculate the Autotune L Input (P217) and Autotune T DCLnk (218). At the end of the tuning Input Impedance is set to Autotune L Input and T DC Link is set to Autotune T DCLnk. During tuning if the values are determined to be out of range, the drive will issue warnings indicated below. Try to tune the drive again, but if the warnings persist, verify the result by tuning the drive manually.

You may encounter one or more of the following warnings during Rectifier tuning:

- L Input Low - indicates that the measured L Input is less than 0.02 pu. The L Input must be tuned using the manual method described below.
- L Input High - indicates that the measured L Input is greater than 0.5 pu. The L Input must be tuned using the manual method described below.
- T DC Link Low - indicates that the measured dc link time constant is less than 0.020 second. The step response of the current regulator should be checked using the manual method described below.
- T DC Link High - indicates that the measured dc link time constant is greater than 0.150 second. The step response of the current regulator should be checked using the manual method described below.

Input Impedance Manual Tuning

1. Set parameter Operating Mode in Feature Select to DC Current to enter dc current test mode.

2. If not already at default value, set parameter Input Impedance in "Current Control" to an initial value of 0.05 pu.

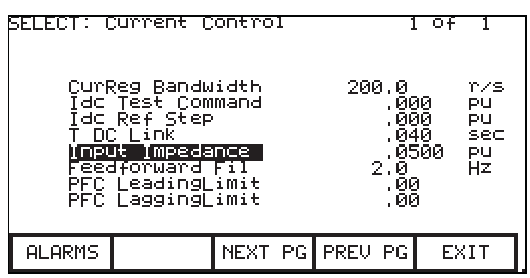


Figure 53 - Current control parameter screen

3. Energize the drive by closing the input contactor.

4. Record the value of the rectifier input voltage by looking at parameter Rec Input Voltage (P696); for example, V_{in0}.

5. For SCR drives set parameter Idc Command Test in Current Control to 0.800 pu. For AFE drives set the parameter to 0.300 pu; for example, I_{dc}.

6. Start the drive and wait for a few seconds for steady state conditions to be established.

7. Record the value of the rectifier input voltage by looking at parameter Rec Input Voltage (P696); for example, V_{in1}.

8. Calculate the value of input impedance for AFE drives as follows:

$$L_{in} = \frac{V_{in0} - V_{in1}}{I_{dc} + C_{in}(V_{in0} - V_{in1})} \Rightarrow \textit{for } \text{PWM } \textit{drives}$$

C_{in} is the value of input filter capacitor given by Line Filter Cap (P133).

9. Calculate the value of input impedance for SCR drives as follows:

$$L_{in} = \frac{3(V_{in0} - V_{in1})}{I_{dc}} \Rightarrow \textit{for SCR drives}$$

10. Stop the drive. Set the Operating Mode parameter to Normal and Idc Command Test to zero.

T DC Link (P#115) Manual Tuning

Determine an appropriate value for the T DC Link parameter from the current regulator step response while operating in DC Current test mode. Use the following procedure:

1. Ensure you set all parameters in the Drive Hardware and Motor Ratings groups to the correct values. Otherwise, the calculated value of parameter T DC Link in Current Control will be incorrect.

2. Set parameter Operating Mode in the Feature Select to DC Current to enter the test mode.

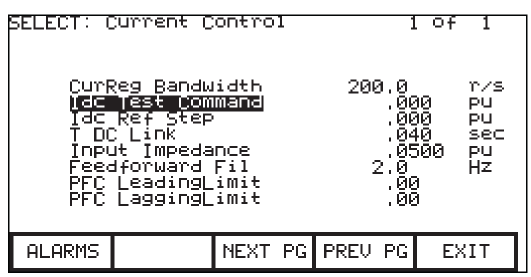


Figure 54 - Current control parameter screen

3. Set parameter Idc Test Command in Current Control to 0.225 pu for AFE rectifier drives and 0.400pu for SCR drives.

4. Set parameter CurReg Bandwidth in Current Control to 100 rad/sec. A lower than the normal bandwidth makes the step response easier to measure.
5. Set parameter T DC Link in Current Control to 0.020 sec, which is at the low end of the normal range of values and should produce an under-damped response.
6. Assign parameters Idc Reference and Idc Feedback in the Current Control group to 2 DPM test points e.g. RTP1 and RTP2. This process is similar to the meter assignments described earlier. Use an oscilloscope to view the results.
7. Start the drive. Set parameter Idc Ref Step in Current Control to 0.075pu for AFE rectifier drive and 0.200 pu for SCR drives. The dc link current will step up and down by this amount at regular intervals.
8. Adjust the scope to trigger on the rising edge of the dc current reference and observe the dc current feedback on the other channel. The step response may have noticeable overshoot, indicating that the dc link time constant is too low.
9. Adjust the T DC Link parameter until the current feedback rises to ~63% of its final value in 10 ms as shown in Figure 55 and Figure 56. The overshoot should reasonably small. Increasing T DC Link causes the rise time to increase. Since the desired step response is slightly under-damped, do not increase the T DC Link beyond the value at which the overshoot disappears.

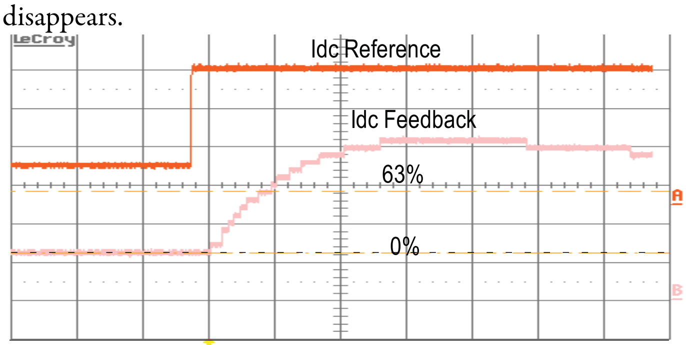


Figure 55 - Current regulator tuned incorrectly

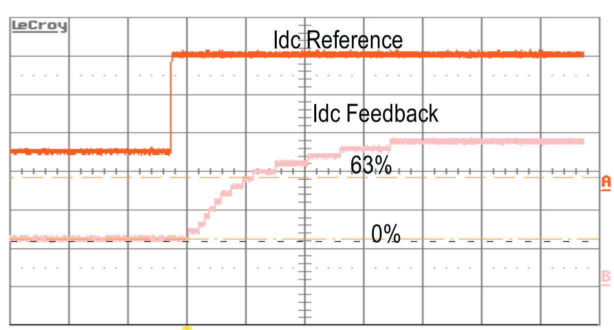


Figure 56 - Current regulator tuned correctly

10. Set the CurReg Bandwidth parameter to the normal value of 200 rad/sec. Confirm that the rise time of the current feedback is now approximately 5 ms and that the overshoot is not excessive.
11. Set the Idc Ref Step parameter to zero. The dc link current will return to a steady level given by Idc Test Command.
12. Stop the drive. Set the Operating Mode to Normal, and Idc Test Command to 0.000pu.

Motor Impedance

The motor impedance tuning function calculates stator resistance R Stator (129) and total leakage inductance L Total Leakage (130) in the Motor Model Group. Use these parameters to reconstruct the rotor flux. If you adjust these parameters incorrectly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors.

You must tune these parameters during commissioning; they are affected by motor parameters and cable length. Perform the tuning process with the motor stationary, using the following procedure.

ATTENTION: During tuning, the motor may rotate in the wrong direction. To avoid possible equipment damage, disconnect the motor from the load and test for direction before proceeding, if the equipment is sensitive to reverse direction rotation.

1. Ensure that the motor is stationary. Motor turning may render test results invalid. It is not necessary to lock the rotor.
2. Set the Autotune Select parameter in Auto-tuning to Motor Impedance.
3. Start the drive. In the first half of the test the output frequency is zero; the dc current increases to 0.6pu for a few seconds to calculate R Stator, then decreases to zero.
4. In the second half of the step the output frequency increases to rated frequency with the dc current equal to 1.0pu for a few seconds. This test may produce a small amount of motor torque and some rotation may occur. This step calculates the L Total Leakage. Decrease the current and set the Autotune Select parameter to Off.

Set the Parameter Autotune RStator (219) to the measured Stator resistance. Set R Stator (129) in Motor Model equal to Autotune R Stator. If the test fails or the values are out of range, the interface prompts with a warning indicating the cause of the failure.

Set the Parameter Autotune LLeakage(220) to the measured leakage inductance. Set L total leakage(P130) in Motor Model equal to Autotune LLeakage. If the test fails, the interface prompts with a warning.

The following warnings may occur during this test:

- R stator High - this is probably caused by extremely long motor cables increasing the apparent stator resistance of the motor. The drive cannot operate with stator resistance greater than 0.50 pu.
- L Leakage Low - indicates that the measured leakage inductance is less than 0.10 pu. Possible causes are:
  - The motor is much larger than the drive and the motor nameplate parameters do not correspond to the actual motor ratings.
  - Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. Obtain the leakage inductance from the motor data sheet, or if this is not possible, set the L Total Leakage parameter to its default value of 0.20 pu.
- L Leakage High - indicates that the measured leakage inductance is greater than 0.35 pu. Possible causes are:
  - The inductance of long motor cables is increasing the apparent leakage inductance of the motor. In this case, the measured leakage inductance is probably correct.
  - The motor is very small (leakage inductance generally increases with decreasing motor size).
  - Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. Obtain the leakage inductance from the motor data sheet, or if this is not possible, set the L Total Leakage parameter to its default value of 0.20 pu.

Flux Speed Regulator (Induction Motors)

This method combines the auto-tuning of the Flux and Speed regulator in a single step. It calculates parameters, Lm Rated (P131), T Rotor (P132) in Motor Model Group and Total Inertia (82) in Speed Control group.

IMPORTANT	For synchronous motors, please refer Flux Speed Regulator (Synchronous Motors) on page 103.

During this auto-tune step the motor will run at speed set in Autotune Spd Cmd. The default setting is 30Hz. Ensure the motor rotates during this auto-tune. Verify motor rotation physically or by monitoring FlxFbk VoltModel (342). Stall condition may calculate wrong tuning parameters. If it happens, ensure you set the tuning parameters Lm Rated, T Rotor, and Total Inertia to default before re-starting this tuning.

Flux Regulator

Three parameters determine tuning for the flux regulator in an induction motor:

- FlxReg Bandwidth in Flux Control
- Lm Rated in Motor Model
- T Rotor in Motor Model

Set FlxReg Bandwidth to the default value of 10 r/s for almost all applications. Lm Rated and T Rotor are usually unknown; measure them individually. Both of these motor parameters change substantially with different operating conditions, but the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed, determined by two parameters:

- Base Speed in Flux Control
- FlxCmd RatedLoad in Flux Control

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux normally operates at a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator auto-tuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed, and sets the flux command parameter to this value.

Speed Regulator

Two parameters in the Speed Control group determine the speed regulator tuning:

- SpdReg Bandwidth
- Total Inertia

Set Parameter SpdReg Bandwidth to a value determined by the requirements of the application. Total Inertia is usually unknown; measure it separately. The auto-tuning determines the total inertia by measuring the change in speed that occurs when a low frequency sinusoidal torque perturbation is applied to the motor. Load torque does not affect the inertia measurement as long as the drive does not hit torque limit. Do not disconnect the driven load from the motor, you are measuring the total inertia of motor and load.

Use the following procedure to auto-tune FluxSpeed Reg (Induction Motor):

1. Ensure that parameters Rated Motor RPM in Motor Ratings and L Total Leakage in Motor Model have the correct value. Ensure that parameters Autotune Spd Cmd and Autotune Trq Stp in Autotune use default values.
2. Set the Autotune Select parameter in Autotuning to FluxSpeed Reg.

3. Start the drive. The motor accelerates normally up to the speed specified by parameter Autotune Spd Cmd. Calculate the motor magnetizing inductance from the measured current and flux feedback. Set the Autotune L Magn parameter to this value. Set the flux command to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. Repeat the process until the magnetizing inductance and flux commands stabilise.
4. After completing the flux regulator tuning, the drive waits for a few seconds and adds a sinusoidal perturbation specified by parameter Autotune Trq Stp to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), measure the variation in torque and speed and calculate the Total Inertia. Remove the torque perturbation, and the drive performs a normal stop.

Set the Autotune L Magn (221) parameter to measure magnetizing inductance. Set the FlxCmd RatedLoad parameter in the Flux Control Group to a value that produces rated voltage at rated speed and load. Calculate the value of parameter Autotune T Rotor from parameters Lm Rated and Rated Motor RPM (which gives the rated slip).

If the auto-tuning is successful:

- set Lm Rated (131) in Motor Model equal to the Autotune L Magn,
- set T Rotor (P132) in Motor Model equal to Autotune T Rotor and recalculate the flux regulator gains. and
- set Total Inertia (82) in Speed Control equal to Autotune Inertia and calculate regulator gains

If the auto-tuning fails then a warning is issued indicating the cause of the failure. Following are the list of possible warnings:

- L Magnetize Low - indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning indicates an unusually low value of magnetizing inductance. This may occur if the motor is much larger than the drive and the nameplate parameters do not correspond to the actual motor ratings.
- L Magnetize High - indicates that the measured value of magnetizing inductance is greater than 10.0 pu. This warning indicates an unusually high value of magnetizing inductance. This may occur if the motor is much smaller than the drive, and the nameplate parameters do not correspond to the actual motor ratings. Tune the flux regulator using the manual method described below.
- T Rotor Low - indicates that the calculated value of rotor time constant is less than 0.2 seconds. This is caused by a value of Lm Rated or Rated Motor RPM which is too low.
- T Rotor High - indicates that the calculated value of rotor time constant is greater than 5.0 seconds. This is caused by a value of Lm Rated or Rated Motor RPM which is too high.

- Regulator Limit - indicates that the torque command was greater than Trq Limit Motoring or Trq Limit Braking. The measured inertia value is invalid. Set the Autotune Trq Stp or Autotune Spd Cmd parameter to a lower value and repeat the test.
- Tuning abort - indicates that the deviation in motor speed was greater than 10 Hz. The measured inertia value is invalid. Set Autotune Trq Stp to a lower value and repeat the test.
- Inertia high - indicates that the measured total inertia is greater than 20 seconds. This warning indicates an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result; set Total Inertia manually to equal Autotune Inertia. However, a high inertia measurement might also indicates that the Autotune Trq Stp value is too low.

Flux Regulator Manual Tuning (Induction Motor)

1. Adjust the reference command to a value between 20 and 30 Hz.
2. Start the drive and wait for it to accelerate to the commanded speed.
3. Record the value of parameter Lm Measured (134) in Motor Model.
4. Stop the drive.
5. Set parameter Lm Rated in Motor Model to the recorded value of Lm Measured.
6. Calculate an approximate value of the rotor time constant using the following formula:

$$T_{rotor} = \frac{LmRated}{Rated\ Slip}$$

Where:

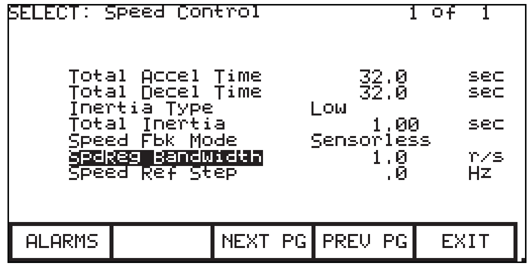
$$Rated\ Slip = (2\pi Freqmotor) \times \frac{(Sync\ RPM - Rated\ RPM)}{Sync\ RPM}$$

Set the parameter T Rotor in Motor Model to the calculated value.

Speed Regulator Manual Tuning (Induction Motor)

If it is not possible to tune the speed regulator using the auto-tune function, then tune the speed regulator's step response manually using the following procedure. To obtain accurate results, the load torque must be steady.

1. Set the SpdReg Bandwidth parameter in Speed Control to 1.0 rad/sec.



2. Set parameter Total Inertia in Speed Control to an initial value of 1.0 sec if it is a low inertial application (pumps etc). Set the parameter to 5.0 seconds if it is a high inertia application (e.g. ID Fans).
3. Assign parameter Speed Error in the Speed Control group to a test point e.g. ITP1 on the DPM. This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then it can be displayed on your oscilloscope.
4. Adjust the reference command to a value around the middle of the operating speed range.
5. Start the drive and wait for it to accelerate to the commanded speed.
6. Set parameter Speed Ref Step in Speed Control to 0.8 Hz. The drive speed will step up and down by this amount at regular intervals. The step of 0.8 Hz corresponds to 0.8V or 800mV on the test point. To capture the error set the scope at 200mV/division and 200msec/division. Trigger the scope on negative edge as shown in Figure.
7. Adjust the value of parameter Total Inertia until the speed rises to approximately 63% of its final value in 1 second as shown in the figure. If the response time is too fast, it indicates that Total Inertia is set too high and should be decreased. If the response is too slow, then Total Inertia is set too low and should be increased.

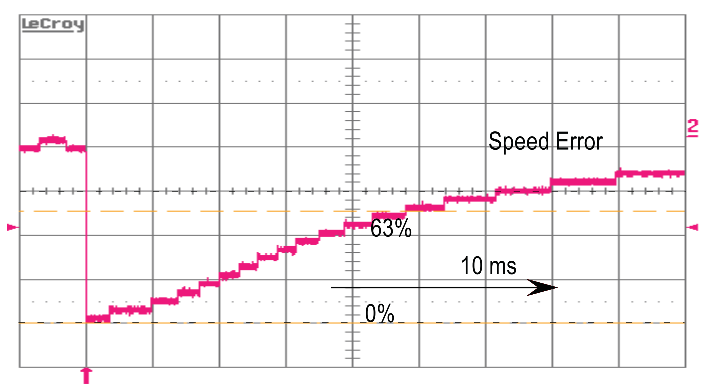


Figure 57 - Speed regulator tuned correctly

8. Set parameter SpdReg Bandwidth to the normal operating value. Confirm that the response time is equal to the inverse of the speed regulator bandwidth and that there is minimal overshoot. For example, if the speed regulator bandwidth is set to 2 rad/sec, the speed should rise to 63% of its final value in 0.5 second.
9. Set parameter Speed Ref Step to zero and stop the drive.

Calculating Total Inertia

If you cannot measure the system inertia, calculate it (if you know the motor's inertial moment motor and load). The value of parameter Total Inertia is the time required to accelerate the motor and load to rated speed when applying the rated torque. Use the following calculation:

$$\text{Total inertia} = \frac{\text{total inertia of motor \& load in kg-m}^2 \times (\text{rated speed in rad/ sec})^2}{\text{rated power in watts}}$$

—OR—

$$\text{Total inertia} = 6.21 \times 10^{-7} \frac{\text{total inertia of motor and load in lb-ft2} \times (\text{rated speed in rpm})^2}{\text{rated power in hp}}$$

If there is a gearbox between the motor and load, refer the inertia of the load to the motor side of the gearbox.

Flux Speed Regulator (Synchronous Motors)

IMPORTANT	Before tuning the FluxSpeed regulator, you must configure the analog output for the field current reference.

Configuring the Field Current Reference

Use a current-regulated field supply to excite the synchronous motor: either a dc supply for a slip ring or DC brushless machine, or a three phase ac supply for an AC brushless machine. The drive provides an analog current reference as an input to the field supply. The analog current reference has a range of 0-10V, where 0V corresponds to zero field current and 10V corresponds to maximum field current. Adjust the scaling of the analog current reference to achieve a linear relationship between the current reference and the actual field current. Failing to do so may result in an unstable flux regulator. Adjust the analog output scaling using the following procedure:

1. Temporarily assign variable Autotune Lmd in Autotuning to the analog output that controls the field supply (e.g. ACB Port 1).
2. Set the analog output scale parameter (e.g. Anlg Out1 Scale in Analog Output) to:
   Analog Scale = maximum analog input of field supply / 10V

3. Set Autotune Lmd to a value of 10.00. Confirm the field supply's reference input is at maximum. Adjust the analog output scaling parameter if necessary.
4. Start the field supply and confirm that the field current goes to its maximum value. If necessary, adjust the field supply to achieve a field current slightly above rated.

ATTENTION: Applying maximum field current to a stationary machine for an extended period may damage the exciter. Adjust the current as quickly as possible.

5. Stop the field supply. Assign variable I Field Command in "Flux Control" to the analog output used to control the field supply (e.g. ACB Port 1). The setup of the field current reference is complete and you can proceed with the tuning of the FluxSpeed regulator.

Flux Speed Reg Auto-tuning (Synchronous Motor)

The following parameters determine the Flux Speed regulator tuning for a synchronous machine:

- FlxReg Bandwidth in Flux Control
- Lm Rated in Motor Model
- T Rotor in Motor Model
- Lmd in Motor Model
- SpdReg Bandwidth in Speed Control
- Total Inertia in Speed Control

The Flux Speed Regulator tuning function calculates parameters, Lm Rated(131), T Rotor (132) in Motor Model Group and Total Inertia (82) in Speed Control group. This is combined Auto-tuning for Flux and Speed regulator.

During this autotune step the motor will run at speed set in auto tune speed Cmd. The default setting is 30HZ. Make sure the motor rotates during this autotune. Motor rotation must be verified either physically or monitoring "FlxFbk VoltModel" (P#342). It is possible that stall condition may calculate wrong tuning parameters. If It happens, make sure the tuning parameters [Lm rated, T rotor, Total Inertia) are set to default before starting this tuning again.

Flux Regulator

Set Flux Regulator Bandwidth to the default value for almost all applications. Lm Rated, Lmd, T Rotor and Total Inertia are usually unknown and must be measured. Although these motor parameters change with different operating conditions, the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters:

- Base Speed in Flux Control
- FlxCmd RatedLoad in Flux Control

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator auto-tuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed and sets the flux command parameter to this value.

Speed Regulator

For more details, refer to Speed Regulator Manual Tuning (Induction Motor) on page 101.

If a position encoder is fitted to the motor, the FluxSpeed regulator auto-tuning is performed with the encoder feedback turned off because it is assumed that the encoder has not been aligned with the rotor axis yet. Since less starting torque is produced with the encoder feedback off, this test should be performed with reduced load. The encoder offset measurement is also most accurate with no load on the motor.

Flux Speed Regulator Auto-tuning (Synchronous Motor)

Tune the Flux Speed Regulator, with the motor running at constant speed, using the following procedure:

1. Ensure that the analog reference for the field current has been set up as described previously, and that parameter L Total Leakage has been set to the correct value.
2. Set parameter Autotune Select in Autotuning to FluxSpeed Reg.
3. Start the drive. The motor accelerates normally up to the speed specified by parameter Autotune Spd Cmd. The motor magnetizing inductance is calculated from the magnetizing current reference and the flux feedback and parameter Autotune Lm is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux command stabilize. If a position encoder is fitted to the motor, the angle between the measured flux and the encoder zero is measured and parameter Encoder offset is adjusted to align the encoder with the motor flux.

The field current reference is then held constant and the response of the flux to changes in stator magnetizing current is measured by stepping “Ix command” up and down at regular intervals. The size of the step in the stator current is specified by parameter Autotune Isd Step. The step response measurement takes about 3 minutes. During this step parameter Lmd, T Rotor, Lm Rated will be calculated.

When the motor speed has settled at the commanded value, a sinusoidal perturbation specified by parameter Autotune Trq Stp is added to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the total inertia. The torque perturbation is then removed and the drive performs a normal stop.

Parameter FlxCmd RatedLoad in Flux Control is set to a value calculated to produce rated voltage at rated speed and load. The value of parameters Autotune T rotor and Autotune Lmd are calculated from the step response data.

If the flux regulator auto-tuning is successful, then parameter Lm Rated in Motor Model is set equal to Autotune L Magn, parameter T Rotor in Motor Model is set equal to Autotune T Rotor, and parameter Lmd in Motor Model is set equal to Autotune Lmd. Parameter Total Inertia(63) in Speed Control is set equal to Autotune Inertia.

If the flux regulator auto-tuning fails, a warning indicates the cause of the failure:

- L Magnetize Low – indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.
- L Magnetize High – indicates that the measured value of magnetizing inductance is greater then 15.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.
- T Rotor Low – indicates that the calculated value of rotor time constant is less than 0.2 seconds
- T Rotor High – indicates that the calculated value of rotor time constant is greater than 5.0 seconds.
- Regulator Limit - indicates that the torque command was greater than Trq Lmt Motoring or Trq Lmt Braking. The measured inertia value is invalid. Parameter Autotune Trq Stp or parameter Autotune Spd Cmd must be set to a lower value and the test repeated.
- Tuning Abort - indicates that the deviation in motor speed was greater than 10 Hz. The measured inertia value is invalid. Parameter Autotune Trq Stp must be set to a lower value and the test repeated.
- Inertia high - indicates that the measured total inertia is greater than 20.0 seconds. This warning is intended to draw attention to an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result and parameter Total Inertia should be manually set equal to Autotune Inertia. However, a high inertia measurement could also be produced by a value of Autotune Trq Stp which is too low.

Running the Load

Motor Starting Torque

When starting without a tachometer or encoder, the drive operates in an open loop mode below approx. 3 Hz at which point the drive switches to closed loop speed control. The starting currents are set by three parameters; Torque Commands 0 sensorless (P86), 1 (P87), Torque Command 0 sensorless sets the breakaway torque and Torque Command 1 sensorless is the torque at the transition point from open to closed loop. Torque Command Minimum operates in conjunction with Torque Command 1 to minimize speed overshoot at the transition point. If you are starting an uncoupled motor, or simply auto-tuning, the default starting torque values may be sufficient to run the motor. But the defaults are generally not high enough to start a loaded motor.

Be prepared to have to increase starting torque and ensure Motor Stall faults during initial operation.

Reaching Specific Load Points

Verify the drive can reach rated speed and load. Monitor the Torque Reference (P291) and the displayed value of the motor current. If you are running into a torque limit the Torque Reference will be running near the Torque Limit Motoring (P84) limit. If you are not realizing rated motor current you may increase the Torque Limit Motoring slightly. If increasing the Torque Limit Motoring does not help to increase the motor amps and speed then the drive is most likely running out of input voltage.

Monitor the Line Voltage pu (P135), and increase the tap setting on the drive feed if the measured value is less than 1.03 pu. It is desirable to have Line Voltage pu read in the 1.03 to 1.07 pu range. Alpha Rectifier (P327) should be greater than 15° while running at rated speed and load, indicating how far forward the rectifier is phased. The input voltage should be increased by tapping up the transformer.

Fill in the following table with data from the various load points. If possible, capture the running parameters with the printer, DriveTools, or Hyperterminal as a substitute for recording the data in the table below. This should be forwarded with all commissioning data back to Product Support for future reference.

TEST #	Motor/Drive Operating Point		Drive Variables										
	%Speed/ RPM	AMPS	Volts (Vline)	Speed Ref (Hz)	Speed Fdbk (Hz)	Flux Ref (pu)	Torque Ref (pu)	I DC Ref (pu)	I DC Fdbk (pu)	Alpha Machine (degrees)	Alpha Line (degrees)	Inverter Heatsink Temp (°C)	Rectifier Heatsink Temp (∞°C)
1	25%/____												
2	50%/____												
3	75%/____												
4	100%/____												
5	____%/___												
6	____%/___												
7	____%/___												
8	____%/___												
9	____%/___												
10	____%/___												
11	____%/___												
12	____%/___												

Note: You can also capture and upload varaibles from the DPM as a .csv file. See Capturing Drive Data on page 125 for more details.

Capturing Data

Once you complete the final commissioning procedures and the drive is running, it is VERY IMPORTANT TO CAPTURE ALL THE DRIVE DATA for future reference.

The last step should be to either PRINT DRIVE SETUP or upload "black box" data from the DPM. This will capture all the parameters (regardless of the user access level), the various firmware revisions, the exploded fault masks, the PLC links, and the Analog configuration.

For instructions on uploding or printing drive data, refer to Printing and Uploading Drive Data on page 125.

All of this information is necessary as reference to address future customer issues.

Guidelines For Data Capture

This section provides some guidelines for capturing required commissioning data and setting up oscilloscope to capture the waveforms. For detailed instructions, always refer to the PowerFlex7000 user manual. Some sample waveforms have been included for reference purpose.

Drive Input Voltage Phasing Checks

After applying medium voltage to the drive, perform an input voltage phasing check.

Summary:

- Drive input contactor should be closed. If the drive input contactor configuration is set to NOT RUNNING, you will have to temporarily change it to ALL FAULTS.
- Ensure that the drive is not running when capturing these waveforms.
- Capture the three line voltage waveforms at ACB test points
  - Master winding: V2uv, V2vw & V2wu
- In the case of 18-Pulse drive, verify 20 deg phase shift between the Master and two Slave windings for each phase voltage and capture the waveforms at ACB test points:
  - Slave 1 winding: V3uv, V3vw, V3wu
  - Slave 2 winding: V4uv, V4vw, V4wu
- Label the waveforms as "V2uv", "V2vw" and "V2wu", etc.
- Save the worksheet as "Input Phasing".

Table 2 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label	Sheet Name
Chan. 1		2U Line Voltage	V2uv	V2uv	
Chan. 2	10ms/div.	2V Line Voltage	V2vw	V2vw	Input phasing
Chan. 3		2W Line Voltage	V2wu	V2wu	

Use the same settings on the oscilloscope when capturing waveforms for the two Slave bridges. If you are using a 2-channel oscilloscope, then first capture two waveforms and move them onto a wavestar worksheet and after that capture the remaining waveforms and move them onto the same wavestar worksheet.

Sample Waveforms

Sample Waveforms captured on ACB test points showing incoming line voltage phasing [Ch1: V2uv (red), Ch2: V2vw (yellow), Ch3: V2wu (blue)]

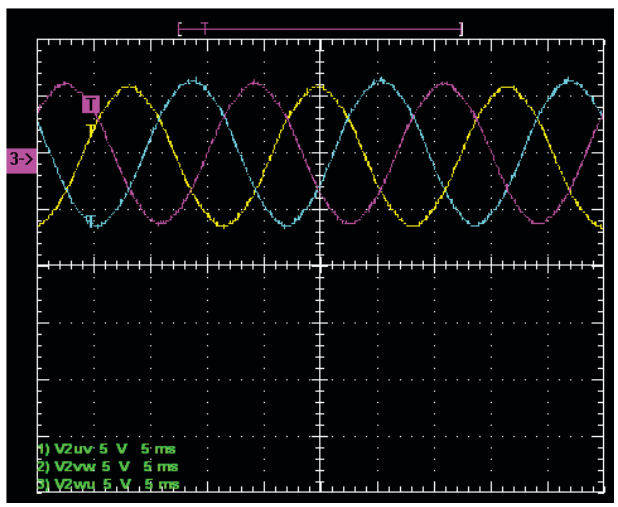


Figure 58 - Sample waveforms: incoming line voltage phasing

Sample waveforms captured on ACB test points showing 20 deg Phase Shift between Master and two Slave Bridges [Ch1-Master: V2uv (red), Ch2-Slave 1: V3uv (yellow), Ch3-Slave 2: V4uv (blue)]:

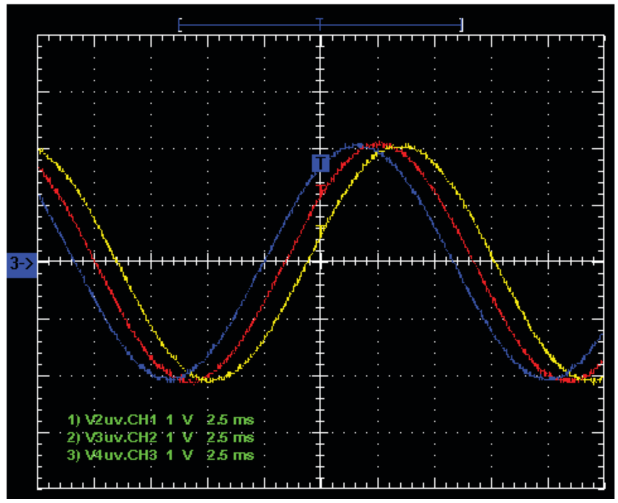


Figure 59 - Sample waveforms: 20 deg phase shift between master and 2 slave bridges

Harmonic Analysis (required for PWM drives only)

Measure the harmonic (resonance) levels at the input to the drive. If you notice considerable distortion in the waveforms, you MUST send those waveforms to MV Support via e-mail at mvsupport_technical@ra.rockwell.com, and then call 519-740-4790 (option 1) to discuss the issue and action plan. After-hours, call MV Support pager (Pager # 519-654-5616) to talk with MV Tech Support Specialist. Outside North America, call 1-440-646-3434 and request MV Tech Support.

Summary:

- Close all drive input contactors. If the drive input contactor configuration is set to NOT RUNNING, you will have to temporarily change it to ALL FAULTS.
- Ensure that the drive is not running when capturing these waveforms.
- Capture line voltage at ACB test point “V2uv” and line current at ACB test point “I2u”.
- Label the waveforms as “V2uv”, and “I2u”.
- Save the worksheet as “Harmonics (Drive Not Running)”.

Table 3 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label	Sheet Name
Chan. 1	10ms/div.	Line Voltage	V2uv	V2uv	Harmonics (drive not running)
Chan. 2		Line Current	I2u	V2vw	

Sample Waveforms

Sample waveforms captured on SCBL test points under Drive Not Running Condition [Ch1: V2uv (red), Ch2: I2u (yellow)]

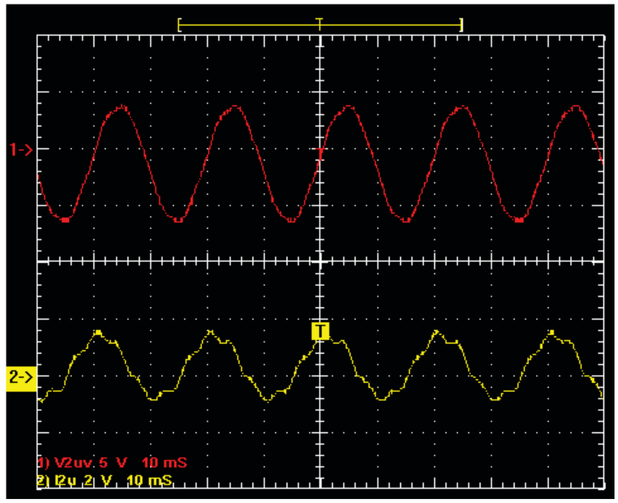


Figure 60 - Sample waveform: SCBL test points (drive not running)

DC Current Test

Perform DC Test.

Summary:

- Make sure the Diagnostic Trend has been setup and is armed.
- Run the DC Test with Idc Command Test (P119) set to 0.1pu. Increase Idc Command Test from 0.1 ? 0.3pu (for AFE drives) or from 0.1 ? 0.7pu (for 18-pulse drives) in steps of 0.1pu. At each step, verify DC link current regulation by monitoring Idc Error (P323) and Alpha Line (P327).
- Capture DC link voltage waveform at ACB test point "Vdcr1" and DC link current waveform at ACB test point "Idc1" at 0.3pu (for AFE drives) or at 0.7pu (for 18-pulse drives).
- Label the waveforms as "Vdcr1", and "Idc1".
- Save the worksheet as "DC Test @ 0.3pu" (for AFE drives) or "DC Test @ 0.7pu" (for 18-pulse drives).

Table 4 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label	Sheet Name
Chan. 1	2ms/div.	DC Link Voltage	Vdcr1	Vdcr1	DC Test
Chan. 2		DC Link Current	Idc1	Idc1	

Sample Waveforms

Sample waveforms of DC Test recorded on a PWM drive: Idc Cmd Test = 0.2pu [Ch1- Vdcr1 (yellow) Ch2 – Idc1 (blue) at ACB test points]

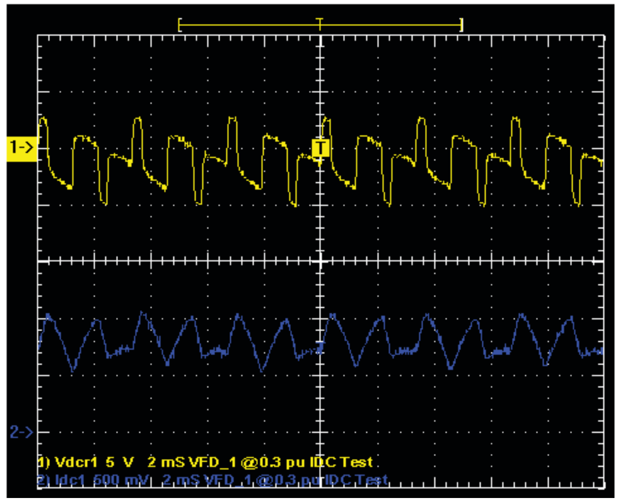


Figure 61 - Sample waveform: DC test on PWM drive

Sample waveforms of DC Test recorded on 18-Pulse Drive: Idc Cmd Test = 0.5pu [Ch1- Vdcr1 (yellow) Ch2 – Idc1 (blue) at ACB test points]

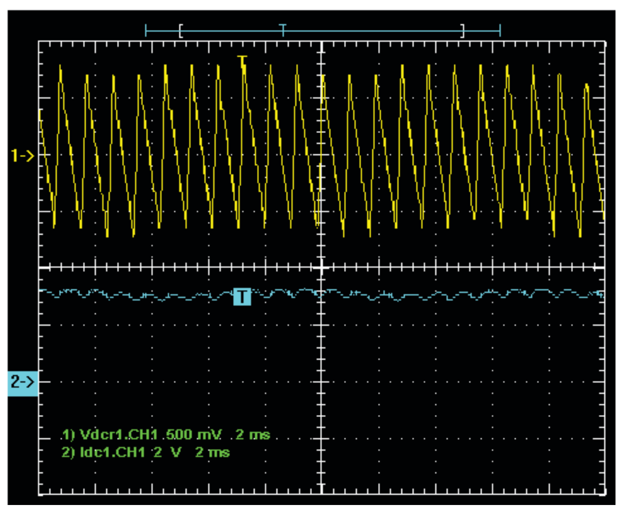


Figure 62 - Sample waveform: DC test on 18-pulse drive

Load Test

After autotuning of the drive, run the motor on load and capture the following waveforms at 50% load and at 100% load. If the system is not ready for 100% load test, then capture the waveforms at the max load you are allowed to run the drive at. Also, print variables at 50% and 100% load points. Before printing variables make sure the drive Access Level is at SERVICE.

- Capture line voltage & current waveforms at ACB test points “V2uv” & “I2u”.
- Label the waveforms as “V2uv” and “I2u”.
- Capture motor voltage & current waveforms at ACB test points “Vuv” & “Iu”
- Label the waveforms as “Vuv” and “Iu”.
- Save the worksheet as “Line and Load Voltage and Current Waveforms at 1048 rpm, 31 A”, for example.

Table 5 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label	Sheet Name
Chan. 1	10ms/div.	Line Voltage	V2uv	V2uv	{see above]
Chan. 2		Line Current	I2u	I2u	
Chan. 3		Motor Voltage	Vuv	Vuv	
Chan. 4		Motor Current	Iu	Iu	

Sample Waveforms

Sample waveforms recorded on PWM drive running at full load (Ch1: Line Voltage, Ch2 - Line Current, Ch3 - Motor Voltage, Ch4 - Motor Current)

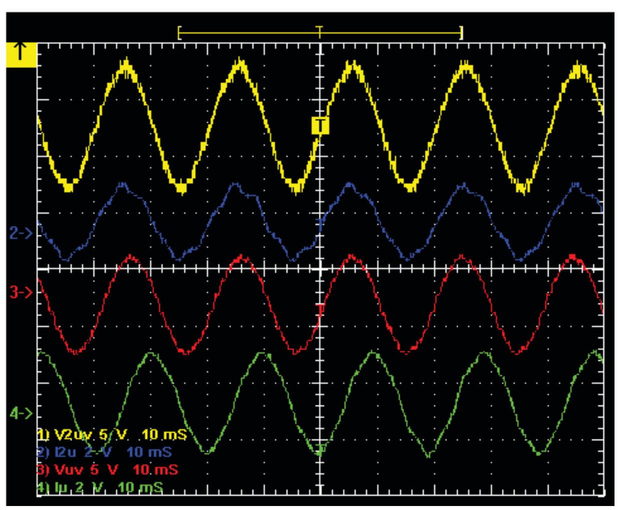


Figure 63 - Sample waveform: PWM drive under full load condition

Sample waveforms recorded on 18-Pulse Drive running at 75% load (Ch1: Line Voltage, Ch2 - Line Current, Ch3 - Motor Voltage, Ch4 - Motor Current)

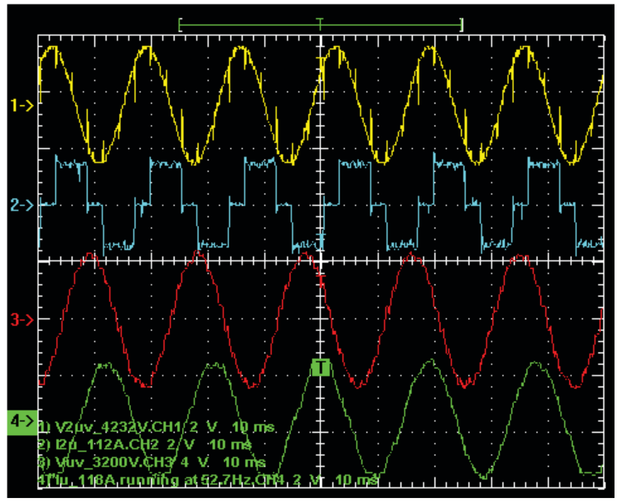


Figure 64 - Sample waveform: 18 pulse drive at 75% load capacity

Synchronous Transfer

When commissioning a drive employing synchronous transfer, capture and submit the following waveforms with the commissioning package.

While measuring the bypass (BP) contactor closing time:

- Capture 120V bypass close command from the BP Contactor Close output (J1-12) at the ACB (refer to electrical drawing for specific wire/ terminal number).
- Capture the 9V signal across the bypass contactor vacuum bottles (refer to the tech note PF7000_GEN-78 for details).
- Label the waveforms as “BP_Close_Cmd” and “Actual_Closure”.
- Save the worksheet as “Bypass Contactor Close Delay”.

Table 6 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label
Chan. 1	25ms/div.	BP Contactor Close Command	BP Contactor Close Command	BP_Close_Cmd
Chan. 2		Actual Closure of BP	Across 2K-Ohm resistor connected in series with 9V battery	Actual_Closure

Bypass Contactor Closures

Sample Waveforms

Ch1: Bypass Contactor Close Command (BPC output at ACB, J1-12 & 402)

Ch2: Actual Closure of Bypass Contactor (using 9V battery across contactor vacuum bottles)

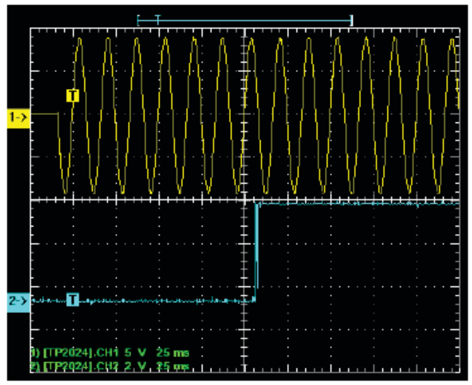


Figure 65 - Sample waveform: Bypass contactor closures

Synchronous Transfer Test: Verify Sync Lead Angle

While simulating a synchronous transfer to determine the best lead angle:

- ensure you have configured and armed the Diagnostic Trend.
- capture motor voltage at ACB test point “Vuv” & bypass voltage at ACB test point “Vuvs”.
- capture and trigger on falling edge of the DC Link current waveform at ACB test point “Idc1”.
- label the waveforms as “Vuv”, “Vuvs” and “Idc1”.
- save the worksheet as “Drift @ 15 Degree Lead Angle”, for example.

Table 7 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label
Chan. 1	10ms/div.	DC Link Current	Idc1	Idc1
Chan. 2		Motor Voltage	Vuv	Vuv
Chan. 3		Bypass Line Voltage	Vuvs	Vuvs

Sample Waveforms

Synchronous Transfer Test to verify Sync Lead Angle (50Hz System); Ch1: Idc1 (yellow), Ch2: Vuv (blue), Ch3: Vuvs (red)

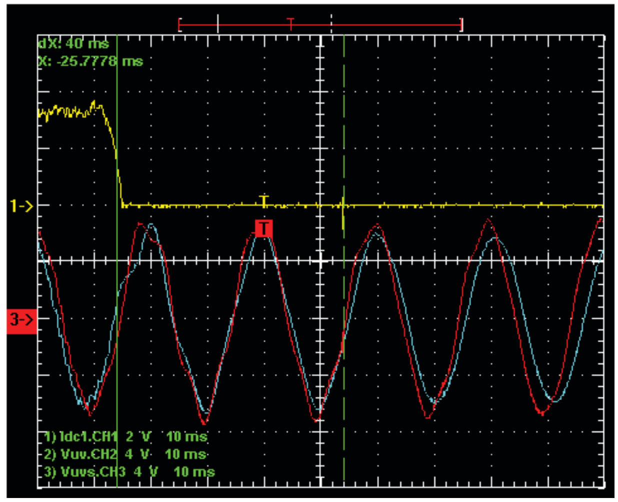


Figure 66 - Sample waveform: Synchronous transfer test

Live Synchronous Transfer

While performing a live synchronous transfer:

- capture motor voltage at ACB test point "Vuv" & bypass voltage at ACB test point "Vuvs".
- capture and trigger on falling edge of the DC Link current waveform at ACB test point "Idc1".
- label the waveforms as "Vuv", "Vuvs" and "Idc1".
- save the worksheet as "Synch on Motor 01", for example.

Table 8 - Oscilloscope Settings

Oscilloscope	Time Base	Wave Form	Test-Point	Waveform Label
Chan. 1	10ms/div.	DC Link Current	Idc1	Idc1
Chan. 2		Motor Voltage	Vuv	Vuv
Chan. 3		Bypass Line Voltage	Vuvs	Vuvs

Sample Waveforms

Live Synchronous Transfer Capture (50Hz System); Ch1: Idc1 (yellow), Ch2: Vuv (blue), Ch3: Vuvs (red)

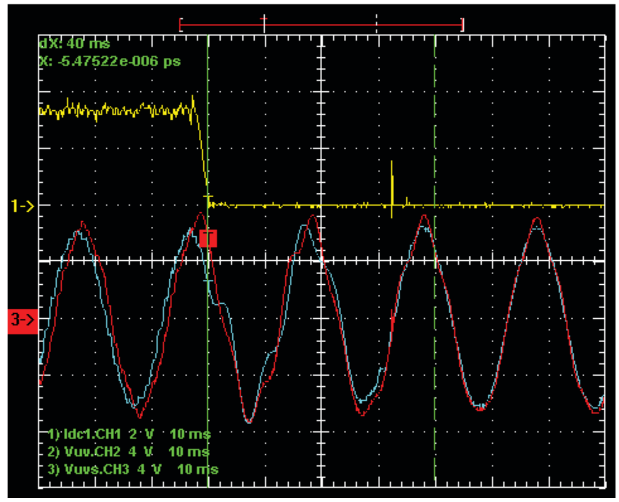


Figure 67 - Sample waveform: Live synchronous transfer

General Reference

Torque Requirements for Threaded Fasteners

Unless otherwise specified, use the following values of torque in maintaining the equipment.

Diameter	Pitch	Material	Torque (N-m)	Torque (lb.-ft.)
M2.5	0.45	Steel	0.43	0.32
M4	0.70	Steel	1.8	1.3
M5	0.80	Steel	3.4	2.5
M6	1.00	Steel	6.0	4.4
M8	1.25	Steel	14	11
M10	1.50	Steel	29	21
M12	1.75	Steel	50	37
M14	2.00	Steel	81	60
1/4″	20	Steel S.A.E. 5	12	9.0
3/8″	16	Steel S.A.E. 2l	27	20

Preventative Maintenance Schedule

Rockwell Automation recognizes that following a defined maintenance schedule improves your drive's performance and operational lifespan. By rigorously following this maintenance schedule, you can expect the highest possible uptime. Annual maintenance includes a visual inspection of all drive components visible from the front of the unit, resistance checks on the power components, power supply voltage level checks, general cleaning and maintenance, checking of all accessible power connections for tightness, and other tasks. These tasks are described in great detail in the PowerFlex 7000 "B" Frame User Manual.

I – Inspection	This indicates that the component should be inspected for signs of excessive accumulation of dust/dirt/etc. or external damage (e.g. looking at Filter Capacitors for bulges in the case, inspecting the heatsinks for debris clogging the air flow path, etc.).
M – Maintenance	This indicates a maintenance task that is outside the normal preventative maintenance tasks, and can include the inductance testing of Line Reactors/DC Links, or the full testing of an isolation transformer.
R – Replacement	This indicates that the component has reached its mean operational life, and should be replaced to decrease the chance of component failure. It is very likely that components will exceed the design life in the drive, and that is dependent on many factors such as usage, heating, etc.
C – Cleaning	This indicates the cleaning of a part that can be reused, and refers specifically to the door-mounted air filters in the liquid-cooled drives and some air-cooled drives.
Rv – Review	This refers to a discussion with Rockwell Automation to determine whether any of the enhancements/changes made to the Drive Hardware and Control would be valuable to the application.
RFB/R – Refurbishment/Replacement	The parts can be refurbished at lower cost OR the parts can be replaced with new ones.

Tachometer Usage

When is a Tachometer Required?

A tachometer is required under the following conditions:

1. When speed regulation accuracy must be between 0.01 – 0.02% of nominal speed.
2. When the zero speed breakaway torque needed is greater than 90% of continuous running torque.
3. When continuous running speed is greater than or equal to 0.1 Hz, but less than 6 Hz.
4. For minimizing restart times using the flying start capability in forward or reverse direction.

Table 9 - PowerFlex Speed Regulation

Tachometer	Frequency Output		
	<6 Hz	6-15 Hz	>15 Hz
Without Tachometer	Not applicable	0.1%	0.1%
With Tachometer	0.02%	0.01%	0.01%

Notes:

- Speed regulation is based on a percentage of motor synchronous speed.
- Tachometer to be mounted on the AC machine
- Operational 15 V DC Power Supply mounted in drive to power the tachometer as a standard option with the tachometer feed back card.
- Customer is responsible for providing and mounting of tachometer
- Sleeve bearing motors require the tachometer to have an axial movement tolerance.
- Recommended tachometers are shaft mounting type.
- Magneto resistive models are more adaptable to harsh environments.
- When installing, the tachometer body and electronics must be isolated from ground (options available from the tachometer manufacturer to accomplish this).
- There are usually limits on tachometer cable lengths. Ensure the maximum length is suitable for the application.

Recommended Tach PPR	
Motor RPM	Tach ppr
3600	600
3000	600
1800	1024
1500	1024
1200	2048
1000	2048
900	2048
720	2048
600	2048

PowerFlex 7000 Drive Performance (Torque Capabilities)

The PowerFlex 7000 drives have been tested on a dynamometer to verify performance under locked rotor, accelerating, and low speed-high torque conditions. Table A-5 below shows the PowerFlex 7000 drive torque capabilities as a percent of motor rated torque, independent of the drive's momentary overload conditions.

Table 10 - PowerFlex 7000 Drive Torque Capabilities

Parameter	7000 Torque Capability Without Tachometer (% of Motor Rated Torque)	7000 Torque Capability With Tachometer (% of Motor Rated Torque)
Breakaway Torque	90%	150%
Accelerating Torque	90% (0-8 Hertz)	140% (0-8 Hertz)
	125% (9-75 Hertz)	140% (9-75 Hertz)
Steady State Torque	125% (9-75 Hertz) **	100% (1-2 Hertz)
		140% (3-60 Hertz) **
Maximum Torque Limit	150%	150%

** Drive will require over sizing to achieve greater than 100% continuous torque.

Glossary of Terms

Breakaway Torque: Torque required to start a machine from standstill.

Accelerating Torque: Torque required to accelerate a load to a given speed, in a certain period of time. The following formula may be used to calculate the average torque to accelerate a known inertia (WK^2):

$T = (WK^2 \text{ x change in RPM}) / 308t$

where:

- T = acceleration torque in N.m (lb.-ft.)
- W = force N or kg*f* (lb)
- K = gyration radius m (ft)
- WK^2 = total system inertia (kg*f* x m^2 [lb-ft^2]) that the motor must accelerate, including motor, gear box, and load
- t = time (seconds) to accelerate total system load

Steady State Torque: Continuous operating torque required to control the load, without instability.

Torque Limit: An electronic method of limiting the maximum torque available from the motor. The software in a drive typically sets the torque limit to 150% of motor rated torque.

Table 11 - Typical Application Load Torque Profiles

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Tachometer Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
AGITATORS						
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	100	100	Heavy	Yes
BLOWERS (centrifugal)						
Damper closed	VT	30	50	40	Normal	No

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Tachometer Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
Damper opened	VT	40	110	100	Normal	No
CHIPPER (WOOD)—starting empty	CT	50	40	200	Contact factory	No
COMPRESSORS						
Axial-vane, loaded	VT	40	100	100	Normal	No
Reciprocating, starting unloaded	CT	100	100	100	Contact factory	Yes
Conveyors						
Belt type, loaded	CT	150	130	100	Heavy	Yes
Drag type	CT	175	150	100	Contact factory	Yes
Screw type, loaded	CT	200	100	100	Contact factory	Yes
EXTRUDERS (rubber or plastic)	CT	150	150	100	Contact factory	Yes
FANS (centrifugal, ambient)						
Damper closed	VT	25	60	50	Normal	No
Damper open	VT	25	110	100	Normal	No
FANS (centrifugal, hot gases)						
Damper closed	VT	25	60	100	Normal	No
Damper open	VT	25	200	175	Contact factory	No
FANS (propeller, axial flow)	VT	40	110	100	Normal	No
KILNS (rotary, loaded)	CT	250	125	125	Contact factory	Yes
MIXERS						
Chemical	CT	175	75	100	Contact factory	Yes
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	125	100	Heavy	Yes
Solids	CT	175	125	175	Contact factory	Yes
PULPER	VT	40	100	150	Contact factory	No
PUMPS						
Centrifugal, discharge open	VT	40	100	100	Normal	No
Oil field Flywheel	CT	150	200	200	Contact Factory	Yes
Propeller	VT	40	100	100	Normal	No
Fan Pump	VT	40	100	100	Norma	No
Reciprocating / Positive Displacement	CT	175	30	175	Contact factory	Yes
Screw type, started dry	VT	75	30	100	Normal	No
Screw type, primed, discharge open	CT	150	100	1000	Heavy	Yes
Slurry handling, discharge open	CT	150	100	100	Heavy	Yes

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Tachometer Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
Turbine, Centrifugal, deep-well	VT	50	100	100	Normal	No
Vane-type, positive displacement	CT	150	150	175	Contact factory	Yes
SEPARATORS, AIR (fan type)	VT	40	100	100	Normal	No

Appendix B

Printing and Uploading Drive Data

Capturing Drive Data

You can capture and save drive data such as drive setup, parameters, variables, trend data, fault masks, alarm queues etc., onto a laptop using the HyperTerminal program. When using HyperTerminal to upload the data, the program prompts you to select a file for data storage. Open a new Notepad (text) file and save that file on the laptop before uploading data from the drive.

IMPORTANT	As of Rectifier module firmware revision 7.002G, you can record control data in PF7000 MV ForGe Control drives using the Drive Data Recorder. This feature captures a pre-selected set of critical control data to NVRAM whenever there is a drive fault or there occurred any of the following warnings: Line Loss, Line Synch Loss or Bus Transient. There is no setup or arming requirement to enable this trending.

The following example illustrates the method to create an empty .txt file (example1.txt) and print the data from drive to a laptop.

Required:

- Laptop with Windows HyperTerminal program
- A null-modem cable with a 9-pin female connector for the laptop serial port, and a 9-pin male connector for the ACB Printer Port (J11). (A serial cable with pins 2-3 swapped at one end will also work.)

1. To create an empty notepad (.txt) file, run the NotePad program (Start >Program > Accessories > Notepad). A blank Notepad window will appear as shown below.

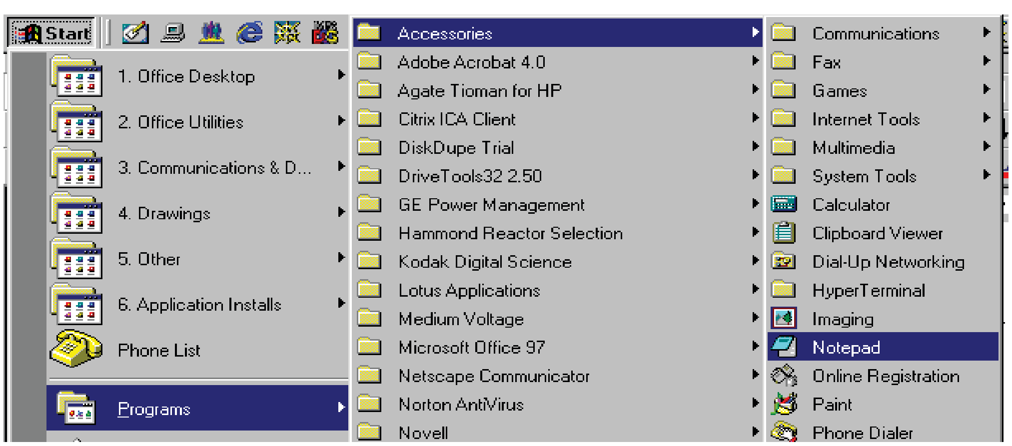


Figure 68 - Opening NotePad

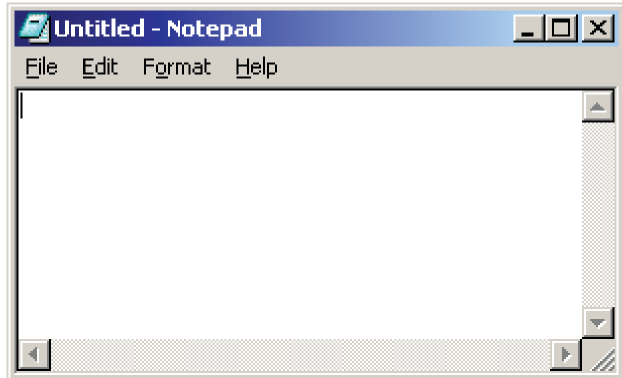


Figure 69 - Blank NotePad file

2. From the File menu, select Save As.

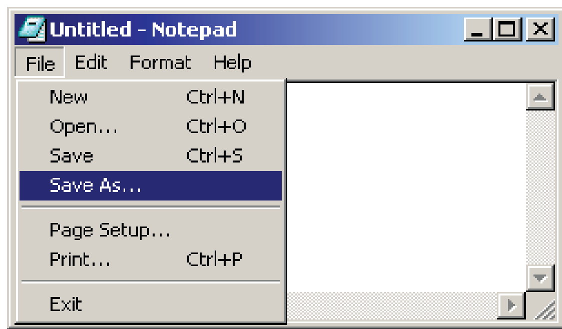


Figure 70 - Saving a blank file

3. In the Save As window, enter a filename (for instance, example.txt) and select the directory from the drop list. In this example the selected directory is C:\temp. Click Save.

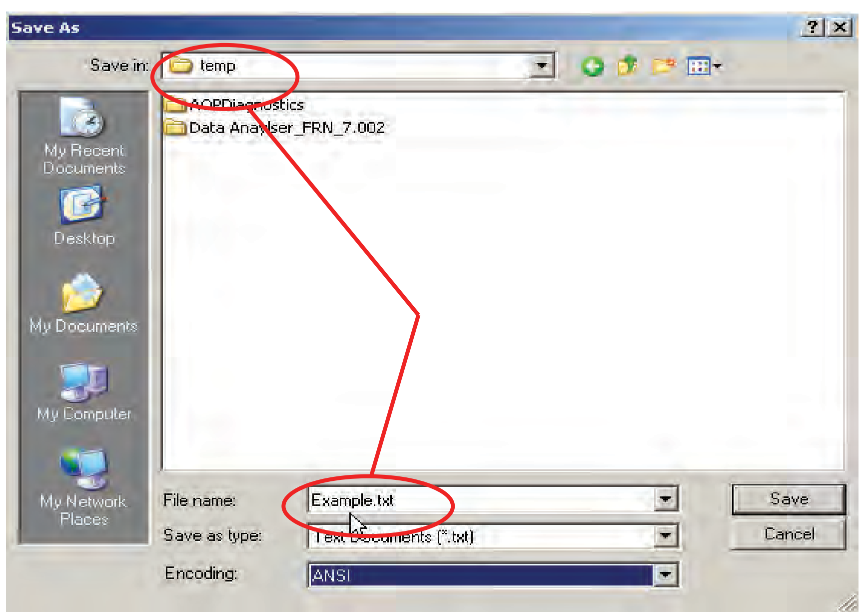


Figure 71 - Selecting filename and directory

4. Once you create the empty file, close the Notepad program.
5. Run the HyperTerminal program.
6. On the ‘Connection Description’ window, enter a name (for instance, Parameters) for the new connection as shown below, then click OK.

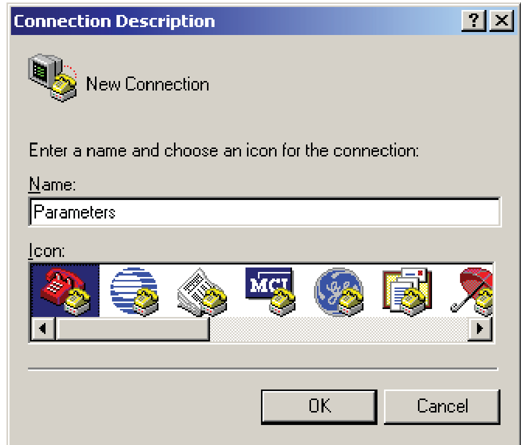


Figure 72 - HyperTerminal Connection Description window

7. In the ‘Connect to’ window, select COM1 from the drop list next to ‘Connect Using,’ then click OK.

Figure 73 - HyperTerminal connections, cont’d.

8. In the 'COM1 Properties' window, specify the port settings as shown below, then click OK.

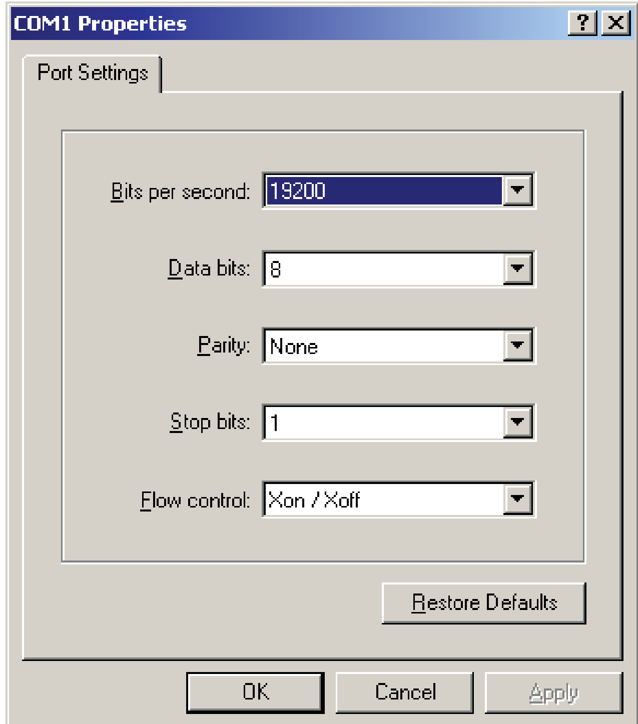


Figure 74 - HyperTerminal COM1 properties

Click OK to close the HyperTerminal program. Following message appears.

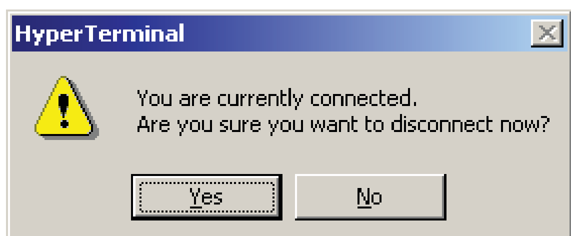


Figure 75 - Hyper Terminal disconnection prompt

9. Click Yes, and at the prompt, click Yes again to save the session and close the program.

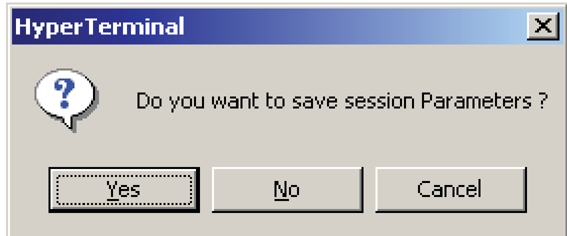


Figure 76 - HyperTerminal — save session data

10. To upload data from the drive, connect a null-modem cable between your computer's serial port and the serial port 'J11' on the Analog Control Board (ACB).

11. Restart the HyperTerminal program. On the 'Connection Description' window click Cancel.

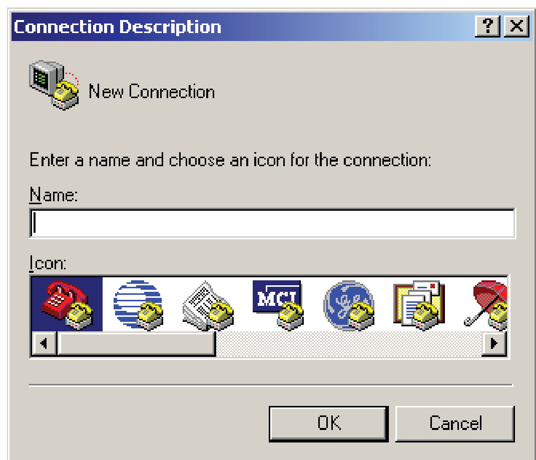


Figure 77 - Reopening HyperTerminal

12. From the File menu, click Open. In the Open dialog box, locate the HyperTerminal connection you just created (e.g. Parameters), then click Open.

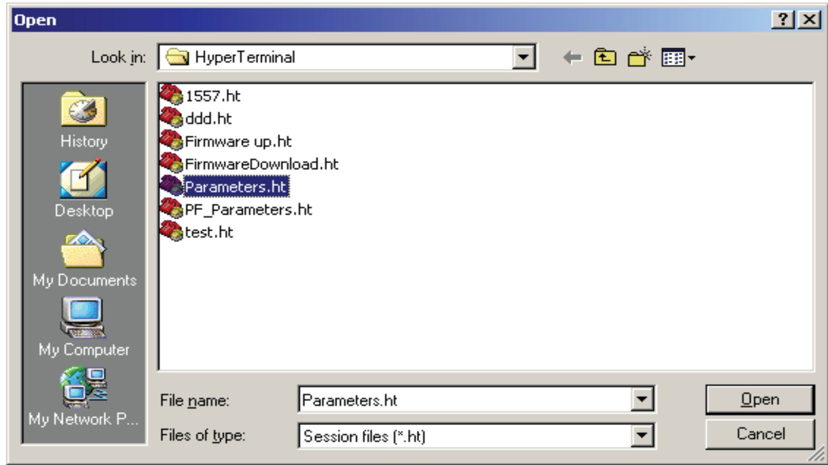


Figure 78 - HyperTerminal — open the created connection

13. From the Transfer menu, select Capture Text, as shown below.

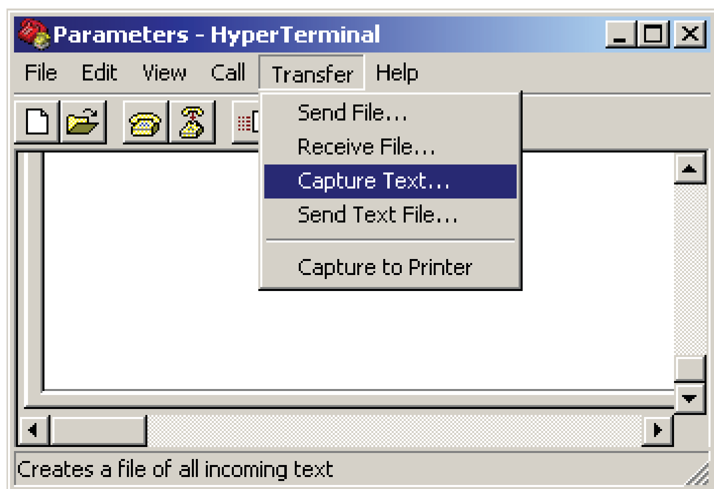


Figure 79 - HyperTerminal — Capture text

14. In the Capture Text dialog, click Browse and search the file Example.txt that you created in previous steps.

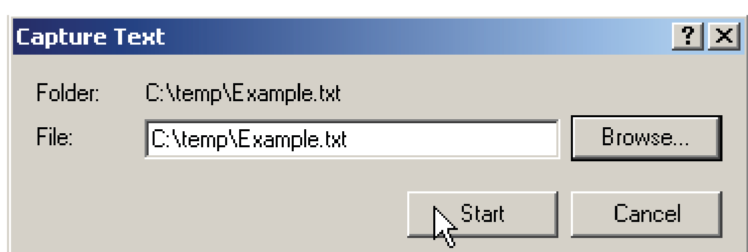


Figure 80 - HyperTerminal - specify text filename

15. Click Start. HyperTerminal now acts as a dummy printer and waits for the information to be transmitted from the drive to the laptop.
16. On the drive terminal, press [F3] (PRINT) at the main screen as shown below.

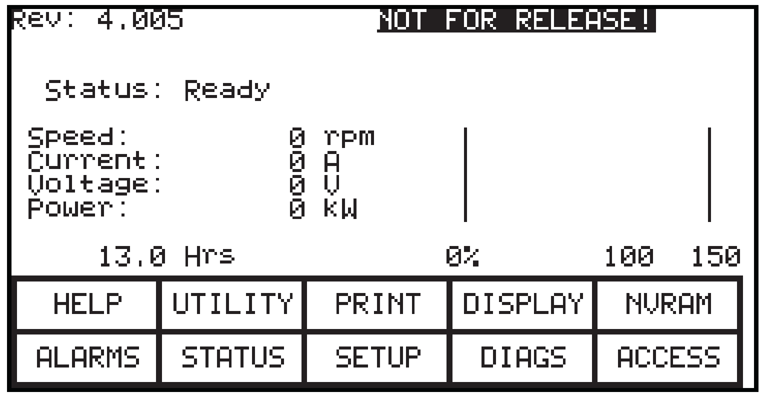


Figure 81 - Printing to HyperTerminal from the drive interface

17. The terminal displays the Printer options, as shown below. Use ▲ or ▼ to scroll to the item you want to print (i.e., upload the info into laptop) and press Enter. The drive will print the selected information to your laptop through the specified file (in this example, C:\temp\Example.txt). Repeat this step to upload any other data into your laptop.

    The most common downloadable selections are:
    - Drive Setup: for complete setup including parameters, fault masks and revisions
    - Trend Data: for analyzing the drive trending
    - Variables: snapshot of real-time operational data
18. Stop the communication between your laptop and the drive and close the file Example.txt. On the laptop, click on Transfer menu and select Stop option under Capture Text … as shown in the screenshot below.

IMPORTANT	While the data is being transferred, the Printer Status will show Transfer in Process. Once the data transfer is complete, the Printer Status changes to either Auto-Off or Auto-On.

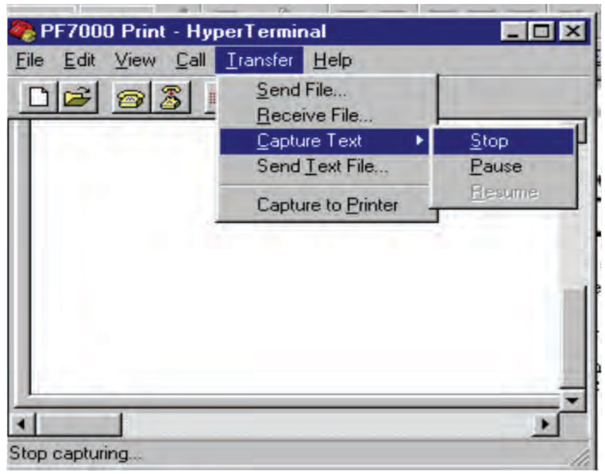


Figure 82 - HyperTerminal —stop transfer

19. Close the HyperTerminal program and disconnect the laptop from the drive.

Uploading Control Data

PF7000 drives with ForGe control have a specifically-allocated memory location to capture and store critical data in the event of a fault condition, referred to as "Control Data". There are 8 buffers that store data sequentially on a first-in first-out basis, ensuring the data of the eight most-recent faults is always available for analysis.

This section describes the process for retrieving and uploading Control Data.

For required components and cable diagrams, refer to Capturing Drive Data on page 125.

1. Connect your laptop to the drive using a 9-pin null-modem cable to a serial data port (J4) on teh DPM board.

2. Run the HyperTerminal program. At the 'Connection Description' window, enter any name for new connection under the Name field as shown below and then click OK.

Figure 83 - HyperTerminal — Naming control data connection

3. In the 'Connect to' window, select COM1 from the drop list and click OK.

4. In the 'COM1 Properties' window, configure the port settings as shown below and click OK.

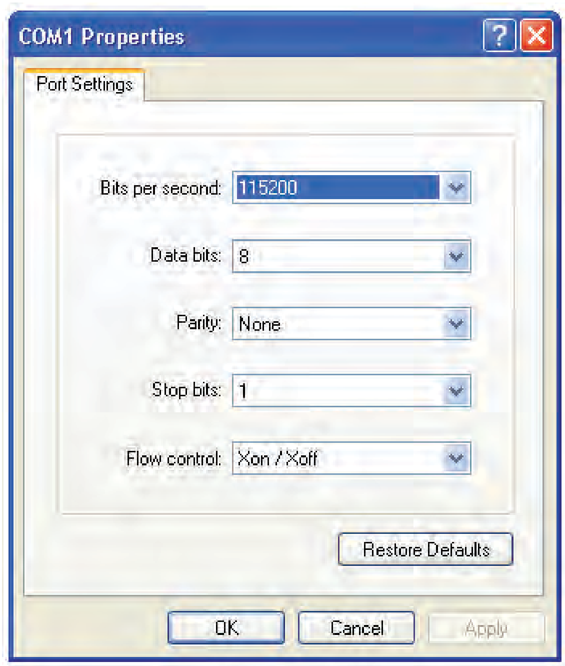


Figure 84 - HyperTerminal — upload control data configuration

5. Close HyperTerminal program. When prompted, click Yes to disconnect and save the connection.

6. To upload the control data, restart the HyperTerminal program, and in the 'Connection Description' window, click Cancel.

7. From the File menu, select Open. Locate the HyperTerminal connection that you just created (ForGe_CONNECTION in this example), and click Open.

   If you have not already connected the null-modem cable betweent eh laptop and DPM board, do so now.

8. Press the ENTER keyto open the following options menu in the HyperTerminal window.

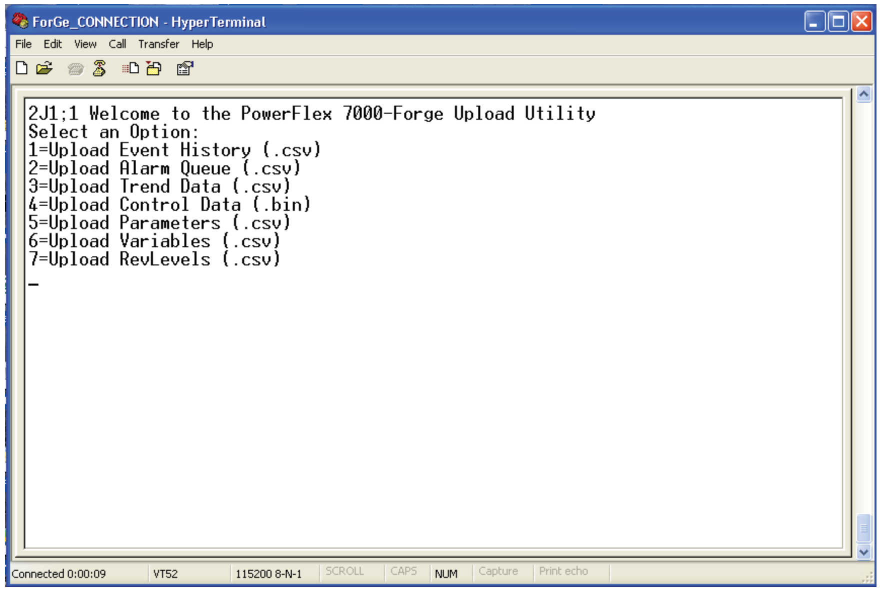


Figure 85 - HyperTerminal — Upload utility main menu

9. From the Options menu, choose an option by pressing the corresponding number to upload the data. To upload Control Data, select option 4.

10. Start the transfer by selecting Receive File ... from the Transfer menu as shown below.

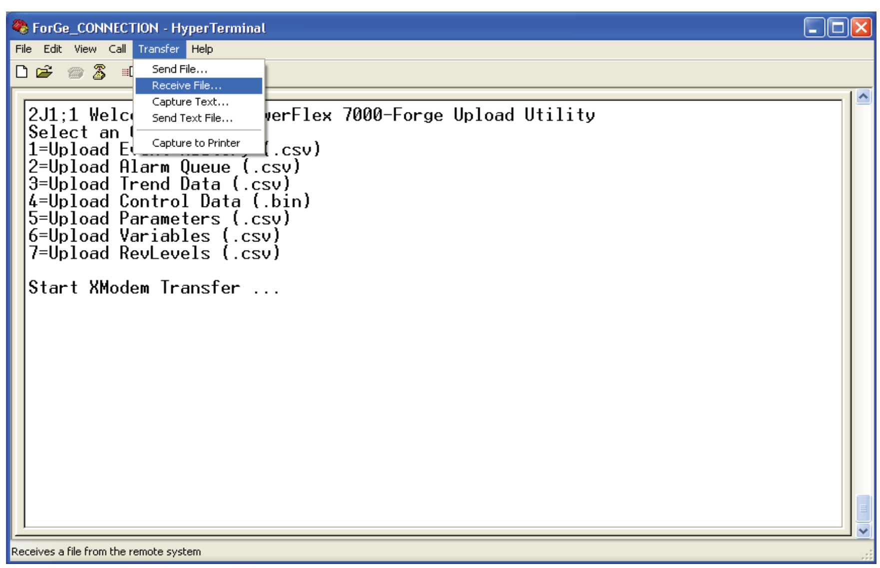


Figure 86 - HyperTerminal — Transfer menu options

11. In the Receive File window, click Browse and select the directory to which you want to save the data file. Ensure you set the Receiving Protocol to Xmodem, then click Receive.

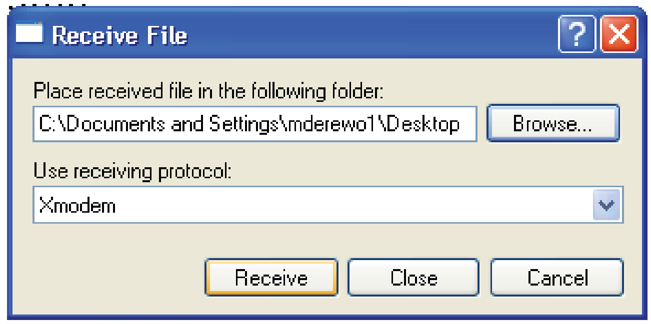


Figure 87 - HyperTerminal — Receive file transfer protocols

12. In the Receive Filename dialog, enter the file name, using the correct extension as given in the options menu. For Control Data use “.bin”; for all other data use “.csv”. Click OK.

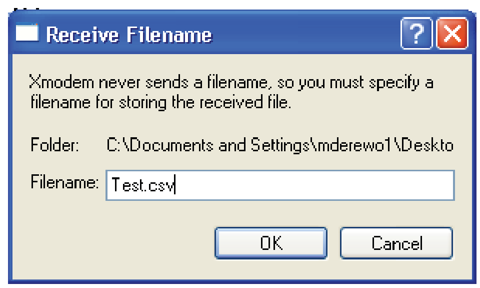


Figure 88 - HyperTerminal — Receive file name/extension

HyperTerminal provides a dialog box to track the the file transfer progress. When the data transfer is complete, the above dialog box closes automatically. Once you have printed all the data files, close the HyperTerminal program and unplug the null-modem cable from the DPM board.

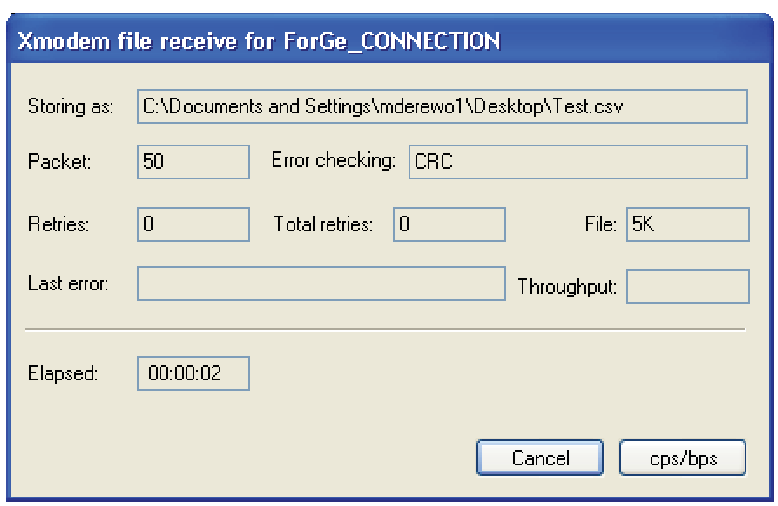


Figure 89 - HyperTerminal — file upload tracking dialog

Specifications

ATTENTION: In the event of discrepancies between information published in generic manual specifications and those included with your specific design or electrical drawings, take the DD or EE ratings as correct values.

"B" Frame Drive Specifications

Description	Specifications
Control Power	220/240 V or 110/120 V, 1 phase – 50/60 Hz (20 Amp)
External I/O	16 Digital Inputs, 16 Digital Outputs
External Input Ratings	50/60 Hz AC or DC 120-240 V – 1 mA
External Output Ratings	50-60 Hz AC or DC 30-260 V – 1 amp
Analog Inputs	(3) Isolated, 4-20mA or 0-10 V
Analog Resolution	• Analog input 12 Bit (4-20 mA) • Analog input 13 Bit (0-10V)
Analog Outputs	• (1) Isolated, 4-20 mA • (8) Non-isolated, 0-10 V
Communication Interface	DPI
Scan Time	Internal DPI – 2 ms min., 4 ms max.
Communications Protocols (Optional)	R I/O, Lon Works DeviceNet, Can Open Ethernet, RS485 HVAC Profibus, RS485 DF1 Modbus, RS232 DF1 Interbus, USB
Enclosure	NEMA 1 (IP21), NEMA 12 (IP42)
Lifting Device	Standard / Removable
Mounting Arrangement	Mounting Sill Channels
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)
Interlocking	Key provision for customer input Disconnecting Device
Corrosion Protection	Unpainted Parts (Zinc Plates / Bronze Chromate)
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning/Trip)
Door Filter	Painted Diffuser with Matted Filter Media
Door Filter Blockage	Air Flow Restriction Trip/Warning
Ambient Temperature	0°C to 40°C (32°F to 104°F) 0°C to 50°C (32°F to 122°F) - Optional
Storage and Transportation Temperature Range	-40°C to 70°C (-40°F to 185°F)
Relative Humidity	95% Non-Condensing
Altitude (Standard)	0 to 3300 ft. (0 to 1000 m)
Altitude (Optional)	0 to 16400 ft. (1001 to 5000 m)
Seismic (UBC Rating)	1, 2, 3, 4
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE

Description	Specifications	
Power Rating (Air Cooled)	NEMA: 200 to 5,500 hp	
	IEC: 150 to 4,100 kW	
Motor Type	Induction or Synchronous	
Input Voltage Rating	2400V, 3300V, 4160V, 6600V	
Input Voltage Tolerance	± 10% of Nominal	
Voltage Sag ❶	-30%	
Control Power Loss Ride-Through	5 Cycles (Std)	
Input Protection ❷	Metal Oxide Varistor (MOV) – 6P/18P Surge Arrestors (AFE/D2D)	
Input Frequency	50/60 Hz, +/- 5%	
Input Short-circuit Current Withstand	5 Cycle	
3300 V – 6000 V ❸	25 MVA RMS SYM	
Basic Impulse Level ❹	50 kV (0 – 1000 m)	
Power Bus Design	Copper – Tin plated	
Ground Bus	Copper – Tin plated 6 x 51 mm (¼ x 2 in.)	
Customer Control Wireway	Separate and Isolated	
Input Power Circuit Protection ❺	Vacuum Contactor with Fused Isolating Switch	
Input Impedance Device	Isolation Transformer or AC Line Reactor	
Output Voltage	0 – 2300 V 0 – 3300 V 0 – 4160 V 0 – 6600 V	
Inverter Design	PWM	
Inverter Switch	Symmetrical Gate Commutated Thyristor (SGCT)	
Inverter Switch Failure Mode	Non-rupture, Non-arc	
Inverter Switch Failure Rate (FIT)	100 per 1 Billion Hours Operation	
Inverter Switch Cooling	Double Sided, Low Thermal Stress	
Inverter Switching Frequency	420-540 Hz	
Number of Inverter SGCTs	Voltage	SGCTs (per phase)
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
SGCT PIV Rating (Peak Inverse Voltage)	Voltage	PIV
	2400 V	6500 V
	3300 V	6500 V
	4160 V	6500 V
	6600 V	6500 V
Rectifier Designs	AFE (Active Front End), 6 Pulse, 18 Pulse Direct-to-Drive	
Rectifier Switch	SCR (6 Pulse, 18 Pulse) SGCT (AFE, Direct-to-Drive)	
Rectifier Switch Failure Mode	Non-rupture, Non-arc	
Rectifier Switch Failure Rate (FIT)	50 (SCR) 100 (SGCT) per 1 Billion Hours Operation	
Rectifier Switch Cooling	Double Sided, Low Thermal Stress	

❶ Voltage Sag tolerance is reduced to -25% when control power is supplied from medium voltage via CPT.
❷ MOVs are used for 6 Pulse/18 Pulse. Surge Arrestors are used for AFE/D2D configurations.
❸ Short-circuit fault rating based on input protection device (contactor or circuit breaker).
❹ BIL rating based on altitudes < 1000 m (3,300 ft.) Refer to factory for derating on altitudes >1000 m.
❺ Optional

Description	Specifications			
Number of Rectifier Devices per phase	Voltage	6-Pulse	18-Pulse	AFE / D2D
	2400 V	2	6	2
	3300 V	4	6	4
	4160 V	4	6	4
	6600 V	6	6	6
SCR PIV Rating (Peak Inverse Voltage)	Voltage	6-Pulse	18-Pulse	AFE / D2D
	2400 V	6500 V	4500 V	6500 V
	3300 V	6500 V	4500 V	6500 V
	4160 V	6500 V	4500 V	6500 V
	6600 V	6500 V	6500 V	6500 V
Output Waveform to Motor	Sinusoidal Current / Voltage			
Medium Voltage Isolation	Fiber Optic			
Modulation Techniques	SHE (Selective Harmonic Elimination) Synchronous Trapezoidal PWM Asynchronous and Synchronous SVM (Space Vector Modulation)			
Control Method	Digital Sensorless Direct Vector Full Vector Control with Tach Feedback (Optional)			
Tuning Method	Auto Tuning via Setup Wizard			
Speed Regulator Bandwidth	5-25 Radians / Second			
Torque Regulator Bandwidth	15-50 Radians / Second			
Speed Regulation	0.1% without Tachometer Feedback 0.01-0.02% with Tachometer Feedback			
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 1200 sec.			
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel			
S Ramp Rate	Independent Accel/Decel – 2 x 1200 sec.			
Critical Speed Avoidance	3 x Independent with Adjustable Bandwidth			
Stall Protection	Delay / Speed			
Load Loss Detection	Adjustable level, delay, speed set points			
Control Mode	Speed or Torque			
Current Limit	Adjustable in Motoring and Regenerative			
Output Frequency Range	0.2-85 Hz			
Service Duty Rating Overload Rating	Normal Duty		Heavy Duty	
	110% Overload for 1 minute every 10 minutes (Variable Torque Load)		150% Overload for 1 minute every 10 minutes (Constant or Variable Torque Load)	
Typical VFD Efficiency	> 98% (6/18 Pulse) > 97.5% (AFE) Contact Factory for Guaranteed Efficiency of Specific Drive Rating			
Input Power Factor	AFE Rectifier			
	0.98 minimum, 30 – 100% Load			
IEEE 519 Harmonic Guidelines ❻	IEEE 519 – 1992 Compliant			
VFD Noise Level	< 85 dB(A) per OSHA standard 3074			
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required			
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction			
Operator Interface	40-character, 16-line formatted text			
Languages	English French Spanish Italian		German Chinese (Mandarin) Portuguese	

❻ Harmonic filter required on 6-pulse drive to meet IEEE 519-1992.
Under certain conditions, power system analysis will be required.

History of Changes

This appendix summarizes the revisions to this manual. Reference this appendix to determine what changes have been made across multiple revisions.

7000-IN006A-EN-P, September 2011

Change
Commissioning material removed to new manual
Converted documentation from Word to FrameMaker
Conditionalized text in shared chapters
Specifications removed to Technical Data publication
Numbering styles for graphics and tables changed
Significant rewrites to change passive to active voice
Replaced words for cursor keys with symbols
Added consistent formatting for key names, i.e. [Enter]
Removed all references to 6-pulse motor controllers
Significantly reduced text in Intro chapter to remove sales-oriented content in favour of a focus on technical content relevant to post-sales user documentation.
Added paragraph: "Use this document in conjunction with the most recent version of the Rockwell Automation "Commissioning Guidelines for MV PF7000 [A/B/C] Frame Drives with ForGe Control" document, available to field service engineers on the Intranet at http://rain.ra.rockwell.com/mvb."
Replaced last three bullet points from "Before Commissioning" section with text: "Applying power and tuning or performance-testing the drive are part of the actual commissioning process, not part of the preparation"
Added "Commissioning Guide lines for Rockwell Automation MV PF7000 Frame drives (available internally at http://rain.ra.rockwell.com/mvb)" to list of required TechPubs
Added resource bullets: "Functional specifications for the drive to be commissioned (generally available from the online MV Literature Library)" and "Any commissioning notes for this customer/installation, available from the Rockwell Automation Application Specialist or Project Manager."
Added "(also available through ShopView/SAP)." to bullet "Rockwell Automation electrical and mechanical diagrams for each drive"
Added "materials available from the MV website using the order number as a reference" to "PLC program (if supplied with a PLC)"
Added "the Rockwell Automation Project Manager or" to "If any of the above information is not available prior to the time of commissioning, please contact the factory."
Added point: "Black Box Data before leaving the site, followed by instructions on relevant Tech Note."
Added point: Ensure the drive hardware and parameters are correct, Such as HECS/CT ratio and burden resistors installed in the drive are accurately programmed in drive parameter settings
Added Note: "Note: For variations in drive cabinetry (such as the heat pipe B Frame or Marine liquid-cooled drives) please refer to the appropriate Installation Manual for that drive.)"
Changed output voltage value for IGDPS board from +1% to +2%
Updated sample waveform graphics
Removed sample AFE waveforms from Load Test section to synchronize with other Commissioning documentation
Added Printing and Uploading Drive Data as Appendix
Re-added Specifications as Appendix
Commissioning material removed to new manual

Change
Converted documentation from Word to FrameMaker
Conditionalized text in shared chapters
Specifications removed to Technical Data publication
Numbering styles for graphics and tables changed
Significant rewrites to change passive to active voice
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Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support, you can find technical manuals, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools. You can also visit our Knowledgebase at http://www.rockwellautomation.com/knowledgebase for FAQs, technical information, support chat and forums, software updates, and to sign up for product notification updates.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect[SM] support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

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