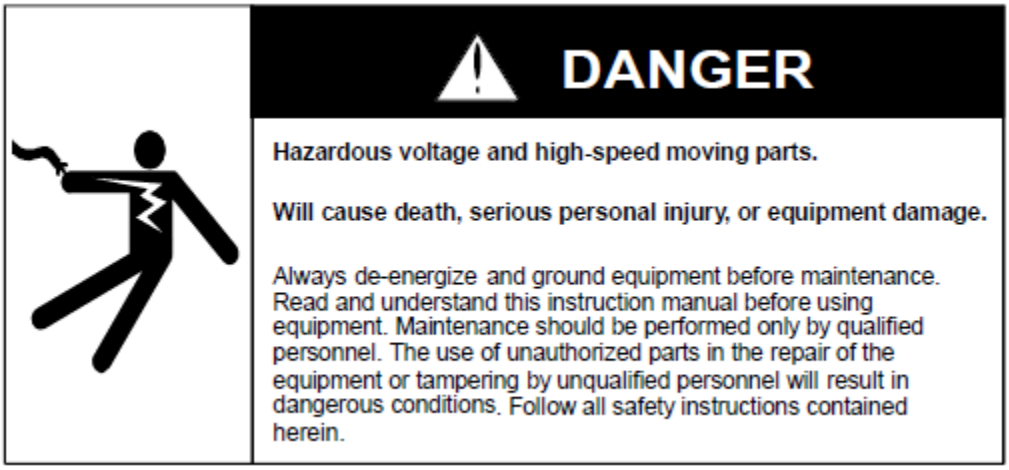
SIEMENS

MJ-5(TM) Voltage Regulator Control Panel

Installation and Operations Manual



IMPORTANT

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes at any time without notice of obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material, or both, the latter shall take precedence.

QUALIFIED PERSON

For the purposes of this manual, a qualified person is one who is familiar with the installation, construction, or operation of the equipment and the hazards involved. In addition, this person has the following qualifications:

a) **He or she is trained and authorized** to de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

b) **He or she is trained** in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety procedures.

c) **He or she is trained** in rendering first aid.

NOTE

These instructions do not purport to cover all details or variations in equipment, not to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local sales office.

The contents of the instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Power Transmission & Distribution, Inc. The warranty contained in the contract between parties is the sole warranty of Siemens Power Transmission & Distribution, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

DANGER Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury

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1 Introduction

The MJ-5(TM) is a next generation Voltage Regulator Control Panel, which is a member of the Siemens Accu/Stat® series of digital controls, designed for use with many regulators and load tap changer models.

Although the MJ-5 Control Panel includes some new functions, its operational characteristics are similar to those of earlier-model Accu/Stat MJ-1A, 2A, 3, 3A, 4A, 4B, MJ-X, and MJ-XL controls. It is electrically and mechanically interchangeable with these controls.

Voltage Reduction Control, Voltage Limit Control, six Power Flow modes, and Data Logging are all standard features of the MJ-5 Control Panel.

In addition to manual and automatic voltage monitoring and control, the MJ-5 Control Panel also offers full *remote* monitoring and control capability. Via a communications link, a remote operator can monitor operating conditions and adjust set points or command tap changes—just as if he/she were locally operating the controls.

When equipped with Communications Module, the MJ-5 Control Panel provides remote communications and SCADA (Supervisory Control And Data Acquisition) compatibility. Please refer to the MJ-5 *Communications Module Installation Manual* for an in-depth treatment of the Communications Module.

The regulator control function has two operating modes—manual and automatic. Remote control can be enabled or disabled for each of these operating modes. The operating modes and remote control settings are described in Section 2.5.

- **Manual control**. In Manual mode, the operator directly controls the regulator tap changer and uses this mode to enter regulator set points for automatic control.
- **Automatic control**. In Automatic mode, the microprocessor controls the regulator tap changer, based on set points stored in memory.
- **Remote control**. If enabled, this setting permits a remote operator to change operational values and set points as well as to monitor operational values. If disabled, a remote operator can only monitor operational values.

1.1 About This Manual

This manual is designed to help you become acquainted with all aspects of the MJ-5 Control Panel. The manual starts with the operator panel and controls, followed by physical installation considerations, setup procedures, day-to-day operations, and finally, troubleshooting. The Appendices provide further information about MJ-5 Control Panel operation and setup.

1.2 Features of the MJ-5 Control Panel

This section briefly describes the standard MJ-5 Control Panel features and functions.

Display Panel and Operator Controls

Operator input to the MJ-5 Control Panel is accomplished through a set of touch-keys. MJ-5 output is presented in plain text through a four-line sixteen-character alphanumeric display panel. For status items, such as Voltage Reduction and Voltage Limit, indicators provide a quick glance summary of MJ-5 Control Panel operating conditions.

Metering

The MJ-5 Control Panel maintains and presents operational data to help you monitor system operation. Instantaneous and demand values (along with minimum and maximum for each) are readily available.

Data Logging

The Data Logging function maintains historical data for subsequent review and analysis. This data can be very useful in the assessment of load characteristics by time of day or season; the reconstruction of system problems; and the improvement of the overall efficiency of the power distribution system.

Voltage Limit Control

Voltage Limit Control (VLC) automatically maintains regulator output voltage within preset high and low limits.

Line Drop Compensation

Line Drop Compensation (LDC) models the resistive and reactive voltage drop of the line. The resulting model is used by the microprocessor to correct regulator output voltage for the effects of line drop between the regulator and the load.

Voltage Reduction Control

Voltage Reduction Control (VRC) reduces output voltage and can be activated automatically, manually, or remotely.

Reverse Power Flow Detection and Operation

In many systems, power only flows in one direction; however, in some systems power flow reverses from time to time. To accommodate power flow reversal, the MJ-5 Control Panel monitors power flow direction and adjusts its operation accordingly. Six different Power Flow Modes allow flexibility in selecting a control algorithm which best matches the power flow needs of the system.

Communications

The MJ-5 panel provides local communications via the front-panel with both a USB serial port and an SD card, which can be used for uploading and downloading configurations. The MJ-5 also supports remote communications via RS-232, RS-485, or network cable.

Barrier Terminal Strips

Terminal contacts on the back of the MJ-5 Control Panel allow for external control over certain functions such as VRC activation and tap changing. These terminals can be used to provide an electrical interface to a SCADA system for remote control applications and/or other desired control functions.

1.3 Mounting on Siemens Regulators

The MJ-5 Control Panels are mechanically and electrically compatible and interchangeable with earlier MJ, IJ and SJ series and earlier control units. They can be mounted in the existing enclosure by simply swinging the control to be replaced outward on its hinges, disconnecting the polarized disconnect switch (PDS), then removing the unit and inserting the new unit (see Appendix B).

1.4 Mounting on Cooper Regulators

A retrofit kit is available for mounting the MJ-5 Control Panels on Cooper regulators. The kit includes all of the necessary hardware and a set of complete instructions for mounting and connecting the MJ-5 to the regulator. The retrofit is accomplished without the necessity of replacing the waterproof housing. See the Retrofitting Cooper Regulators Application Note for details. Contact your Siemens representative for ordering information.

1.5 Mounting on GE Regulators

A retrofit kit is available for mounting the MJ-5 Control Panel on GE regulators. The kit includes all of the necessary hardware and a set of complete instructions for mounting and connecting the MJ-5 to the regulator. The retrofit is accomplished without the necessity of replacing the waterproof housing. See the Retrofitting GE Regulators instruction manuals in Appendixes O and P.

Contact your Siemens representative for ordering information.

1.6 Mounting on Load Tap Changers

A retrofit kit is available for mounting the MJ-5 Control Panels on LTCs. The kit includes all of the necessary hardware and a set of complete instructions for mounting and connecting the MJ-5 to the LTC.

Contact your Siemens representative for ordering information.

1.7 Support Documentation

In addition to this manual, Siemens provides a number of supporting documents that provide details about the use of Siemens regulators and control products.

Contact your Siemens representative or visit the Siemens T&D website for a complete list of Application Notes and other supporting documentation.

1.8 Siemens Website

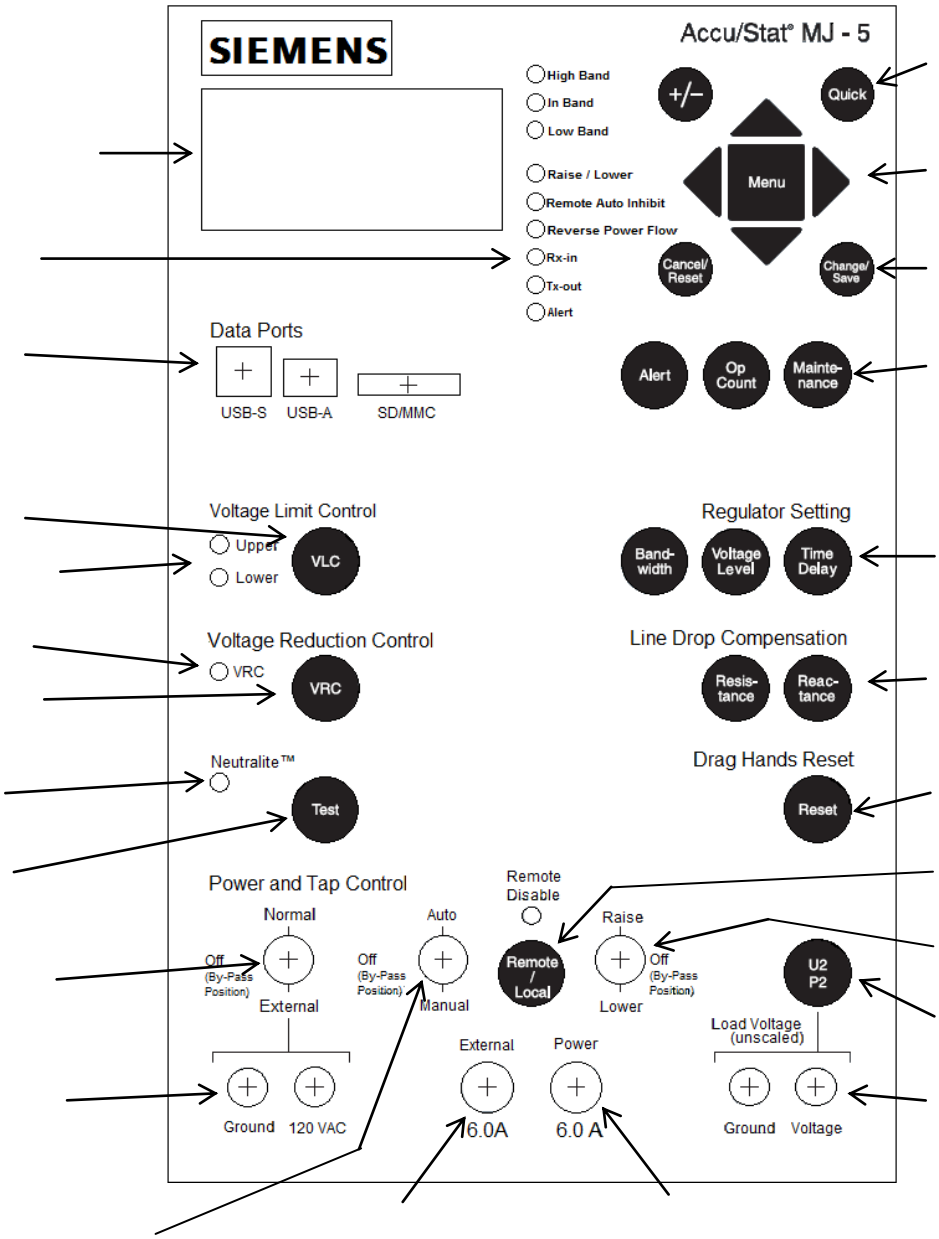
The Siemens website contains information about all of Siemens' transmission and distribution products, including regulators and controls.

All voltage regulator products can be located on the Voltage Regulator product page after navigating to the Siemens Energy website below:

http://www.energy.siemens.com

Browse this section for information about the regulators, regulator accessories, upgrades, downloadable files, and more.

2 Using the MJ-5 Operator Panel and Controls



2 Using the MJ-5 Operator Panel and Controls

2.1 Introduction to the Front Panel

The Front Panel (Figure 2.1) provides access to all controller information. Configuration settings, set point adjustments, and data requests are entered through a set of large touch-keys. Front panel output devices include indicator lights (LEDs) and a four-line sixteen-character alphanumeric display screen.

The front panel is logically divided into three areas from top to bottom:

The top third of the front panel contains various indicator lights, a USB serial port for local data communication, and a four-line sixteen-character display screen. Also included in this area are touch-keys for the selection and modification of set points and data. The keys below and to the right of the display screen select specific readings or settings; the keys to the right of the display screen can be used to change the selected value. This section also contains the Quick, Op Count, and Alert fast-path keys.

The middle third of the front panel includes a group of special fast-path keys that provide direct access to frequently-used functions (Regulation Setting, Line Drop Compensation, Voltage Reduction Control, Voltage Limit Control, Neutralite Test, and Drag Hands Reset).

In the bottom third, the MJ-5 Panel has mode and raise lower switches, a power switch, binding posts for the attachment of external power and metering equipment, and controller fuses.

This chapter describes each of the front panel controls and explains how you can use them to select, view, and change stored data. For more detailed information about the functions provided by these controls, read chapters 4 and 5.

2.2 Four-Line Sixteen-Character Display Screen

The microprocessor presents information to the operator by way of a four-line sixteen-character alphanumeric display screen. This display screen presents both alphabetic and numeric characters in plain text, eliminating the need for special codes. The display screen uses an LCD with backlight that is easy-to-read in direct sunlight as well as in low light conditions.

2.3 Data Display

Front panel touch-keys provide easy access to all data stored in MJ-5 Control Panel memory.

To view or change a given data item you must first display it. Two types of touch-keys are provided to help you display a data item:

- Use the menu selection keys to view any stored data item grouped by Menu Headings.
- Use the fast-path keys to jump directly to frequently used data items without scrolling.

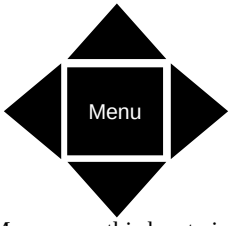
2.3.1 Menu Selection and Change Keys

Use the Menu Selection and Change/Save keys, located in the top third of the front panel, to view and change controller set points and data items.

To view a specific data item, you must first select the menu that contains that item. For example, meter readings are selected from the <**METER**> menu; set points are selected from the <**REGULATOR**> menu. Once the correct menu is selected use the Scroll keys to step through the data items in that menu until the desired data item is viewed on the display screen. (For details about the menus, see Chapter 3 and Appendix G.)

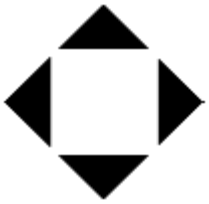
Menu Key

Press this key once to return to the top of the current menu. To return to the start of all menus from any position in any



Menu press this key twice.

Scroll Keys



These triangular keys surround the Menu key. Their shape indicates the direction of scrolling performed by the key.

Use the right and left Scroll keys to scroll across menu headings and move the cursor when in Change mode.

Use the up and down Scroll keys to scroll through data items within a column and change settings when in Change mode.

Change/Save Key

Use this key to place the panel in the Change mode. In Change mode, you can make changes to set points and other stored configuration information.

To change an item:

1. View the item using either the menu selection keys or the fast-path keys.

2. While the indicator arrow is beside an item press the Change/Save key. The indicated data item's value will be displayed and will flash to indicate that it can be changed.

3. Use the Scroll keys to make the desired change.

4. After modifying a data item, press the Change/Save key again to record the change and exit Change mode.

Special Use: While viewing any max/min. screen, press Change/Save key to view the Time/Date stamp for the max/min. item.

Cancel/Reset Key

The function of this key depends upon the function currently being performed:

• If the microprocessor is in Change mode, press the Cancel/Reset key to exit the Change mode and cancel any changes. (The data item will revert to its previous setting.)

• If you are viewing a max or min value, press the Cancel/ Reset key to reset the item to the present meter value.

• If you are viewing Tapmax/Tapmin data items, press the Cancel/Reset key to reset them to the current tap position (see Section 5.7, <**COUNTERS**> menu).

• If you are viewing an ALERT, press the Cancel/Reset key to acknowledge the Alert (see Section 5.8, <**ALERTS**> menu).

Max/Min. Key

Use this key to view max/min values for meter parameters. First view the desired data item, then press the Max/ Min key to view the maximum and minimum values.

Max/Min. data items are displayed for a short period of time, after which the display returns to the current value. The length of this period can be selected by the operator. See Section 4.3.24, Min/Max Time Out.

For example, if you wish to see the minimum load voltage since the last reset, use the Menu Selection keys to select Vld from the Meter Menu. The current voltage value is displayed on the screen. Press the Max/Min key. The minimum and maximum values will display for a short time.

To clear max/min values, see Cancel/Reset Key description.

To display max/min Time/Date stamp, see the Change/ Save key Special Use description.

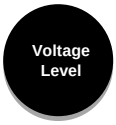
2.3.2 Fast-Path Keys

Fast-path keys are shortcuts that provide direct access to frequently used data items. Once you have selected a data item with a fast-path key, use the Change/Save and Scroll keys to view and change the data item just as you would do with the menu selection keys.

Many of the data items selected by the fast-path keys have both forward and reverse values. For example, if you press the fast-path key labeled "Voltage Level", the data item "Fwd Volts" appears on the display screen. Press the key again to view the *reverse value*. "Rev Volts" is displayed. Press the key repeatedly to alternate the display between forward and reverse values.

Regulation Setting Fast-Path Keys:

Voltage Level Key



The Voltage Level set point defines the output voltage you want the regulator to maintain. Use this key to view the Voltage Level set point. Once you display the Voltage Level, press the Change/Save key to modify the value.

Bandwidth Key

The Bandwidth set point defines a voltage range (on either side of the Voltage Level set point) which you consider to be acceptable. When regulator output voltage falls outside this value, the MJ-5 Control Panel activates the tap changer motor to restore the voltage to an in-band condition.
Use this key to view the Bandwidth set point. Once you display the Bandwidth, press the Change/Save key to modify the value.

Time Delay Key

The Time Delay set point defines the amount of time you want the controller to wait (after regulator output voltage has fallen outside the Bandwidth limit) before activating the tap changer motor. Use this key to view the Time Delay set point. Once you display the Time Delay, press the Change/Save key to modify the value.

Line Drop Compensation Fast-Path Keys

Line Drop Compensation (LDC) defines your estimate of the voltage drop between the regulator and the load center. The MJ-5 control program adjusts regulator output voltage to compensate for this drop. Specify both Resistive and Reactive components of Line Drop Compensation. See Appendix D.2 for instructions about calculating the line drops.

Resistance Key

Press this key to view the Resistive LDC component. The component is broken down into Forward and Reverse. The first value displayed is the FWD Comp. To view the REV Comp, press the Resistance Key again. Once you display the Resistive LDC, (FWD or REV) press the Change/ Save key to modify the value.

Reactance Key

Press this key to view the Reactive LDC component. The component is broken down into Forward and Reverse. The first value displayed is the FWD Comp. To view the REV Comp, press the Reactance Key again. Once you display the Reactive LDC, press the Change/Save key to modify the value.

+/- Polarity Select Key

This key is multiplexed with the Min/Max Key.

Other Fast-Path Keys

Alert Key

Press this key to view the contents of the <**ALERTS**> menu. If any Alert messages are active, press this key repeatedly to step through them in order of priority. If no alerts are active, the message “No Active Alerts” will be displayed. Section 5.8 contains additional information on how to determine the meaning of the various Alerts, and how to acknowledge them.

Press the Cancel/Reset Key to acknowledge the messages.

Voltage Reduction Control (VRC) Key

Press this key to view the Voltage Reduction Control data items. The first data item in that function is VRC status. Press this key repeatedly to step through the VRC settings (Local % reduction, Stage 1-3, VRC Remote, etc.) and then return to VRC Mode and repeat the sequence. See Section 4.4.3 for a discussion of these data items.

Voltage Limit Control (VLC) Key

Press this key to view the VLC Enable data items. Press the VLC key repeatedly to step through the VLC – Upper Voltage set point, and the VLC - Lower Voltage set point and then repeat the sequence. See Section 4.4.4 for a discussion of these data items.

Operation Counter (Op Count) Key

Press this key to select the <**COUNTERS**> menu. The first parameter displayed is the Total Operations count. Press this key repeatedly to step through the <**COUNTERS**> menu data items. See Section 5.7 for a discussion of this menu.

Press this key to view the Overall Contact status screen from the <**MAINTENANCE**> menu. Press the key repeatedly to scroll through the contact status screens and the settings for the maintenance algorithm.

U2 P2 Key

Press this key to toggle between the U2 and P2 voltages when the setting under <**ADV CONFIGURE**> menu U2/ P2 out is set to Toggle.

Neutralite Test Key

Press this key to illuminate the Neutralite Indicator. This is an LED test.

Drag Hands Reset Key

Press this key to reset the electromechanical drag hands on the Position Indicator to the present tap changer position. This also resets the electronically stored max/min. tap position values (viewable from the display).

Quick Key

Press this key to view the items stored in the Quick List. The user-defined Quick Key can display up to 15 different commonly referenced screens. To set a screen to the Quick List, first navigate the menu to display the desired screen. Press and hold the Quick Key for 3 seconds. After which, a notification will show Quick added.

Note: The Quick Key is supported with MJXplorer version 6, however it is not supported with version 5. See Section 4.10 for how to setup this functionality.

Remote/Local Key

Press this key to enable or disable remote control of the control panel. The Remote Disabled LED indicates the status of Remote control.

2.4 Indicators

The front panel also provides user information via individual status indicators. These indicators provide a direct means of assessing operational status.

Alert LED

This indicator is illuminated whenever one or more alerts are active. The indicator may either flash or remain on steadily.

- If flashing, it indicates that one or more alert conditions are active and have not yet been acknowledged.
- If the Alert Indicator glows steadily, it means that a previously-acknowledged alert condition continues to exist.

To acknowledge an Alert, view the Alert screen with the Alert button and then press the Cancel/Reset button.

Reverse Power Flow LED

The Reverse Power Flow (RPF) indicator is illuminated when the microprocessor senses reverse power flow. The indicator will either be off, on, or flashing depending upon both Power Flow mode and Current direction. See Section 4.3.11 and Table 2.1 below.

Table 2.1 Reverse Powere flow Indicator Status

Power Flow Mode	RPF Indicator Status	
	Reverse Current	Forward Current
Neutral R	On	Off
Idle R	On	Off
Co-Gen	On	Off
Bi-Dir	On	Off
F Lock	Flashing	Off
R Lock	On	Flashing
1. (Real component) exceeds 1% rated current for 5 seconds		

If the real component of load current drops below 1% of the rated current, then RPF indicator continues to display its previous state.

If the real component of current is less than 1% when the MJ-5 Control Panel is powered up, the RPF LED is OFF (indicates forward).

Remote Auto Inhibit LED

This indicator is illuminated when automatic tap changes are inhibited. Either the remote operator has sent an automatic inhibit command, the Automatic Inhibit contacts have been activated, or a local operator has pressed the Auto/Manual push-button.

Remote Disabled LED

This indicator is illuminated when Remote control is disabled. When Remote control is enabled a remote operator can change the settings, configuration, and control the regulator remotely. When Remote control is disabled, a

remote operator can only view the status of the control panel. Only a local operator can change the Remote control status by using the Remote/Local push-button.

Band Indicator LEDs

Three Band Indicators, “High", "In Band,” and “Low,” are located at the top of the front panel. The microprocessor continuously compares load voltage (corrected for line drop) against the Voltage Level and Bandwidth set points. The Band Indicator LEDs show the results of this comparison (see Table 2.2).

“In Band” indicates that regulator output voltage is within voltage and bandwidth set points.

“High” indicates that regulator output voltage is out-of-limits on the high side.

“Low” indicates that regulator output voltage is out-of-limits on the low side.

In all power flow modes except Neutral Reverse, if one of the three Band Indicators is *flashing*, it is an indication that tap changes are being inhibited by the control program. In Neutral Reverse, the flashing Band Indicator in conjunction with a Reverse Power Flow condition may mean that the control program is returning the tap position to Neutral.

Table 2.2 Band Indicator Status

Power Flow Mode	Band Indicator Status		
	RPF active and current magnitude exceeds I Threshold %	RPF or FPF with current magnitude < I Threshold %, but not = 0	FPF active and current magnitude exceeds I Threshold %
Neutral R	Flash	Flash	On solid
Idle R	Flash	Flash	On solid
Co-Gen	On solid	Flash	On solid
BI-Dir	On solid	Flash	On solid
F Lock	Flash	On solid	On solid
R Lock	On solid	On solid	Flash

In the above table, the indicator that is flashing or is on solid is the respective Band Indicator (High, Low, or In Band). If all band indicators are *off*, it is an indication that Voltage Limit Control (VLC) is active and compensated regulator output voltage is either higher than the VLC upper limit, or lower than the VLC Lower limit.

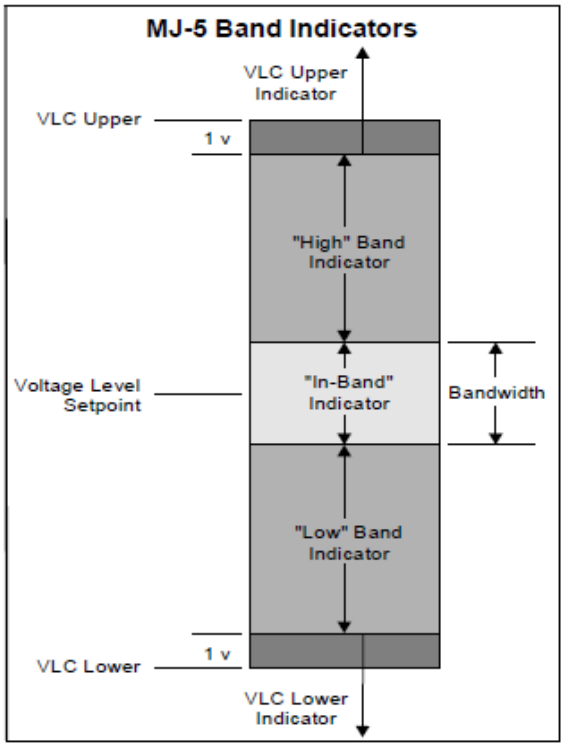


Figure 2.2 Band Indicators and VLC Indicators

Raise / Lower LED Indicator

As a default, the Raise / Lower indicator is continuously illuminated when the tap changer motor is raising or lowering the tap position. However, the Raise / Lower indicator can be configured to flash when the tap changer motor is lowering the tap position. This is accomplished by choosing the Lower LED setting under the <**ADV CONFIGURE**> menu.

Voltage Limit Control LED Indicators

The Voltage Limit Control (VLC) indicators illuminate to indicate that VLC is active. With the VLC upper limit activated, the VLC Upper indicator is illuminated. If the VLC lower limit is activated, the VLC Lower indicator is illuminated.

If VLC is active, and Vld is within 1 volt of the VLC limit, the appropriate VLC and Band Indicator will both be illuminated.

Voltage Reduction Control Active Indicator LED

This indicator is illuminated whenever Voltage Reduction Control is in effect. The VRC LED indicator flashes a unique pattern to indicate which stage, step, or set is active. The pattern depends upon the VRC Mode as described in Table 2.3. See Section 4.4.3 for more information.

Table 2.3 VRC Indicator Flash Patterns

Flashing Patter	VRC Modes			
	Local	Remote (MJ-X)	Remote (MJ-3A)	Auto
On	Active			
long-short		Stage-1	Step 1	Set 1
long-short-short		Stage-2	Step 2	Set 2
long-short-short-short		Stage-3	Step 3	

Neutralite Indicator

The Neutralite indicator illuminates when the tap changer is in the Neutral position. The Neutralite indicator also illuminates when the Neutralite Test key is pressed and held.

Rx-In Indicator

The Rx-In indicator illuminates to indicate Control has received date from the RTU.

Tx-Out Indicator

The Tx-Out indicator illuminates to indicate the Control has transmitted data from the RTU.

2.5 Switches

Power Switch

This three-position switch selects the power source for the MJ-5 Control Panel.

- In the upper (Normal) position, the regulator Utility (tertiary) winding provides power through the polarized disconnect switch (PDS).
- In the lower (External Source) position, the External Source terminals (described below) provide power.
- In the middle (Off) position, the Control Panel is turned off. This is also called the By-Pass Position.

Tap Control Switches (Mode Select Switches)

Auto/Off/Manual Switch

In the MJ-5 panel, the 3 position discrete switch, has the Center = OFF, Down = Manual and Up = Auto functionalities. When in Auto, the panel may be switched between Auto-Remote or Auto-Local modes by pressing the Remote / Local push button.

Tap Control Modes

- Manual / Auto Disabled (By-Pass Position): The operator has control of the regulator's tap changer motor; automatic tap changes are disabled. In this mode, a local operator can use the Raise and Lower switches or push buttons to adjust the tap position or a remote operator could control the tap motor.
- Auto Enabled. The microprocessor has control of the tap changer motor and local manual tap changes are disabled.

Remote / Local Push Button

This push button determines whether the MJ-5 Control Panel is under local control or remote control. Note that the ultimate determination of the point of control is established manually; this switch setting cannot be overridden from a remote location.

- Remote Disabled. In this mode, a remote operator can obtain MJ-5 Control Panel data. However, the remote operator cannot make configuration changes or exercise control of the tap changer motor.
- Remote Enabled. In this mode, a remote operator has access to all functions available to the local operator, including the ability to override automatic control of the tap changer motor.

Raise and Lower Switches

When the Auto Manual Switch is in Manual Mode, this discrete switch activates the Tap changer motor to raise or lower the Tap position.

Switch Positions for Bypassing

The front panel switches must be in the following positions before bypassing the regulator.

- Auto / Manual - OFF
- Remote/Local push-button- Remote Disabled LED is ON
- Power Switch – OFF

DANGER

Possible explosion if bypassed while not on neutral.

Will cause death, serious injury, or property damage.

To prevent:

Place regulator in neutral position before bypassing and disable control panel. See Appendix E for details.

2.6 Binding Posts

Front panel binding posts are dual banana-style receptacles on standard 0.74 inch centers.

External Source Binding Posts

These binding posts can be used to apply 120 V from an external power source to the MJ-5 Control Panel when the power source switch is in the External Source position. The binding posts are dual banana-style receptacles. Ensure that any voltage source attached to these binding posts is properly polarized.

CAUTION

Improper external power connection will place 120V on the ground circuit.

May result in minor or moderate injury including equipment damage.

To prevent:

Observe proper polarity of external power supply.

Voltage Calibration Binding Posts

These binding posts can be used with an external voltmeter to monitor regulator P2 or U2 voltage. Displaying "U2 Cal" or "P2 Cal" in the <DIAGNOSTICS> menu defines the voltage (U2 or P2) you can read at these binding posts. The binding posts are dual banana-style receptacles.

Note that the voltage measured at these binding posts is not turns-ratio corrected. By contrast, the metered voltage presented on the display screen (under <**METER**>) is corrected by control-program software (see Section 4.3.7 and Section 4.3.8 for configuring the voltage transformer U2/P2 turns ratio).

WARNING

Voltage applied at calibration terminals may energize regulator with high voltage through voltage transformer.

Could result in death or serious injury

To prevent:

Do not connect any voltage source at the voltage calibration terminals.

2.7 Fuses

Power Fuse

This 6.0 Amp fuse protects the MJ-5 Control Panel circuit and the tap changer motor circuit.

External Power Source Protection Fuse

This 6.0 Amp fuse protects the MJ-5 Control Panel circuit and the tap changer motor circuit when powered through the external source binding posts.

WARNING

Hazardous voltage present on various control leads when regulator is energized.

Could result in death or serious injury including equipment damage from contact with live line conductors

To prevent:

Bypass the regulator and de-energize before removing accessory items from the control box.

2.8 Terminal Strip Connections

Complete descriptions of all terminal contacts are provided in Appendix K.

Terminal strips are located on the lower back side of the MJ-5 Control Panel. These terminals can be used to provide access to certain microprocessor and other control functions.

The terminal strips include four terminal pairs for VRC control and external inhibit function. The terminal strips include the Current Circuit terminal pair.

Each terminal strip contact is screw type, to facilitate connection and disconnection of external wiring.

Current Circuit Terminal Contacts

The nominal 200 mA secondary of the regulator current transformer (CT) is routed through these terminals labeled C and C2. This terminal pair is provided with a removable shorting bar to accommodate auxiliary apparatus. These terminals are shorted at the factory and must remain shorted unless an appropriate external device is attached.

DANGER

Open CT secondary will result in high voltage at CT terminals.

Will result in death or serious injury including equipment damage.

To prevent:

Do not operate with CT secondary open. Short circuit or apply burden at CT secondary (C2-C) during operation.

2.9 USB Serial Port and SD Card

The USB Serial Port and the SD Port on the front panel supports connection to a PC or other communications device. It transfers data in either direction: the MJ-5 Control Panel can provide meter and status information to an external device, and the control program can be configured from an external device.

The USB Serial Port supports data transmission at standard data rates from 300 to 19200 baud, inclusive, using the 2200 communications protocol enhanced with MJ-5 data fields.

The SD Card Port supports Low Capacity (< 4GB) and High Capacity (>4GB) SD card which can store the configuration and use it to configure the entire system at one time. The SD Card is also used for saving the Logs and is conducted either manually or periodically at certain intervals.

The device used for communications must be configured to match the following Data Port items in the <**COMMUNICATIONS**> menu.

- DatPortBaud
- Data Parity
- DataPortAddr - If addressing is on, use the Comm Addr parameter as the Data Port address.

Note: First time users must download a serial port driver from Siemens.com or by contacting their Siemens representative.

3 Viewing and Changing MJ-5 Data Items

The MJ-5 Control Panel stores a considerable amount of data. Some of the data items are set points used to control the tap changer; others are meter readings and logged historical data that can be used to monitor system activity. All of the major data items can be displayed on the four line sixteen-character screen. The set points and other configuration items can be displayed and changed from the front panel.

This chapter describes how data items are organized, how to view a specific data item, and, if applicable, how to change it.

3.1 Viewing Data Items

The MJ-5 Control Panel provides two techniques for viewing data items:

1. Use Menu Selection keys and Scroll keys to view any data item.
2. Use Fast-path keys to view certain frequently-used data items.

3.2 Understanding Menus

MJ-5 Control Panel information is organized into lists (menus) of related data. Each specific piece of information in MJ-5 memory is known as a data item. To view or change a specific data item, you must select the menu that contains the desired item. Appendix G provides a menu Structure Quick Reference for help in locating a specific data item.

For example, the <**LOG SETUP**> menu contains data items that you can use to define logging requirements. To define logging requirements, view the <**LOG SETUP**> menu; then display the particular data item from that menu. As another example, the <**METER**> menu contains meter-reading data. To determine the present load voltage meter reading, view the <**METER**> menu and then the Load Voltage data item from that menu. The <**METER**> menu is considered the home position in the MJ-5 Control Panel's menu structure.

MJ-5 Control Panel menus are divided into two major categories:

1. Setup menus define the environment. In general, these menus are only used at installation. Examples include:

    - The <**CONFIGURE**> menu, which defines the regulator and its application.
    - The <**REGULATOR**> menu, which defines set points.
    - The <**LOG SETUP**> menu, which defines logging preferences, etc.

2. Operational menus contain daily operational information that can help you monitor system performance. Examples include:

    - The <**METER**> menu, which provides RMS meter readings.
    - The <**DEMAND**> menus, which provide Demand data.
    - The <**LOG**> menu, which contains historical data.

3.3 Using the Menu Selection Keys to View Data Items

This section describes how the Menu Selection and Scroll keys can be used to view data items.

Think of the menu arrangement as a table of data items on a sheet of paper as illustrated in Table 3.1.

Each column of the table has a heading (menu name). Since you are viewing this “table” through a four-line sixteen- character window, you must scroll through the table to view the desired data item. The following scrolling rules apply:

- At the heading level, scroll through the menu headings with the left and right Scrolling keys.
- Within a selected menu, use the up and down Scrolling keys to step through the various data items.

Table 3.1 Structure of MJ-5 Menus

…	<RW DEMAND>	<REV DEMAND>	<COUNTERS>	…
data item 1	data item 1	data item 1	data item 1	data item 1
data item 2	data item 2	data item 2	data item 2	data item 2
data item 3	data item 3	data item 3	data item 3	data item 3

The menu you are viewing is always listed at the top of the screen, pressing the Menu key once will return you to the top of that menu. Press the Menu key again to return to the <**METER**> menu or home position.

Viewing a specific data item with the Menu Selection keys is a two-step process:

1. View the menu that contains the desired data item by stepping left and/or right through the menu structure. Use the ◄ key to move left and the ► key to move right. Data items are grouped according to function so you can readily determine which menu contains the desired data item (see the Menu Structure Quick Reference in Appendix G for help in locating a specific data item).

2. View the desired *data item* by stepping *up* or *down* through the menu until you see the data item name and its value on the display screen. Use the ▼ key to move down in the list; use the ▲ key to move up in the list.

Example

Suppose you want to view the regulator Forward Time Delay set point. This data item is contained in the <**REGULATOR**> menu:

1. Press the Menu key twice to return to the <**METER**> menu.

2. Press the ► key multiple times to step through several menus. When **<REGULATOR>** appears on the display screen, you are positioned in that menu and you can view its data items.

3. Press the ▼ key multiple times to step down through the various data items in the menu (Fwd Volts, Fwd BW, and so on) until "Fwd Delay nnnS" appears and has the indicator arrow => to its left. "nnn" will be the currently stored value (in seconds) for Forward Time Delay.

3.4 Changing Data Items

To change data, you must first view it, as described above. Then press the Change/Save key. The displayed value flashes to indicate that a Change will be accepted and to indicate the data that is to be changed. Press the ▲ and ▼ keys to sequence through the acceptable values. When the desired value is displayed, press the Change/Save key to complete the change.

The procedure for changing configuration parameters is slightly different from the procedure for changing alphanumeric ones. Examples of each type of change follow:

Changing Configuration Parameters

In some cases, you will be choosing from one of several alphabetic settings (for example, the <**CONFIGURE**> menu asks you to select among three System types: WYE, DELTA LAG, and DELTA LEAD).

Example

Suppose you want to change the system type from Delta Lag to Wye. You know (perhaps from checking the menu Structure Quick Reference Appendix G) that the System data item is in the <**CONFIGURE**> menu, so you must first scroll to that menu.

1. Press the Menu key twice to return the display to **<METER>**.

2. Press the ► key to step through the menus until **<CONFIGURE>** is viewed.

3. Press the ▼ key until **Syst:** appears and has the indicator arrow => to the left of it. In this example, the display screen would indicate that the present setting is **Syst: DELTA LAG**.

4. Press the Change/Save key. **Syst:** is displayed with **DELTA LAG** flashing beneath it to indicate that it is the data to be changed. Note: The underscore in this section of the manual denotes flashing.

5. Press the ▼ key to see the next option. **DELTA LEAD** appears on the screen.

6. Press the ▼ key again to see another option. **WYE** appears. Since this is the option you want, press the Change/Save key a second time to complete the change. Data item list appears with **Syst: WYE** on the screen but **WYE** no longer flashes. This indicates that the change has been accepted.

7. Alternative to step 6. If you do not want to save the changes made, press the Cancel/Reset key to exit change mode without changing the values.

Changing Alpha or Numeric Settings

The process of changing alpha or numeric settings is similar to that of changing configuration parameters, except that there are more choices because there may be multiple characters to change, and each character may range in value from 0 to 9, and/or A-Z.

Example

Suppose you want to change the regulator Forward Volts set point from 123.0 volts to 122.5 volts. Set points are contained in the <**REGULATOR**> menu, so you need to view that menu.

1. Press the Menu key twice to return the display to the <**METER**> menu.

2. Press the ► key until **<REGULATOR>** is viewed.

3. Press the ▼ key until **FwdVolts: 123.0** appears with the indicator arrow **=>** to the left of it.

4. Press the Change/Save key to activate Change mode. (The flashing digit indicates the digit to be changed.) **FwdVolts:** appears with **123.0** beneath it. Note: the underscore in this section of the manual (in this case under the 0) denotes flashing.

5. Press the ▲ key five times to increment the digit from 0 to 5.

6. Press the ◄ key to step left one digit. **123.5** now appears. The digit 3 is flashing to indicate that it can be changed.

7. Press the ▼ key to decrement the digit from 3 to 2.

8. Press the Change/Save key to make the change take effect. The data item list appears and **FwdVolts: 122.5** is present.

9. Alternative to step 8. If you do not want to save the changes made, press the Cancel/Reset key to exit change mode without changing any values.

3.5 Using the Fast-Path Keys to View/ Change Data Items

Fast-path keys are the labeled keys on the middle portion of the MJ-5 Control Panel, such as the Voltage Level key. Use the Fast-path keys as a shortcut to certain frequently used data items. Simply press the fast-path key and the desired data item appears immediately.

After viewing an item with a fast-path key, the change procedure is the same as the one just described. In the previous example, the Voltage Level fast-path key would replace steps 1-3 and save a number of key strokes.

4 Setting Up the MJ-5 Control Panel

4.1 Setup—Overview

MJ-5 Control Panel setup procedures allow you to customize the control panel to your needs and to the environment in which it is installed. You can describe specific regulator parameters and power-flow conditions, and define automatic-mode operation. Previous generation controllers used dip switch settings and jumpers for this purpose. With the MJ-5 Control Panel, simply use front panel touch-keys and the display screen to define the operating environment. Also, the MJ-5 communication facilities in conjunction with the MJXplorer software can be used to set up the MJ-5 Control Panel.

The setup process for the MJ-5 Control Panel consists of several steps:

Configuration

In this step, use the <**CONFIGURE**> menu to describe the regulator and the power distribution system. Use the <**ADV CONFIGURE**> menu to adjust optional or advanced settings if desired.

Set Points

In this step, use the <**REGULATOR**> menu to define Automatic Mode set points (voltage level, bandwidth, time delay, etc.).

Logging Requirements

In this step, use the <**LOG SETUP**> menu to define data logging requirements (what values you want logged, how often, under what conditions, etc.).

Security Definition

In this step, use the <**PASSWORD**> menu to define passwords and to activate security protection.

Communications Definition

In this step, use the <**COMMUNICATIONS**> menu to define communications parameters (baud rate, unit address, etc.).

This chapter describes each of the setup parameters, and explains how they are defined. The Communications Module Instruction book contains additional detail and background information to help you make the proper selections.

Table 4.1 The <**CONFIGURE**> menu

DATA ITEM	DESCRIPTION	VALID INPUTS	DEFAULT	INC
TapChngr	Tap Changer Type	SIEMENS, GE, LTC, LTC.5, or COOP SD, DD, or QD	**SIEMENS**	- - -
Type	Regulator type	STRAIGHT or INVERTED	**STRAIGHT**	- - -
Syst	System wiring configuration	WYE, DELTA LAG, DELTA LEAD	**WYE**	- - -
DeltaPwr	Delta power configuration	OPEN or CLOSED	**OPEN**	- - -
Utility Pol	Utility winding polarity	NORM, REV	**NORM**	- - -
Vprimary Max	Maximum primary voltage	65K (for regulators) or 650K (for LTC transformers)	**65K**	- - -
U2 PT	Utility winding turns ratio	1500 to 65,500:100 to 150	**7200:120**	1 Volt
P2 PT	Potential Transformer turns ratio	1500 to 65,500:100 to 150	**7200:120**	1 Volt
CTratio	Current Transformer turns ratio	50 to 7200:0.0 to 9.5	**200:0.2**	1:0.1
I FullLoad	Regulating Device Full Load Rating	50 to 7200	**200**	1 Amp
PwrFlow	Power flow modes	F LOCK, R LOCK, IDLE R, BI-DIR, NEUT R, CO-GEN	**F LOCK**	- - -
Basis volts	Controller nominal voltage level	115, 120, or 125v	**120**	- - -
NeutOvRun	Neutral Over Run	0.0 to 3.0 seconds	**2.0**	0.1 sec
Reset Min/Max?	Reset all min/max readings	N or Y	**N**	- - -
Vers	Microprocessor software version	NN.NNNN	- - -	- - -
Memo1	User-supplied text	Up to 10 Characters	**Reg. Serial#**	- - -
Memo2	User-supplied text	Up to 10 Characters	**Tested by**	- - -

Table 4.2 The <**ADV CONFIGURE**> menu

DATA ITEM	DESCRIPTION	VALID INPUTS	DEFAULT	INC
Meter Volts	Display Primary or Secondary volts	SEC, PRI	SEC	---
I Threshold %	Tap change minimum current	0% to 10 %	0%	1%
I Shift	Current shift for reverse power flow	0˚ to 359˚	0˚	1 ˚
I Load Max	Max. Load Current (for Overcurrent)	0% to 350%	350%	1%
PT Threshold	Tap change low voltage limit	0 to 134	90	1%
Time	Time of day	HH:MM:SSA/P	---	---
Date	Date	NN/NN/NN	---	---
Format	Date format	Mo/Da/Yr or Da/Mo/Yr	Mo/Da/Yr	---
Daylight Savings	Daylight Savings Time	ON or OFF	ON	----
Dmd Type	Method for determining Demand	THERMAL or WINDOW	THERMAL	---
Dmd Time	Demand Period length (minutes)	1 to 999	30	1 Minute
Dmd Subperiods	Number of Demand subperiods	1 to 99 (For Sliding Window mode only)	6	1
Min/Max t.o.	Min/Max display timeout (seconds)	1 to 99	15	1 Second
Screen t.o.	Show default display screen (min.)	1 to 99	5	1 Minute
Quick t.o.	Quick menu display timeout (second)	1 to 59	10	1 Second
QuickDispTim	Quick menu slideshow time (second)	1 to 10	2	1 Second
AutoVari-Amp	Automatic Vari-Amp Protection	ON or OFF	OFF	---
SoftVari-Amp	Sofware Vari-Amp setting	ON or OFF	OFF	---
R Limit	Raise Limit (Alert & Soft Vari-Amp)	10, 8 $^3/_4$, 7$^1/_2$, 6 $^1/_4$, 5 %	10%	1 $^1/_4$%
L Limit	Lower Limit (Alert & Soft Vari-Amp)	10, 8 $^3/_4$, 7$^1/_2$, 6$^1/_4$, 5 %	10%	1 $^1/_4$%
Slave Master	Put two tap changer in locked step (Ref. Comm. Manual Section 8)	OFF,MA,Sl,S2	OFF	
Tap Alert	Enable or disable tap alerts	ENABLE or DISABLE	ENABLE	---
Alrt M= Alrt C= Alrt S=	Metering Control System	Y (to enable) or N (to disable) Y (to enable) or N (to disable) Y (to enable) or N (to disable)	Y Y Y	--- --- ---
Tap Resync	Synchronizes tap position at Neutral	ON or OFF	OFF	---
Comm AutoInh	Turns SCADA auto inhibit ON or OFF	ON or OFF	OFF	---
Lower LED	Raise Lower Indicator Functionality	Solid, Blink	Solid	---
P2 Calc	P2 Calculation	ON, OFF	ON	---
U2/P2 Out	Load Voltage Terminal Locking	VLoad, Toggle, U2, P2	VLoad	---
I Dir Bias	Current Bias Functionality	None, Fwd, Rev, Neut T	None	---
Bias %	Current Bias Percent	0 to 10%	0%	---
Remote BTN	Remote/Local Button Functionality	Enabled, Disabled	Enabled	---
Macntrl	Master slave control voltage (Ref. Comm. Manual Section 8)	Master, Highest, Lowest, Average		

4.2 Setup for Retrofit Panels

If you are retrofitting either a G. E. or Cooper regulator for use with the Siemens MJ-5 Control Panel, please refer to the Appendix. Contact your Siemens representative for details.

4.3 Defining Your Regulator— The <CONFIGURE> and <ADV CONFIGURE> Menus

When the MJ-5 Control Panel is delivered pre-installed on a regulator, many of the configuration variables are already set. However, the MJ-5 Control Panel provides a wide range of additional variables that can be used to make the regulator perform more effectively in your system.

Variables in the <**CONFIGURE**> menu are summarized in Table 4.1; variables in the <**ADV CONFIGURE**> menu are summarized in Table 4.2; both menus are explained in the following pages.

Figures 4.1 to 4.4 show typical Siemens regulator nameplates. Refer to these figures for information that can be obtained from Siemens regulator nameplates

CAUTION

Use of incorrect drawings or Schematics

Could result in minor or moderate injury including damage to the regulator or control components

Use the Example diagram for illustration purposes. Refer to the regulator nameplate for the proper control diagram to use with a particular installation

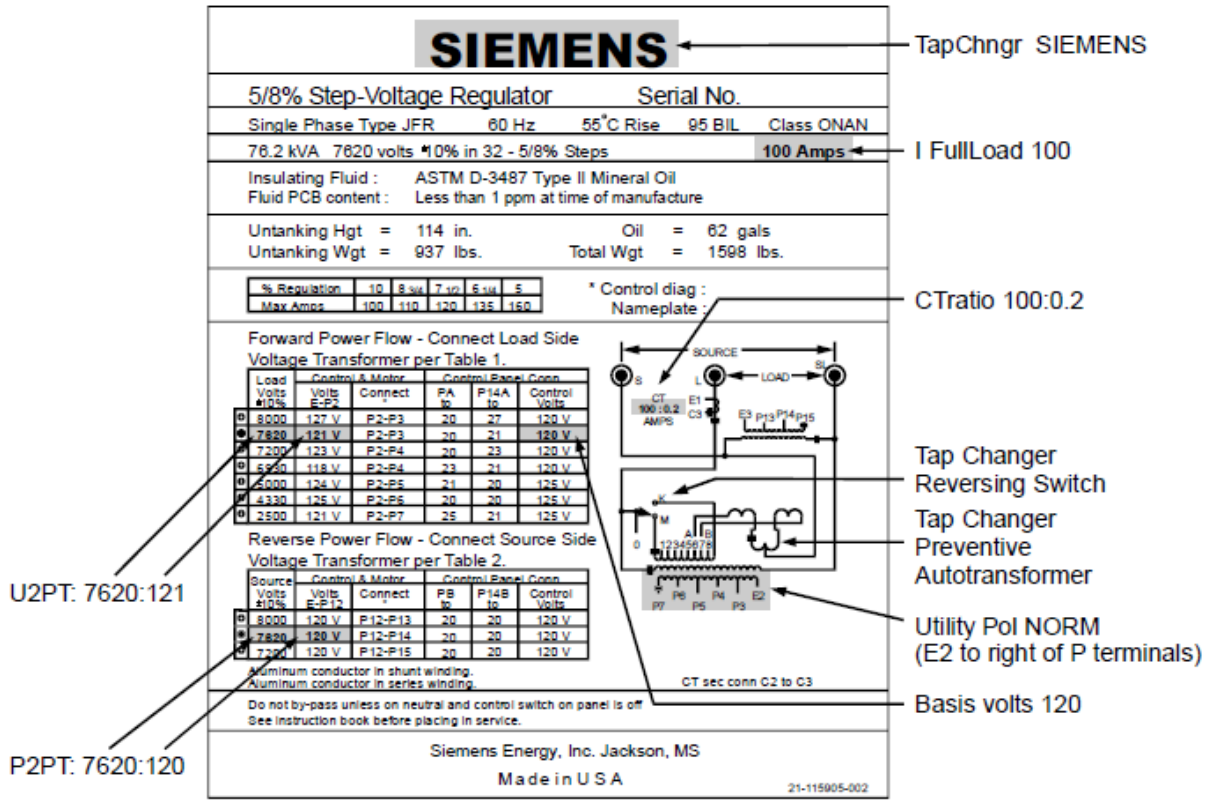


Figure 4.1 Typical Siemens Regulator Nameplate for older ANSI Type B (Inverted) Regulator
Note: Items are not highlighted on actual nameplate

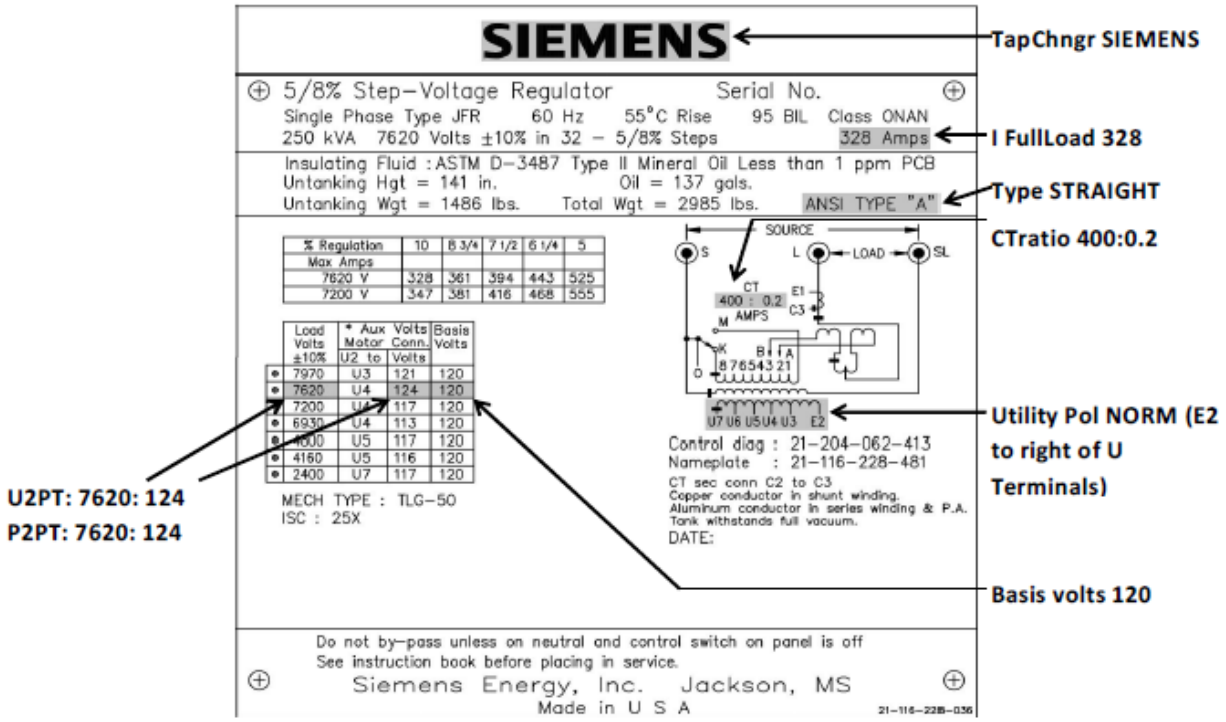


Figure 4.2 Typical Siemens Regulator Nameplate for ANSI A (Straight) regulator without a Load Side PT.

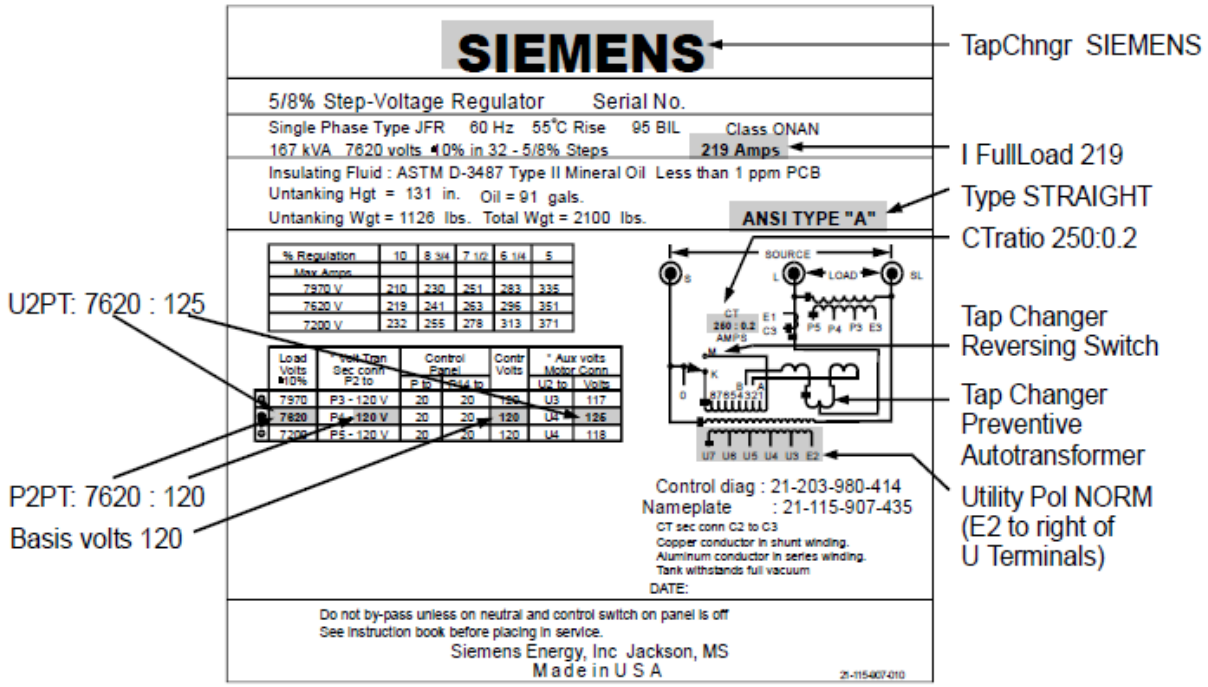


Figure 4.3 Typical Siemens Regulator Nameplate for ANSI Type A (Straight) regulator
Note: Items are not highlighted on actual nameplate.

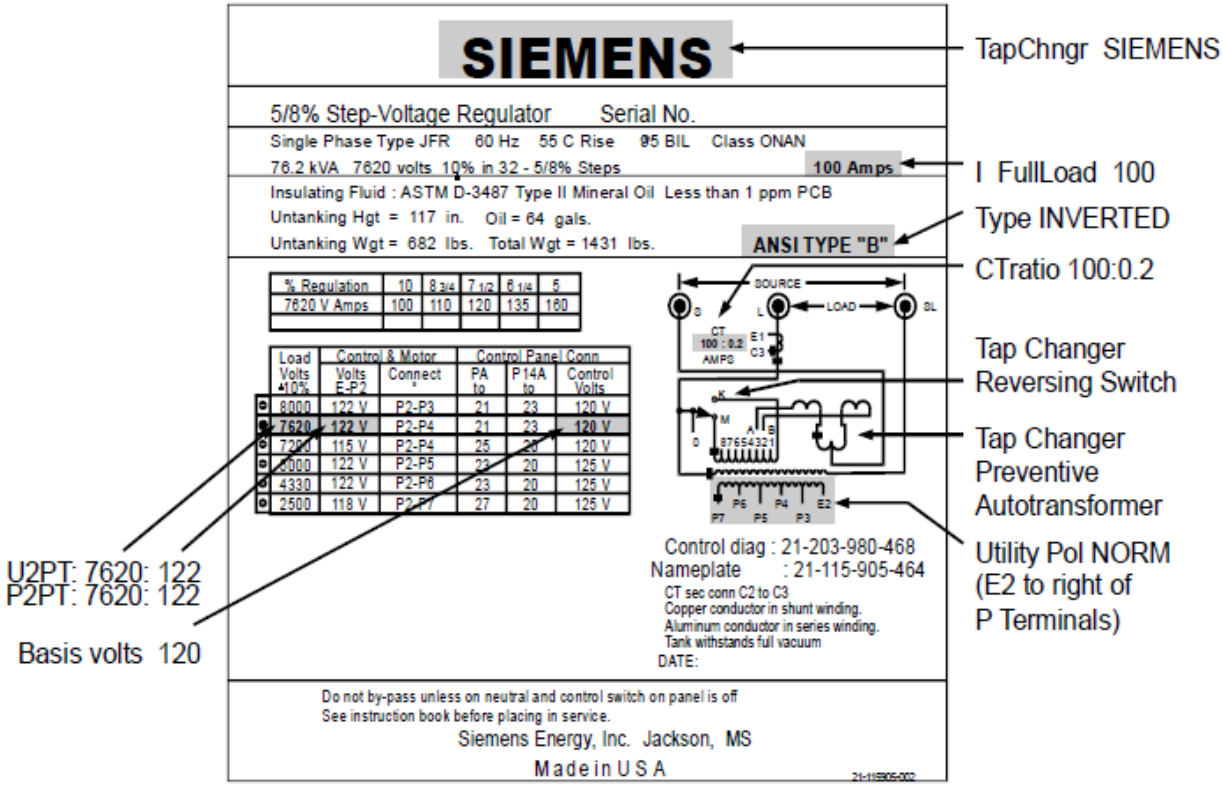


Figure 4.4 Typical Siemens Regulator Nameplate for ANSI Type B (Inverted) Regulator
Note: Items are not highlighted on actual nameplate.

The <CONFIGURE> Menu

4.3.1 TapChngr (Tap Changer Type)

The TapChngr data item defines the tap changer mechanism type. Tap changer mechanisms vary among regulating device suppliers. This data item allows the MJ-5 to be configured specifically for the connected tap changer device.

4.3.2 Type (Regulator Type)

The Type data item defines the step-voltage regulator type. The designations "straight" (ANSI Type: A) and "inverted" (ANSI Type: B) are frequently used to denote the difference. See Figures 4.1 to 4.4 for examples.

Since November, 1995, the regulator type is identified by either an ANSI Type A or B designation. Older nameplates did not include this information and the type must be determined from the schematic diagram on the regulator nameplate.

"STRAIGHT" design characteristics: (See Figure 4.2 and 4.3).

- The source ('S') bushing is connected to the tap changer reversing switch and to one end of the main winding.
- The load ('L') bushing is connected via the preventive autotransformer to the moving contacts of the tap changer.
- The utility (tertiary) winding leads are labeled U3, U4, U5, ...

"INVERTED" design characteristics: (See Figures 4.1 and 4.4)

- The source ('S') bushing is connected via the preventive autotransformer to the moving contacts of the tap changer.
- The load ('L') bushing is connected to the tap changer reversing switch and to one end of the main winding.
- Utility (tertiary) winding leads are labeled P3, P4, P5, ...

4.3.3 System (Regulator Installation)

The System data item defines whether the regulator is Delta or Wye-connected. See Appendix D, section D.1 for guidance in determining which regulator is leading and which is lagging (for Delta-configured regulators).

4.3.4 DeltaPwr (Delta Power)

The Delta Pwr item defines the wiring arrangement for Delta-connected systems. Specify either Open or closed. The setting does not matter for a Wye-connected system.

4.3.5 Utility Pol (Utility Polarity)

The Utility Pol data item allows you to correct for polarity differences between the CT winding and the Utility (Tertiary) winding.

To define the Utility Polarity, view Utility Pol; then,

1. If you have a single-phase Inverted-type regulator, specify Utility Pol: Norm.
2. If you have a single-phase Straight-type regulator, see Appendix D, section D.3.

4.3.6 Vprimary Max

The Vprimary Max setting defines the maximum voltage on the primary side of the U2 PT and P2 PT ratios. Set 650k for LTC transformers; use the default of 65k for voltage regulators.

4.3.7 U2 PT (Utility (tertiary) Winding)

The U2 Potential Transformer ratios are used by the control program to scale the voltages supplied by the regulator to the basis voltage (nominal 115, 120, or 125 V).

Many regulators are built with transformer turns ratios that do not provide the exact basis voltage (115, 120, or 125 V) to the controller. Previous generation controllers include a tapped sensing transformer to correct the voltage. Instead of using a sensing transformer, the MJ-5 corrects the voltage mathematically, using the U2 PT turns ratio. Determine the turn ratio for the regulator from the regulator's nameplate.

The U2 PT data item defines the turn ratio of the winding that appears at the U2 terminal on the Polarized Disconnect Switch (PDS).

To define the turn ratio, you must first determine which column in the nameplate describes the "U2" secondary for a given primary voltage. The U2 pin is attached to the regulator Utility Winding. The U2 lead provides the power to the controller, and is always present. It is often labeled Motor Conn. or Control & Motor on the nameplate. See Figure 4.1 to 4.4 for examples.

View U2 PT. Then, specify the turn ratio exactly as it is specified on the regulator nameplate (e.g., 7620:121). The microprocessor will correct the reference voltage to the basis voltage (115, 120, or 125 V).

4.3.8 P2 PT (Potential Transformer)

The P2 PT data item defines the turn ratio of the Potential Transformer appearing at the P2 terminal on the Polarized Disconnect Switch (PDS).

Note: For regulators with no potential transformer, set the P2 ratio to the same value as the U2 ratio.

Many regulators are built with transformer turns ratios that do not provide the exact basis voltage (115, 120, or 125 V) to the controller. Previous generation controllers include a tapped sensing transformer to correct the voltage. Instead of using a sensing transformer, the MJ-5 corrects the voltage mathematically, using the P2 PT turns ratio. The turn ratio for a given regulator can be determined from the regulator's nameplate.

To define the turn ratio, you must first determine which column in the nameplate describes the "P2" secondary for a given primary voltage. P2 describes the pin on the Polarized Disconnect Switch (PDS, or jack plug). The P2 pin is attached to the regulator Potential Transformer secondary (if present), and is usually labeled Control Volts on the nameplate. See Figures 4.1 to 4.4 for examples.

Note: For an ANSI type B regulator, the utility winding tap leads are labeled P3, P4, P5, ... and the P2 lead is connected to the U2 terminal on the PDS.

View P2 PT. Then, specify the turn ratio exactly as it is specified on the regulator nameplate (e.g., 7620:121). The microprocessor will correct the reference voltage to the basis voltage (115, 120, or 125 V). Default value is 120 V.

If an inverted (Type B) regulator has a source-side Potential Transformer, the utility (tertiary) winding leads are labeled P3, P4, etc., and the P2 lead is connected to the "U2" terminal on the PDS. The source-side PT leads are now labeled P12, P13, etc., and the P12 lead is connected to the P2 terminal on the PDS in the control box.

Note also that no reverse power flow relay is required. The microprocessor senses the reversal and applies the appropriate polarity.

4.3.9 CTratio (Current Transformer Ratio)

The Current Transformer ratio defines scaling for current measurements.

View CTratio: then specify the ratio exactly as specified on the nameplate. See Figures 4.1 to 4.4 for examples.

The primary side of this ratio is also used by the control program to define the CT primary rating. This rating and the I Threshold % define a tap change deadband for use during certain reverse power flow conditions. (I Threshold % is described below.)

4.3.10 I Full Load

This item specifies the Full Load Current for use in determining when an Overcurrent condition occurs. Typically, the Full Load Current setting is the same as the CT Primary (the first number of the CT Ratio screen), though this is not always the case. Locate the regulator's Full Load Current specification on the upper right side of the nameplate (just below the "Class" specification). The regulator nameplate shows the Full Load Current as "XXX Amps." Enter the value for the Full Load Current setting into the MJ-5. See Figures 4.1 to 4.4 for examples.

4.3.11 Power Flow Modes

The Power Flow Mode data item allows you to specify which control program algorithm will be used under reverse power flow conditions. Systems which experience power flow reversals have unique control requirements. The MJ-5 Control Panel senses the reversal and modifies its operation based on the Power Flow Mode selected.

This section provides an introduction to each of the modes, and describes how to select the desired mode. See Chapter 6 for a detailed discussion of the operational differences between the modes.

Forward Locked Mode

This mode of operation (F LOCK) is intended for use in systems where reverse power flow is not anticipated. Tap changes are inhibited under reverse power flow conditions.

Reverse Locked Mode

This mode of operation (R LOCK) is intended for use in systems where forward power flow is not anticipated. Tap changes are inhibited under forward power flow conditions. For this mode a Source-side Potential Transformer is no longer required. See Sections 5.1 and 5.2.

Bi-directional Mode

This mode of operation (BI-DIR) is intended for use in systems where reverse power flow is anticipated and voltage regulation is desired under both forward and reverse power flow conditions. For this mode a Source-side Potential Transformer is no longer required. See Sections 5.1 and 5.2.

Idle Reverse Mode

This mode of operation (IDLE R) is intended for use in systems where reverse power flow is to be treated as an abnormal situation. When reverse power flow is recognized, the regulator idles at the last tap position held before the reversal.

Neutral Reverse Mode

This mode of operation (NEUT R) is intended for use in systems where reverse power flow is to be treated as an abnormal situation. When power flow reversal is recognized, the regulator returns the tap changer to the neutral tap position.

Co-Generation Mode

This mode of operation (CO-GEN) is for use in systems where consumer-generated power may sometimes flow from the consumer to the Utility. Under reverse current flow conditions, forward regulation is allowed, using reverse Line Drop Compensation settings.

4.3.12 Basis Volts

The Basis Volts data item defines whether the MJ-5 control program is to convert the regulator transformer secondary

voltage to 115, 120, or 125 Volts. See U2 PT and P2 PT data items above. Also see Section 5.3.2.

4.3.13 NeutOvRun (Neutral Overrun)

The Neutral Overrun data item keeps the tap motor on for a specified amount of time when making a tap change into the neutral tap position. This ensures that the reversing switch is always closed in order to prevent the contacts from corroding due to capacitive discharge. For regulators with a TLG mechanism set to 2.0 seconds. For regulators with a TLF mechanism set to 1.7 seconds.

4.3.14 Min/Max Reset

The Min/Max Reset data item resets Meter and Demand max/min values in the microprocessor to current instantaneous values. This function is useful when setting up the microprocessor for the first time, or when you want to reset electronically-maintained values.

Note: Do not use this function unless you want to reset all Meter and Demand min/max values; to reset selected values, use the Cancel/Reset key described in Chapter 2.

To request that Meter and Demand Max/Min values be reset, view Reset Max/Min; use the Change/Save Key and the Scroll keys to change the default N(o) to Y(es). Then press the Change/Save key to complete the change process.

4.3.15 Version

Main Processor software version NN.NNNN. This data item displays the installed version of the microprocessor control program.

4.3.16 Memo 1 and Memo 2

These two data items allow you to record installation-specific information that can be viewed at a later time. For example, you might wish to use one Memo to document the regulator's serial number, and the other Memo to document its location. This information could then be viewed by a remote operator via a communications link.

To enter data into these data items, view the <**CONFIG-URE**> menu; then use the Scroll keys to view Memo 1 or Memo 2. The display screen responds by flashing the "blank" character (■) in the leftmost position of the ten character Memo field. This indicates the character to be changed. Use the ▲ and ▼ keys to step through the alpha and numeric characters until the desired character is presented on the display screen. Then press the ► key to move the cursor to the next character to the right, and so on until all ten characters of the Memo have been entered. When you have completed entering the Memo, press the Change/Save key to complete the change.

Valid characters are A-Z; 0-9; space; comma; semi-colon; period; dash; slash; ampersand (&), and the # character. Default is for Memo 1 to contain the regulators serial number and for Memo 2 to contain the initials of the control panel tester.

The <ADV CONFIGURE> Menu

4.3.17 Meter Volts (Meter Scaling)

The Meter Volts data item determines which voltage is presented on the display screen. You can choose either the Primary side (system voltage—e.g., 7620 V) or the Secondary side (120 V nominal).

Specify PRI if you wish to monitor the system-level voltage; specify SEC if you wish to monitor voltage scaled to the nominal 120 volt range. Voltages in the <METER> menu are displayed according to the Meter Volts setting.

Note: Power and energy calculations are always derived from the system-level voltage and are not affected by the Meter Volts setting.

4.3.18 I Threshold% (Low Current Threshold)

The I Threshold% data item defines a threshold for load current magnitude, below which automatic mode tap changes are inhibited. This threshold is defined as a percentage of the CT primary rating (see CTratio above).

For example, in the case of a regulator with a CTratio of 200:0.2, the CT primary rating would be 200 A. If you specify I Threshold% = 4, you are defining a low current threshold of 8 A. (4%*200 A = 8 A). To set the low current threshold, view I Threshold%: and specify a percentage of the full scale CT primary rating.

4.3.19 I Shift (Current Shift)

The I Shift data item compensates for system current-to-voltage phase differences. Consult the factory for proper application of this data item. (Note: This data item is primarily intended for use with Load Tap Change (LTC) transformers.)

4.3.20 I Load Max (Maximum Load Current)

This item specifies the Maximum Load Current as a percentage of the Full Load Current. When the load current (Ild) exceeds the Maximum Load Current, the MJ-5 activates the Overcurrent Alert condition.

4.3.21 PT Threshold (Potential Transformer Threshold)

The PT Threshold data item defines a low-voltage threshold. This parameter allows you to specify a voltage level below which automatic mode tap changes will be inhibited.

4.3.22 Time and Date Items

Time (Time of Day)

The Time data item allows you to set the real-time clock. Specify the present time, TIME: HH:MM:SS A/P (e.g. 04:34:54P).

Date

The Date data item allows you to set the real-time calendar. Use the format selected in the Format item. If the format defined below is MO/DA/YR, enter the date as 09/30/07.

Format

The Format item allows you to set the format for the Date.

Daylight Sav (Daylight Savings Time)

The Daylight Sav data item automatically adjusts the clock for the time changes on the second Sunday in March and the first Sunday in November.

4.3.23 Demand Methods

Demand values are system parameters that have been averaged over a user-defined time period. Demand values are accumulated separately for both forward and reverse power flow conditions. Demand values can be viewed in the Forward and Reverse <**DEMAND**> menus (see Chapter 5).

The MJ-5 Control Panel accumulates demand values for Load Voltage, Source Voltage, Compensated Voltage, Load Current, kW, kVAR, and kVA. In addition, Power Factor is stored whenever a new kVA maximum or minimum is recognized.

Demand calculations are reset at the following times: system power up, when demand configuration items are changed, and when power flow direction changes.

When a demand value is reset, dashes '-' appear on the display screen until completion of the first demand period.

The MJ-5 Control Panel provides two methods of computing demand: the Sliding Window method and the Thermal averaging method.

Sliding Window Method

The Sliding Window (or rolling interval) method divides the time interval into subperiods. Meter values are individually recorded once each second. At the end of each subperiod an average value is derived for each Meter value; the values for the oldest subperiod are discarded and new demand values are calculated.

The DmdTime parameter specifies the number of minutes in the period; the DmdSubperiods parameter specifies the number of subperiods in the demand period. For example, a DmdTime of 30 minutes and a DmdSubperiod of 6 subperiods defines a thirty minute sliding window that moves every five minutes.

To use the Sliding Window method, view Dmd Type and specify WINDOW. Then view DmdTime and specify the length of the period in minutes (1 to 999); view DmdSub-periods and specify the number of subperiods as a number between 1 and 99.

Thermal Method

The Thermal method is typical of the characteristic time lag of mechanical or thermal devices as they absorb electrical energy. It is based on the Code for Electricity Meters, ANSI C12-1975, which defines the interval of a thermal demand meter as the time required for the meter to indicate 90% of a change in the load. Demand values are updated once each second.

For example, if you specify DmdTime = 15, the demand meter indicates 90% of a steady load fifteen minutes after the load is applied. In the next fifteen minutes, it responds to 90% of the remainder of the total load. As a result, the load is constantly averaged and transient variations are not reflected.

Note: The Demand Subperiod data item is ignored by the Thermal method.

4.3.24 Min/Max t.o. (Min/Max Time Out)

The Min/Max t.o. data item defines the length of time that the Min/Max data items will be presented at the display screen. At the end of this period, the display returns to the present value.

To specify the Min/Max timeout period, view Min/Max t.o.; use the Change/Save key and the Scroll keys to define the number of seconds in the time-out period. Then press the Change/Save key to complete the change process.

4.3.25 Screen t.o. (Screen Time Out)

The Screen t.o. data item defines the length of time that any data item is displayed. At the end of the timeout period, the display returns to the default display defined by the DspScr data item.

4.3.26 Quick t.o. (Quick Time Out)

The Quick t.o. data item defines the length of time that the Quick List data items will be presented at the display screen. At the end of this period, the display returns to the previous screen. See section 4.10.

4.3.27 QuickDispTim (Quick Display Time)

The QuickDispTim data item defines the length of time that each data item in the Quick List will be displayed before moving to the next item when the Quick List is in its slide show mode. See section 4.10.

4.3.28 AutoVari-Amp

The AutoVari-Amp data item enables a capability that automatically reduces the tap position based on the average load current over the last 10 minutes compared to the I Full Load. For example, if the regulator is at 105% of its rated current on average for the last 10 minutes, the regulator will not be permitted to move past 14 raise or lower and it will move to 14 raise or lower if it is on a higher tap. If the regulator is at 140% of its rated current on average for the last 10 minutes, the regulator will not step past 8 to

raise or lower and it will move to 8 raise or lower if it is on a higher tap.

When planning to overload a regulator use either the Soft Vari-Amp or the knobs on the position indicator. AutoVari-Amp is for protection in case of accidental overload only. The Vari-Amp limits are defined in the voltage regulator instruction manual.

4.3.29 Soft Vari-Amp (SoftwareVari-Amp)

The Soft Vari-Amp data item is a software implementation of Vari-Amp knobs on the position indicator. If set to ON, the R Limit % and L Limit % will prohibit tap raise/lower past that position. The regulator will be limited by both the Vari-Amp knobs and the SoftVari-Amp. The actual boundary will be the most restrictive combination of the two (e.g., knobs limit R to 10%, L to 7.5% and software limit R to 5% and L to 8.75%. In this case the limits would be R at 5% and L at 7.5%).

4.3.30 R Limit, L Limit

These items set the Tap Position Raise and Lower Limit values; the control uses the limit values to check for "raise/lower limit reached" Alert conditions. Configure these parameters to match the Vari-Amp settings on the side of the Tap Position Indicator Dial mounted on the regulator. (For most applications, the Vari-Amp settings are at 10%.) If the Tap Position reaches or exceeds the R Limit Setting, the control activates the "R Limit Reached" Alert. Likewise, if the Tap Position reaches or exceeds the L Limit Setting, the control activates the "L Limit Reached" Alert. The R Limit/L Limit settings are always used for alerting—these limit settings only prevent tap raise/lower operations from exceeding the limits if Soft Vari-Amp setting is turned ON.

4.3.31 Tap Alert

The Tap Alert data item enables or disables all tap alerts, including: R Limit Reached, L Limit Reached, Neut Sig Err, Tap Pos ???, and Tap Track Err.

4.3.32 Alrt M=? C=? S=?

The Alrt data item permits groups of alerts to be turned off and on. Metering (M) alerts include Low Current, Low PT Thresh, Over Current, and High Voltage. Control (C) alerts include Auto Inhibit, Pseudo Manual, and Not in Auto. System (S) alerts include NV RAM Reset, Low Battery, and Self-Test Fault. Press change and use the left/right and up/ down arrows to adjust the M, C, and S alert settings.

4.3.33 Tap Resync

The Tap Resync data item determines whether the electronic tap position will re synchronize itself to neutral when the tap changer is on the neutral tap. Turning this data item OFF results in better tap tracking and the control will not adjust its tap position according to the neutral signal. Turning this data item ON will require the neutral signal status to precisely match the electronically tracked tap position and the timing of the operations counter or the maintained tap position will be purposely discarded.

4.3.34 CommAutoInh (Communications Auto Inhibit)

The Comm Auto Inhibit data item provides a way to change the state of the Auto Inhibit status at the control panel. This can be used if the Auto Inhibit state is turned on remotely and the communications link goes down; in this event, someone can go to the controls location and enable automatic operation again.

4.3.35 Lower LED

In the MJ-5 panels, the Raise and Lower LEDs have been combined to one single LED. When lowering the Tap position the user may choose to have the LED glow solid or blink by choosing the setting. The Raising of the tap position will be indicated by the LED glowing solid. The default setting for the Lower LED is solid.

4.3.36 P2 Calc

P2 Calculation can be enabled or disabled from the P2 Calc screen. P2 Calculation should be enabled for regulators that have no Potential Transformer. For regulators with voltages on both the Load and Source bushing, the P2 calculation may be disabled. Thus, if the PT is faulty, the voltage in the meter menu will be indicated by dashes. The default is for P2 calculation to be enabled.

4.3.37 U2/P2 Out

When measured with a multi-meter, the Load Voltage (unscaled) terminals on the front panel have been locked to show the Load side voltage by default. The load voltage will vary depending on the user defined power flow mode and the power flow direction. The terminals may be locked to show exclusively U2 or P2 only, or the terminals can be configured to toggle between the two voltages with successive key presses of the U2 P2 Key.

4.3.38 Current Bias

The user may choose None, Fwd, Rev or NeutT for current flow modes. The Bias percent is selected from the following Bias % data item.

4.3.39 Bias Percent

The minimum Bias percent is 0% and the maximum is 10%. The user may choose to use any value between the maximum and minimum in increments of 1%. This functionality is only in effect when the power flow mode is Bi-Directional and Current Bias is not selected as "None". Note that the Bias percent must be greater than the I Threshold %. *Typically, I Threshold % should be set to 0%.* For a detailed description, see *Section 6.5.3*

4.3.40 Remote Btn

The functionality of the Remote / Local button can be enabled or disabled from this screen. When Enabled, pressing the Remote/Local button will cause the control to function as described in Section 6.1; when set to Disabled, the control can enter the Manual, Off, or Auto-Remote modes. The Auto-Local mode is disabled.

4.4 Setting Control Levels— The <REGULATOR> Menu

The <**REGULATOR**> menu defines set points used by the MJ-5 Control Panel when operating in Automatic Mode

Table 4.3 The <**REGULATOR**> menu
Variables in the <**REGULATOR**> menu are summarized in Table 4.3 and described in detail in the following sections.

DATA ITEM	DESCRIPTION	VALID INPUTS	DEFAULT	INCREMENTS
		Forward power flow		
Fwd Volts	Voltage set point level	106.0 to 134.0	**120.0**	0.1 Volt
Fwd BW	Bandwidth set point	1.0 to 6.0	**2.0**	0.5 Volt
Fwd Delay	Time delay set point	10 to 180	**45**	1 Second
Fwd Comp(R)	Voltage compensation (Resistive)	- 24 to + 24	**0**	1 volt
Fwd Comp(X)	Voltage compensation (Reactive)	- 24 to + 24	**0**	1 Volt
		Reverse power flow		
Rev Volts	Voltage set point level	106.0 to 134.0	**120**	0.1 Volt
Rev BW	Bandwidth set point	1.0 to 6.0	**2.0**	0.5 Volt
Rev Delay	Time delay set point	10 to 180	**45**	1 Second
Rev Comp(R)	Voltage compensation (Resistive)	- 24 to + 24.	**0**	1 volt
Rev Comp(X)	Voltage compensation (Reactive)	- 24 to + 24	**0**	1 Volt
		Voltage Reduction Control		
VRC Stat*	Present VRC % reduction	0.0 to 10.0	- - -	- - -
VRC Mode:	Voltage Reduction Control mode	OFF, LOCAL, REMOTE, AUTO	**OFF**	- - -
		VRC Input Special Applications		
Alt Delay	Alternate time delay for voltage reduction	1 to 180	**5**	1 Second
VRC1 In	VRC1 contact configuration	VRC, X-COMP	**VRC**	- - -
VRC2 In	VRC2 contact configuration	VRC, ALTDELAY, LO XBATT, AUTO INH	**VRC**	- - -
		VRC: Local Mode		
LOCAL VRC%	Local mode VRC percent reduction	0.0 to 10.0	**0**	0.1%
		VRC: MJ-X remote mode		
VRC Stage 1	First stage % reduction	0.0 to 10.0	**0**	0.1%
VRC Stage 2	Second stage % reduction	0.0 to 10.0	**0**	0.1%
VRC Stage 3	Third stage % reduction	0.0 to 10.0	**0**	0.1%
		VRC: Remote Mode		
VRC Remote	MJ-X or MJ-3A emulation mode	MJ-X or MJ-3A	**MJ-X**	- - -
		VRC: MJ-3A remote mode		
MJ-3A VRC%	MJ-3A % reduction	0.0 to 10.0	**0**	0.1%
		VRC: Automatic mode		
AutoVRC set1	VRC setting #1 for Auto VRC	0.0 to 10.0	**0**	0.1%
AutoVRC set2	VRC setting #2 for Auto VRC	0.0 to 10.0	**0**	0.1%
AutoVRC1 %I	% Load current #1 for Auto VRC	20 to 150	**150**	1%
AutoVRC2 %I	% Load current #2 for Auto VRC	20 to 150	**150**	1%
		Voltage Limit Control		
VLC Enable	Voltage Limit Control	OFF, ON	**OFF**	- - -
VLC Upper	Upper limit	106.0 to 134.0	**134.0**	0.1 V
VLC Lower	Lower limit	106.0 to 134.0	**106.0**	0.1 V

*VRC Stat is a view-only item. It appears in the <**REGULATOR**> menu for viewing convenience.

4.4.1 Regulator set points

Regulator set points define the operating limits for Automatic mode operation. Two sets of limits are maintained: one for forward power flow conditions and another for reverse power flow conditions.

Voltage Level set point

The Voltage Level set point defines the nominal level you wish the regulator to maintain.

Bandwidth set point

The Bandwidth set point defines the voltage range within which the regulator output is maintained. It is divided equally above and below the Voltage Level set point. For example, a Bandwidth of 6 volts with a Voltage Level set point of 120.0 volts specifies that any load voltage between 117 volts and 123 volts is “in band.”

Time Delay set point

The Time Delay set point defines the amount of time the controller will wait before commanding a tap change.

4.4.2 Line Drop Compensation

The Line Drop Compensation (LDC) data item defines the assumed voltage drop between the regulator and the load center. Settings are expressed in volts.

To specify LDC values, view Fwd Comp (R) for the Forward Resistive component and Fwd Comp (X) for the Forward Reactive component. In systems with reverse power flow, view Rev Comp (R) and Rev Comp (X) to specify the Reverse components. A Line Drop Calculator software application is available on the Siemens website. This application automatically calculates the LDC values when the system parameters are entered.

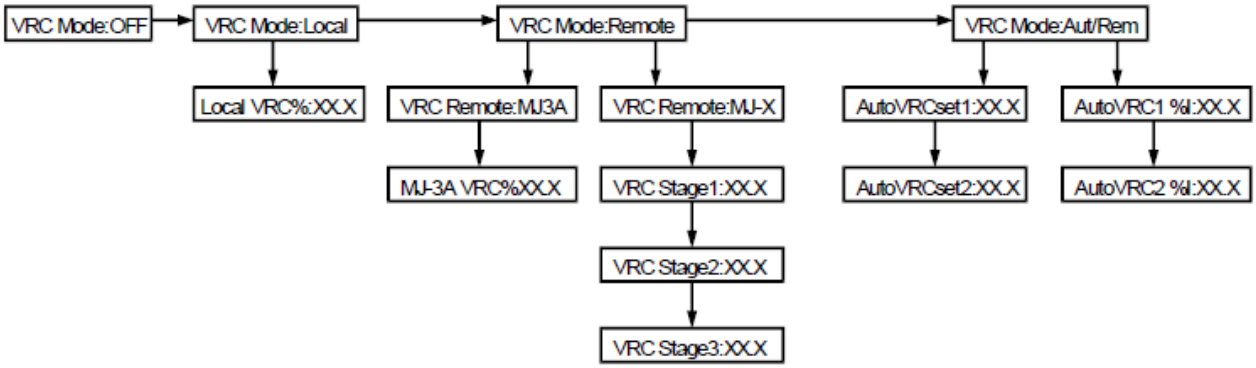


Figure 4.5: Flow Chart of VRC Modes

4.4.3 Voltage Reduction Control Items

Voltage Reduction Control (VRC) is used to reduce output voltage. When activated, VRC has the effect of lowering the Voltage Level set point. Voltage reduction is accomplished in one or more discrete steps which are defined as a percentage of the voltage level set point (Fwd Volts, Rev Volts). VRC operates immediately to reduce output volt-age without waiting for completion of the Time Delay.

The following sections describe each of the VRC menu items, and explain how to set them.

ALT Delay

When the VRC2 In item is set for ALT DELAY, an alternate time delay is used before commanding a tap change when the VRC2 contacts are closed. When the VRC2 contacts are open, the standard (Fwd Delay) time delay is used.

VRC Status

The VRC Status data item displays present VRC information in the display panel. It can be directly accessed with the VRC fast-path key, or viewed from the <**REGULATOR**> menu.

Information displayed includes: percent reduction presently in effect (nn.n%), the VRC mode (L - Local, A -Automatic, R - Remote) and the present step/stage (0-3). For example, if VRC is presently at 5%, Remote, and MJ-X mode Stage 3, the display panel would show VRC Stat=05.0%R3.

VRC1 In

This item defines which feature is implemented when the external terminal block contacts (VRC1) are closed. Select VRC to enable remote Voltage Reduction Control. Choose X-COMP to enable reactive compensation polarity control. When VRC1 contacts are closed, the LDC polarity is reversed.

VRC2 In

This item defines which feature is implemented when the VRC2 contacts are closed. Choose VRC to enable remote Voltage Reduction Control. Choose ALTDELAY to use the ALT Delay feature described above. Choose LO XBATT to use these terminals for monitoring status change (close to open or vice versa). Choose AUTO INH to inhibit the processor from making automatic tap changes.

VRC Mode

This data item defines the VRC mode of operation. Select the desired mode, using the VRC Mode data item. Four options are provided: OFF, LOCAL, REMOTE, and AUTO/REM (see Figure 4.4).

VRC Mode: OFF

This setting disables the VRC function.

VRC Mode: LOCAL

When Local mode is selected, VRC activates immediately to reduce output voltage by the amount specified in the Local VRC % data item.

To enable VRC Local mode, view VRC Mode and select LOCAL. View Local VRC % and define a reduction amount between 0.0% and 10.0% in 0.1% increments.

VRC Mode: REMOTE (via Terminal Contacts)

When this mode is selected, VRC is conditioned to activate VRC upon closure of external contacts. These contacts, which specify the reduction amount, are connected to terminals (labeled VRC1 and VRC2) at the rear of the controller. See Appendixes I and K.

Note that VRC Mode: Remote works differently than VRC Mode: Local. When you enable VRC Mode: Local, voltage reduction begins immediately. When you enable VRC Mode: Remote, the microprocessor is only conditioned to activate VRC. Voltage reduction does not occur until the VRC contacts are activated.

To enable VRC Remote mode, view VRC Mode and select REMOTE. Then to activate voltage reduction, you must close the appropriate VRC contacts.

Remote mode is further subdivided into MJ-X mode and MJ-3A mode (compatible with the previous-generation control). Both modes use the VRC terminal pairs; the difference is in the way the terminal pairs are used.

MJ-X Mode (“Static” Inputs)

In MJ-X mode, you can specify up to three Stages of voltage reduction—each with a different reduction value. View VRC Remote and select MJ-X. Then view VRC Stage1, VRC Stage2, and VRC Stage3 to set the VRC percentage reduction values.

Two terminal pairs (VRC1 and VRC2) on the external terminal block are used to trigger the three Stages (see Table 4.4).

Table 4.4 VRC Indicator Flashing Pattern for MJ-X Mode

Stage	VRC Terminal Pairs	VRC LED flashing pattern
Stage 1	VRC1 iactive: VCR2 in-active	long-short
Stage 2	VRC1 in-active: VRC2 active	long-short-short
Stage 3	VRC1 active: VRC2 active	long-short-short-short

MJ-3A Mode (“Pulsed” Input)

This mode simulates MJ-3A VRC; it uses only one external contact (VRC1). MJ-3A VRC users can achieve compatibility with existing controllers using this mode.

To use MJ-3A mode, view VRC Remote and select MJ-3A. Then select MJ-3A VRC% and specify the reduction value.

The single MJ-3A VRC% value defines a total reduction value which control program logic subdivides into 33%, 67% and 100% steps.

To achieve a reduction equal to 100% of the MJ-3A VRC% specification, activate the VRC1 contact for more than three seconds (“latched”). To achieve partial voltage reduction, “pulse” the VRC1 contact momentarily (a “pulse” is 300 msec. to 3 seconds). See Table 4.5 below.

Table 4.5: MJ-3A Mode VRC Reduction

VRC1 Terminal Pair	VRC Reduction	VRC LED flashing pattern
first pulse	33% of specified value	long-short
second pulse	67% of specified value	long-short-short
third pulse	100% of specified value	long-short-short-short
fourth pulse	0%	not flashing
latched	100% of specified value	long-short-short-short
unlatched	none	none

For example, if you specify Fwd Volts=120 V, and MJ-3A VRC% = 10%, the total reduction value is 12 V. This 12 V reduction value is further subdivided into thirds, so a single pulse would result in a 4 V reduction; a second pulse would produce an 8 V reduction; and a third pulse would produce a 12 V reduction. Contact activation of three seconds or longer is considered to be a “latched condition” and would (in this example) produce a full 12 V reduction.

Automatic Mode VRC with Remote Override

In Automatic mode, voltage reduction is activated automatically whenever load current exceeds a predefined percentage.

There are two automatic VRC set points (AutoVRC1 and AutoVRC2). When load current exceeds the percentage specified in either of the AutoVRC %I data items, regulator output voltage is reduced by the percentage specified in the corresponding AutoVRC set data item.

Only one set is active at a time; they are not additive. AutoVRC remains active until the load current falls below a value that is the lower of:

AutoVRCn% · (1-2 · AutoVRCsetn(%))
or

90% · AutoVRCn% · (rated current).

Example 1

AutoVRC1%I = 60%; AutoVRCset1 = 3%.

I turn-off threshold = lower of:

60% · (1-2 · (3%)) · rated current = 56.4% · rated current

or

90% · (60%) · rated current = 54% · rated current
Auto VRC will remain active until load current drops to 54% of rated current.

Example 2

AutoVRC1%I = 80%; AutoVRCset1 = 7%.

I turn-off threshold = lower of:

80% · (1-2 · (7%)) · rated current = 68.8% · rated current

or

90% · (80%) · rated current = 72% · rated current

Auto VRC will remain active until load current drops to 68.8% of rated current.

To choose Automatic mode VRC, view VRC Mode and select AUT/REM. Use AutoVRCset1 and AutoVRCset2 to specify the reduction amount. Use AutoVRC 1 %I and AutoVRC 2 %I to specify the low current threshold.

AutoVRC settings are overridden by contact closures on terminal block contacts VRC1 and VRC2.

4.4.4 Voltage Limit Control

Voltage Limit Control (VLC) defines limits for load voltage. When VLC is active, the microprocessor compares load voltage with VLC set points. If load voltage changes to a value above VLC Upper, or below VLC Lower, limiting occurs immediately —that is, without waiting for the Time Delay timer to count down. The appropriate LED indicator (VLC Upper/VLC Lower) illuminates to alert the operator that Voltage Limiting is in effect.

- To activate/deactivate VLC, view VLC Enable; then use ON or OFF.
- To set the Upper VLC set point, view VLC Upper; then enter a value between 106.0 and 134.0 volts.
- To set the Lower VLC set point, view VLC Lower; then enter a value between 106.0 and 134.0 volts.

Note that the upper and lower limits must not overlap. For example, if VLC Lower is 115, VLC Upper cannot be changed to a value less than 115 V.

4.5 Activating Data Logging— The <LOG SETUP> Menu

The MJ-5 Control Panel can record status information that will help reconstruct past occurrences. Two logs are maintained: an Event Log, and an Interval Log. Event Log records are stored when predefined Events occur; Interval Log records are stored at predefined time intervals. See Table 4.6; default settings are in bold.

This section describes how to define your logging requirements. See Chapter 5, Reading and Interpreting MJ-5 Control Panel Data, for guidance on how to retrieve logged data.

Table 4.6: The <**LOG SETUP**> Menu

DATA ITEM	DESCRIPTION	VALID INPUTS
Log Event	Enable event Logging	ON or OFF
Event= Tap	Define Tap Change as event	ON or OFF
Event=Neut	Define Tap at Neutral as event	ON or OFF
Event = NNR	Define Tap raise to step NN as event	ON or OFF NN=16
Event = NNL	Define Tap lower to step NN as event	ON or OFF NN =16
Event = VLC	Define VLC activation as event	ON or OFF
Event = VRC	Define VRC as event	ON or OFF
Event = PwrFlow	Define Power Flow reversal as event	ON or OFF
Event = PwrCyc	Define System power up as event	ON or OFF
Event = Cfg	Define configuration change as event	ON or OFF
Event = Alert	Define any Alert activation as event	ON or OFF
Clr Event Log?	Clear All Event Data	Y or N
Clr IntervLog?	Clear All Interval Data	Y or N
Log Interval	Enable Interval Logging	ON or OFF
ResLogMinMax	Reset Min/Max values at start of interval	ON or OFF
Log min/max	Panel will log Instantaneous or Demand Min/Max values	Inst. Dmd
Interval	Logging Interval	NNhrNNmin
Save Logs	Downloads logs to SD card	Yes or No
Uploadconfig	Upload configuration file through SD card	Yes or No
Upload HMI	Upload system update file through SD card	Yes or No
Upload Meter	Upload meter update file through SD card	Yes or No
Save Config	Save the Full Configuration of Control Panel through SD Card	Yes or No
Restore Config	Restores the Configuration of Control Panel through SD Card	Yes or No
Auto Save Log	Save Logs at specified intervals through SD card	Yes or No
Auto Save Time	Time Intervals when Logs will be saved through Auto Save Log	NNN in Hours

4.5.1 Event Logging

The Event Log captures present readings when an Event occurs. You can determine which Events cause logging activity by selecting the ones you want from the <**LOG SETUP**> menu. When that Event occurs, the following readings will be logged:

Event Date and Time, Event Cause, Event ID

plus present values for:

Vld,	Ild,
Power Factor,	Power (KW, KVAR, KVA),
Tap position,	Vsrc

To activate Events Logging, view Log Event; then select ON. You must also define which events are to be logged. To activate logging for a specific Event, view the appropriate Event = data item, and select ON for that Event.

The Event logs contain the 1000 most recent events.

To view the Event logs, scroll down the <**LOG SETUP**> menu until Event Log is selected. Press the Change/Save key to display the event logs. Scroll using the ▲ and ▼ keys for going up and down the list respectively. Pressing the Cancel/Reset key backs out to the <**LOG SETUP**> menu without clearing the Event logs.

4.5.2 Interval Logging

The Interval Log records data at specific time intervals, as defined in the <**LOG SETUP**> menu. At the end of each interval, the following readings are logged:

Interval Date, Time, and Interval ID

Present, max, min, and demand values for:

Vld	Ild
KW	KVAR
KVA	

Instantaneous value of Vsrc

Instantaneous value of Power Factor
Power Factor at KVAmax
Power Factor at KVAmin

Present, max, and min. values for Tap Position

Total Operations

To activate Interval logging, view Log Interval; then select ON.

To define the time between logs, view Interval; then specify the time as HHhrMMmin.

To reset the minimum and maximum values at the start of each interval, view ResLogMinMax; then select ON.

Interval logging is synchronized to the time of day. Interval logging occurs when “seconds” is zero. For 15 and 30 minute intervals, the MJ-5 logs data at even quarter and half-hour increments, respectively. For a 1-hour setting, the MJ-5 logs data on the hour. For 4 and 6-hour settings, the MJ-5 logs data synchronized to 12:00:00 midnight.

The Interval logs contain the 1000 most recent intervals.

To view the Interval logs, scroll down the <**LOG SETUP**> menu until Interval Log is selected. Press the Change/Save key to display the interval logs. Scroll using the ▲ and ▼ keys for going up and down the list respectively. Pressing the Cancel/Reset key backs out to the <**LOG SETUP**> menu without clearing the Event logs.

4.5.3 Clearing Event/Interval Log Data

To clear the entire Event Log, view the Clr Event Log item, toggle to Y, then press the Change/Save key.

To clear the entire Interval Log, view the Clr IntervLog item, toggle to Y, then press the Change/Save key.

4.5.4 Uploading Control Panel Configuration

The Uploadconfig item uploads a control panel configuration to the MJ-5 Control Panel from an SD card placed in the front of the panel. Configuration files are place on the SD card either by MJXplorer or another MJ-5 Control Panel. The file format is MJ0 and must follow the file name. Files from the MJ-4A and MJ-XL are compatible with the MJ-5.

To upload a configuration to MJ-5 control panel, use the Uploadconfig item in the <**LOG SETUP**> menu. Ensure that the SD card with the pre-loaded configuration on it is in the SD/MMC slot on the front of the control panel. There can only be one MJO format file on the SD card for the configuration to upload properly. View the Uploadconfig item and select Yes.

4.5.5 Saving Log Data to SD Card

To save logs to SD card, use the Save Logs item in <**LOG SETUP**> menu. Ensure that an SD card is the SD/MMC slot. View Save Logs item and select Yes. The Save Logs saves both Interval and Event logs to the SD card.

4.6 Password Security Protection—The <PASSWORD> Menu

MJ-5 security allows unrestricted read access to any data item while providing password security against changes and resets.

4.6.1 Overview

MJ-5 password protection is a hierarchical system, consisting of a “System Key” that provides a level of protection for the security system itself, and two Levels of security for MJ-5 data items:

1. A Level 1 password enables the change/reset function; if a valid Level 1 password is entered, any data item (which is not further protected by Level 2) can be changed or reset.

2. A Level 2 password is associated with a specific menu. When a menu is protected at Level 2, the Level 2 password must be entered before changes/ resets can be made to data items within that menu. Entering any Level 2 password provides access to all Level 1 protected data items as well as to data items contained in menus that are protected by that specific Level 2 password. In other words, when a Level 2 (menu) password has been entered, the change/reset function is enabled for any data item that is not protected by another Level 2 password.

Either Level can be activated independent of the other.

Security activation and password assignment are separate functions. In other words, even though you have assigned a password to a Level, password checking can be active or inactive for that Level.

With this flexible structure you can set up a security system with:

- A single Level 1 password.
- A Level 1 password with additional Level 2 passwords for specific menus.
- No Level 1 password, but one or more level 2 (menu) passwords.
- No passwords at all.
- Passwords defined, but password checking temporarily disabled.

The default configuration for the password security system is with all password protection disabled (except for the <**DIAGNOSTIC**> menu).

Control of the security system requires the use of a "System Key," which protects the changing of passwords and the activation and de-activation of the two security Levels. To ensure proper control of the MJ-5 security system, you may wish to designate one individual as security administrator. This person would be responsible for establishing the password protection scheme and for making changes to the passwords as necessary; he/she would be the only individual requiring knowledge of the "System Key." The "System Key" not only allows the user to change the security system, it also acts as a top level password which allows access to all change/reset functions. Once the "System Key" is entered and until the session is ended, the security system is effectively disabled.

A Level 2 password will activate all of the configuration options in that table. The user will not need to enter a separate part under level 2 as shown in table 4.7.

Contact a Siemens representative if your passwords are forgotten.

4.6.2 The <PASSWORD> Menu

The <**PASSWORD**> menu serves three purposes:

1. To enter passwords so that you can change/reset password-protected data items.

2. To define passwords

Table 4.7: The <**PASSWORD**> menu

Data item	Description	Value
The following data items are used to enter passwords		
Enter PW:	Prompts operator for a password	xxxx
End Session ?	End password access to protected data items	**N** or Y
System Key:	Prompt for entering and changing of the System Key	xxxx **0123**
The following data items are visible only after System Key has been accepted.		
	Level 1	
Level 1:	Enable Level 1?	**OFF** or ON
Level 1 PW:	Level 1 password	xxxx 1111
	Level 2	
Configure:	Enable password for <**CONFIGURE**> Menu changes	**OFF** or ON
Config PW:	Password for <**CONFIGURE>** Menu	xxxx **2222**
Regulator:	Enable password for <**REGULATOR>** Menu changes	**OFF** or ON
Reg. PW:	Password for <**REGULATOR>** Menu	xxxx **2222**
Meter:	Enable password for <**METER>** Menu changes	**OFF** or ON
Meter PW:	Password for <**METER>** Menu	xxxx **2222**
Demand:	Enable password for <**DEMAND>** Menu changes	**OFF** or ON
Demand PW:	Password for <**DEMAND>** Menu	xxxx **2222**
Alert:	Enable password for <**ALERTS>** Menu changes	**OFF** or ON
Alert PW:	Password for <**ALERTS>** Menu	xxxx **2222**
Counters:	Enable password for <**COUNTERS>** Menu changes	**OFF** or ON
Counters PW:	Password for <**COUNTERS>** Menu	xxxx **2222**

Table 4.7: The <**PASSWORD**> Menu

Log Setup:	Enable password for <**LOG SETUP**. Menu changes.	**OFF** or ON
Log Set PW:	Password for <**LOG SETUP>** Menu	xxxx **2222**
Ev/Intv:	Enable password for <**EVENT LOG>** and **<INTERVAL LOG>** Menus.	**OFF** or ON
Ev/Intv PW:	Password for <**EVENT/INTERVA>L**	xxxx **2222**
Harmonics:	Enable password for <**HARMONICS>** Menu.	**OFF** or ON
Harm. PW:	Password for <**HARMONICS>** Menu	xxxx **2222**
Comm:	Enable password for <**COMMUNICATIONS>** Menu.	**OFF** or ON
Comm PW:	Password for <**COMMUNICATIONS>** Menu	xxxx **2222**
Mntn	Enable password for <**MAINTENANCE>** Menu	**ON** or Off
Mntn PW	Password for <**MAINTENANCE>** Menu	xxxx **3333**
Diagnostics:	Enable password for <**DIAGNOSTICS>** Menu.	**ON** or Off
Diagnos. PW:	Password for <**DIAGNOSTICS>** Menu	xxxx **3333**
		Bold denotes default values

Note: A Level 2 password will activate all of the configuration options in that table. The user will not need to enter a separate password under level 2 as shown in Table 4.7.

4.6.3 Setting Up the MJ-5 Security System.

Entering the System Key

To make changes to the security system itself, a "System Key" must first be entered. The System Key is a special password that allows the security administrator to change passwords and to enable/disable Level 1 and Level 2 protection.

To enter the System Key, view the System Key xxxx data item from the <**PASSWORD**> menu; then press Change/Save key. The display screen responds by flashing "■" in the leftmost position of the four-character password field. This denotes the position in which a character is to be entered. (The remaining character positions contain "■") Use the ▲ and ▼ keys to select the desired character. Then press the ► key to move the cursor to the next character to the right, and so on, until all four characters of the password have been entered. To complete the process, press the Change/Save key.

When a valid System Key has been entered, "Sys Key Accepted" appears in the display screen. Re-definition of the security system is then possible. Access to security system re-definition continues until the definition session is:

- Manually terminated by selection of End Session Y(es) in the <**PASSWORD**> menu.
- Automatically terminated by expiration of the Screen timeout period.

Because of the security exposure possible during a security system definition session, you should always use the End Session facility when changes are complete to ensure against unauthorized security system re-definition changes.

Changing Passwords

After entering the System Key (see above), scroll down to view Password and Password Enable/Disable items.

To change a Level 1 password, view Level 1 PW: in the <**PASSWORD**> menu and use the Change/Save and Scroll keys to enter the new password. Passwords may consist of any of the following characters: 0-9 and A-Z.

To change a Level 2 password, you must view the menu associated with that password from the <**PASSWORD**> menu. For example, to define a password for the <**CON-FIGURE**> menu view Config. PW; then, use the Change/Save and Scroll keys to enter the new password. You may use the same Level 2 password for several menus, or you may use a different Level 2 password for each menu.

Enabling/Disabling Password Checking

After entering the System Key (see above), scroll down to view Password and Password Enable/Disable items.

In addition to defining passwords for a given level, you must also enable that level before password checking takes place. When password checking is enabled for a given Level, entry of a valid password will be required before you can change/reset any data item that is protected at that Level. Password checking is enabled for each level separately. In other words, you can enable or disable password protection for Level 1, for Level 2, or for both Levels. If password checking for a given Level is disabled, any data item at that Level can be changed or reset without use of the password.

To activate password checking for Level 1, view the Level 1 parameter; then change the OFF to ON.
To activate password checking for Level 2, you must specify each menu for which you wish security to be

enabled. For example, to enable Level 2 security for the <**CONFIGURE**> menu, view CONFIGURE: from the <**PASSWORD**> menu; then change the OFF to ON.

Changing the System Key

To change the System Key, (assuming you have not yet entered the System Key):

1. Enter the present System Key. After all four characters have been selected, press Change/Save. The words "Sys Key Accepted" will appear in the display screen. After a short period, the words "System Key" will be displayed.

2. Press the Change/Save key to indicate that you wish to make a change.

3. Enter the new key. After all four characters have been selected, press Change/Save. The words, "Re-enter xxxx" will appear.

4. Verify correct entry by entering the new System Key once again. After all four characters have been selected, press Change/Save.

If your first and second attempts do not match, you will see the words, "Verify failure" and you will be returned to step 2. When you have successfully entered the new System Key twice in succession, the display screen responds with "Sys Key Changed."

4.6.4 Using the MJ-5 Control Panel With Password Security Activated

MJ-5 Security does not restrict data reading. However, if password security is active, you must first enter the proper password before you can change or reset protected data. If you attempt to change a password-protected item without first entering the proper password, the display screen responds "PW NOT ENTERED" and you must use the <**PASSWORD**> menu to enter the appropriate password.

Note that a Level 2 password includes Level 1 access privileges. Therefore, data items that are only Level 1 protected can be changed or reset after you enter either the Level 1 password or a Level 2 password. Data items contained in menus that are password protected by Level 2 passwords can only be changed or reset after you enter the Level 2 password for that menu.

Entering passwords

You can go directly to the <**PASSWORD**> menu and enter the password(s) you want, or when viewing a specific menu item, press Cancel/Reset or Change/Save. If password protection is enabled for this menu, you are prompted to enter the password. (If you see the password prompt, skip step 1 below.)

1. Use the Menu and Scroll keys to view the <**PASSWORD**> menu. Press the ▼ key. The display screen responds: "Enter PW xxxx".

2. Press the Change/Save key. The display screen responds by flashing "■" in the leftmost position of the four character password field. This represents the character to be entered.

3. Use the ▲ and ▼ keys to step through the alpha and numeric characters until the desired character is presented in the display screen. Press the ► key to move the cursor to the next character to the right, and so on until all four characters of the password have been entered.

4. When you have completed entering the password, press the Change/Save key.

(If you started in the <**PASSWORD**> menu, go to step 6. Otherwise, go to step 7.)

5. If you entered a valid password, the MJ-5 briefly displays "PW Accepted", and then displays "Enter PW". This allows you to enter additional passwords. (You may wish to enter additional passwords if, for example, you have enabled both Level 1 and Level 2; or if you have enabled Level 2 and have different passwords for each menu.) When you have entered all passwords, you can use the Menu and Scroll keys to view the data item(s) you wish to change or reset. Skip step 7.

6. If you enter the correct password, the MJ-5 briefly displays, "PW Accepted" and then returns to the screen you were viewing when you started this process. If you enter a valid password, but not the correct password for this menu, the MJ-5 displays "Enter PW:" again. This process repeats until you enter the correct password for this menu.

Once a password has been accepted, changes and resets are permitted for the remainder of the session. To end the session, view End Session in the <**PASSWORD**> menu, and use the Change/Save and Scroll keys to change the default N(o) to Y(es). If you leave the session enabled (un-terminated) the MJ-5 automatically terminates it when the screen time-out period expires (see <**CONFIGURE**> menu Screen t.o. data item).

4.7 Communications Definition— The <COMMUNICATIONS> Menu

The <**COMMUNICATIONS**> menu provides data items for setting up local communications and remote communications via the Communications Module. These data items are described in the following sections.

4.7.1 Setting Up the Local Data Port

The Local Data Port must be set up for proper operation. The <**COMMUNICATIONS**> menu contains the Data Port setup items described in Table 4.8:

Table 4.8 <**COMMUNICATIONS**> Menu Setup Data Items

DATA ITEM	DESCRIPTION	INPUTS
DatPortBaud:	Local Data Port transmission rate	300, 1200, 2400, 4800, **9600**, or 19200
Data Parity:	Local Data Port parity setting	**Even**, None
DataPorAddr:	Enables/Disables addressing for Data Port	**OFF**, ON
Reg Id:	Regulator identification number. Note that this is NOT the address for Data Port Communications.	NNNNN (Range 0-32765)

Note: Default values shown in bold type.
Note: Data Port Address is always disabled in MJ-5.

To change the baud rate for the data port, view DatPortBaud under the <**COMMUNICATIONS**> menu and select one of the options (300, 600, 1200, 4800, 9600, or 19,200).

To change the parity for the data port, view Data Parity under the <**COMMUNICATIONS**> menu and select one of the options (EVEN or NONE).

To enable or disable addressing for the data port, view DataPortAddr under the <**COMMUNICATIONS**> menu. Then, select one of the options (OFF or ON.) Disable addressing for local communications with MJXplorer or a Data Reader.

To change the Regulator Identification, view Reg Id under the <**COMMUNICATIONS**> menu and set the desired Reg Id value. For extracting data and generating reports using the MJXplorer software, the Reg Id value appears prominently at the top of the reports. If collecting data from multiple controls, select a different value of Reg Id for each MJ-5 unit.

To set the Communications unit address, view Comm Addr under the <**COMMUNICATIONS**> menu. Enter the desired address.

The “Comm Addr” screen shows the communications address for the MJ-5 unit. For the Data Port, the usable

address ranges are listed in Table 4.9 below. Note that the MJ-5 is device type “1”, and its group address is 254.

Table 4.9 Data Port Addresses

Address Range	Function	How Used
0	Wild Card Address	All controls on system respond
1 to 200	Unique Device Address	When an address in this range is sent, only the control that has that unique address responds.
201 to 254	Device Type, Group Address	Any control with the corresponding group address, which is determined by the control's device type, receives and executes commands with no return response.
255	Broadcast Address	All controls on the system receive and execute commands with no return response.

To enable or disable IP address selection, Networkmask, or Default Gateway; view IP config under <**COMMUNICATIONS**> menu and select one of the options (Static or DHCP).(Static allows selection while DHCP will assign a random address and will not allow the user to select them.)

To set the IP address, make sure IP config is set to Static and view IP under <**COMMUNICATIONS**> menu. Enter the desired address.

To set the Network Mask, make sure IP config is set to Static and view NM under <**COMMUNICATIONS**> menu. Enter the desired address.

To set DNP TCP port, view DNP TCP port under the <**COMMUNICATIONS**> menu and input the desired port number.

Currently IEC 61850 is configured to use port number 102.

4.7.2 Using the Communications Module

The Communications Module provides remote communications capability for the MJ-5 Control Panel. The Communications Module is a plug-in option offering choices of communications protocols and physical interfaces. Since the Communications Module Installation Manual describes the configuration items in detail, they are listed only for reference in Table 4.10

Note: Default values shown in bold type.

Table 4.10 Communications Module Configuration Items

DATA ITEMS	DESCRIPTION	SELECTIONS
DatPortBaud	Local Data Port transmission rate	300, 1200, 2400, 4800, **9600**, or 19200
Data Parity	Local Data Port Parity Setting	**EVEN** or NONE
DataPortAddr	Enables/Disables Addressing for Data Port	**OFF** or ON
Reg ID	Regulator Identification Number (Note: This is NOT the address for Data Port Communications)	NNNNN (Range **0**-32765)
Protocol	Communications Module Protocol	**DNP3.0,** 2200, 2200NPA, MJ3A A, MJ3A B1, MJ3A B2, 2179, and Special
CommBaud	Communications Module transmission rate	300,1200,2400,4800,**9600** or 19,200
CommParity	Communications Module Protocol	**NONE**, EVEN, ODD
CommAddr	Communications Module Address	NNNN (range:**0**-32765)
Resync Time	Communications Module resync time (in characters). Used for Communications Module protocols 2200 and 2179 to determine when one message ends and another message begins	NNN (range 0-250, **1**)
TxEnDelay	Communications Module Transmit Enable Delay (in milliseconds), Specifies the amount of time between the RTS output being activated and the start of transmit (output) data.	NNN (range **0**-250)
DnpDlConfirm	DNP Data Link Confirm	Y or **N**
SW repeat	Enable Fiber loop	Y or **N**
HostAddr	Host Address for Unsolicited Responses	NNN (range **0**-65535)
CMUnsolicited	Unsolicited Responses	Y or **N**
AutoInhEnable	Auto Inhibit Enables (Y) Remote Raise/Lower. If disabled, (N) activates automatic operation	Y or **N**
DNP set	Select a predefined or custom DNP point set	**DNPcfg.** 2x3, 2x4, etc.
Deadband CL-1	Class 1--Used to set band without configuration tool	**00.0** or NN.N
Deadband CL-2	Class 2---Used to set band without configuration tool	**00.0** or NN.N
Deadband CL-3	Class 3---Used to set band without configuration tool	**00.0** or NN.N
CommType	Describes the type of communication	**Network,** Serial, Fiber-serial or RS-485
IP config	Enables/Disables IP Configuration Selection	**Static** or DHCP
IP-192:168:001:200	Displays current IP address	**192.168.1.200** or xxx.xxx.xxx.xxx
NM-255:255:255:000	Displays current Network Mask	**255.255.255.0** or xxx.xxx.xxx.xxx
GW-000:000:000:000	Displays current Gateway	**192.168.1.1** or xxx.xxx.xxx.xxx
TCP port	DNP Communication Port Number	**20,000** or NN,NNN (not advisable to change)

Note: If both the Data Port and the Communications Module are simultaneously set up for remote communications, then the Data Port restrictions on the value of the "Comm Addr" data item must apply.

4.8 Regulator Maintenance— The <MAINTENANCE> Menu

The information contained within the <**MAINTENANCE**> menu should be used for information purposes only. All voltage regulator maintenance should be completed as described in the Maintenance section of the Siemens Voltage Regulator Manual.

The <**MAINTENANCE**> menu allows the user to enable an algorithm which will approximate wear and tear on the Tap changer contacts for Siemens Regulators. The menu allows the user to choose a Tap Changer Type, indicate presence of Balance winding and define the range of regulation. The other items in this menu include items which show statuses of the Tap changer contacts, and the operations on the contact(s).

The statuses update based on the accumulated losses due to wear and tear. The status are classified into EXCELLENT, GOOD, WORN, and REPLACE. The Moving contacts have a common status screen while the Stationary contacts have one screen each.

The contact op counters update as operations are added on the individual contacts
The first screen in the <**MAINTENANCE**> menu is the ConsOv screen which is a status screen, it shows the status the most worn contact(s).

Each of the individual contacts' status or operations may be cleared by pressing the Cancel Reset button. If a user wishes to clear all statuses and op counts at once then this can be done by pressing Cancel-Reset key on the ConsOv screen.

If the Maintenance approximation algorithm is disabled, all statuses and contact op counts show "N/A".. If the MaintainRcrds? data item is changed to "Y" then the algorithm is enabled and would update the statuses and op counts.

The Maintenance menu is password protected by default. The default password of "3333" must be entered before changing settings or resetting any statuses and contact op counters.

The last screen in the maintenance menu is the OP_DUR screen. This screen indicates the last measured op counter pulse duration in seconds which is useful when adjusting the TapInPulse time for TapIn=Pulse under <Diagnostics> (i.e. the Tap Chgr is set to Custom or GE).

The Maintenance menu also has a fast path key on the front panel. Press this key to view the status and settings screens of the Maintenance menu; repeat the key press to scroll through the Maintenance menu.

4.9-The <DIAGNOSTICS> Menu

The <**DIAGNOSTICS**> menu includes the MJ-5 configuration items needed to the calibration and MJ-5 internal test items. It also includes time setting for Tap operation and setting for non-Siemens regulators.

See Section 8 for information about the calibration items: See Appendix P for Tap Tracking.

The <**DIAGNOSTICS>** menu items:

- U2 Cal: displays raw voltage of U
- P2 Cal: displays raw voltage of P2
- C Ca l: displays raw load current
- R/LOnTime: maximum time to keep the tap changer motor running before pausing for R/LOffTime.
- R/LOffTime: pause between tap changes for this amount of time.
- Fixed R/L On time: When in Auto mode, if this setting is "Y", motor stays on for exactly R/L On time seconds.
- TapChgT/O: if the control runs the tap changer motor for R/LOnTime and no operations count occurs, then after this many more seconds a Tap Track Err OD alert is generated.
- TapIn: defines the operations count signal input line.
- TapInType: defines the operations counter type.
- TapInPulse: defines the minimum amount of time that an operations count signal must be present in order for the operations counter to increment (applies to Pulse type operations counters only).
- PreTapTime: the measure of load voltage before tap change
- PostTapTime: the measures of load voltage after tap change
- NeutralIn: defines the neutral signal input line.
- NeutralCount: number of Neutral positions (for LTC's only).
- PhaDeg: Displays raw value of phase angle. This value will be used for diagnostic purposes to determine if there is a shift in the current and if that shift is causing false power flow detection.
- CCInput: CCInput will show the status of Input 2 and 4 in back of terminal block.

- MAC: This item will display MAC address of the network.

- InitDataPort: This item it used to reinitialize the front data port in case of loss of communication. If panel is not communicating to MJXplorer or DNP Config tool, then the user can press change/save key and select yes. This will reinitialize the data port.

- U: This item is for Diagnostic purposes to check if calibration is done.

- P: This item is for Diagnostic purposes to check if calibration is done.

- C: This item is for Diagnostic purposes to check if calibration is done.

The <**DIAGNOSTICS**> menu also includes the Serial Number and Product Revision code for the MJ-5 Control Panel. These are set at the factory and cannot be changed.

The configurable tap changer control settings are also contained in the <**DIAGNOSTICS**> menu. Contact your Siemens representative for more information before adjusting these settings.

4.10 Setting up the Quick Key

The Quick Key provides access to the customizable Quick List. The Quick List can be used to step through a series of up to 15 user-set menu items. The Quick List allows creation of a custom menu with the minimal amount of effort. Any changes to the menu parameters must be done using normal configuration and operation procedures. Certain menus cannot be added to the Quick List including: Password menu, Log menu(s), Alert menu. Press the Quick Key repeatedly to step through the Quick List.

Adding Items to the Quick List:
Use the scroll keys to display the desired menu item to be added. Press and hold the Quick key for 3 seconds. The phrase “Quick Added” will appear indicating that the data item has been added.

Removing Items from the Quick List:
Press the Quick Key repeatedly to display the menu item to be removed. Once the desired item is selected, hold the Min/Max key for 3 seconds. The phrase “Quick Delete” will appear on the display.

5 Reading and Interpreting MJ-5 Control Panel Data

The MJ-5 Control Panel microprocessor maintains a considerable amount of operational information—both present and historical:

- Meter data—instantaneous, minimum, and maximum operational information.
- Log data—historical meter data, recorded at specific times.
- Demand data—demand data, continuously updated.
- Counter data—tap change history.
- Harmonics data—harmonic analysis data.
- Communications data—Local Data Port status.

Data is available through the front-panel display screen, the local port, or the communication port (if so-equipped). This chapter lists the data items that are maintained by the microprocessor, and tells you how to retrieve them.

5.1 Source and Load Definitions

In the following paragraphs, the term "Source" is defined as the connection point from which real power is flowing. The term "Load" refers to the connection point into which real power is flowing. In addition, for purposes of the following discussion, U2 and P2 refer to the terminals with the U2 and P2 labels at the MJ-5 Polarized Disconnect Switch. These terminals may or may not match the regulator leads with the same labels.

For a Straight regulator, the "S" bushing potential is provided to U2 via the tertiary winding, while the "L" bushing PT connects to P2. Under forward power flow conditions the source voltage is read at U2 and the load voltage is read at P2. Under reverse power flow conditions, the source voltage is read at P2 and the load voltage is read at U2. If no PT is present, P2 voltage is calculated, see 5.2.

For an Inverted regulator with no Source Side PT, the "L" bushing potential is provided to U2 via the tertiary winding. Under forward power flow conditions, the load voltage is read at U2; no source voltage is available. However, an estimated value is calculated (see the P2 Calculation section below). Under reverse power flow conditions, the source voltage is read at U2; no load voltage is available. However, an estimated value is calculated (see the P2 Calculation section below).

For an Inverted regulator with a Source Side PT, the "L" bushing potential is provided to U2 via the tertiary winding and the "S" bushing potential is provided to P2 via the Source Side PT. Under forward power flow conditions, the load voltage is read at U2; the source voltage is read at P2. Under reverse power flow conditions, the load voltage is read at P2, the source voltage is read at U2.

For applications which require regulation in reverse power flow, users generally select the bi-directional power flow mode. In bi-directional mode with power flowing forward, the "S" bushing voltage is the "Source" voltage and the "L" bushing voltage is the "Load voltage. With power flowing in the reverse direction, the "S" bushing voltage is the "Load" voltage and the "L" bushing voltage is the "Source" voltage.

The table below shows which MJ-5 parameters represent the "S" and "L" readings for each power-flow condition.

Table 5.1

Power Flow Mode	Vld	Vsre	Power Flow Direction
Bi-Dir, Neut R. Idle R	"L"	"S"	Forward
Bi-Dir, Neut R. Idle R	"S"	"L"	Reverse
F Lock, Co-Gen	"L"	"S"	Forward
F Lock, Co-Gen	"L"	"S"	Reverse
R Lock	"S"	"L"	Forward
R Lock	"S"	"L"	Reverse

5.2 P2 Voltage Calculation

This feature provides a calculated value of the "P2" bushing voltage when a measured value is unavailable.

When the P2 voltage reading is less than 50 volts and the P2 Calc setting is enabled under the <**ADV CONFIGURE**> menu, the MJ-5 automatically calculates the P2 voltage. The MJ-5 displays the calculated P2 value as "Vsrc" or Vld" according to Table 5.1. If the P2 Calc is disabled, then the P2 Value is not calculated.

The MJ-5 must know the tap position for the "P2 Calculate" feature to work. See sections 5.7 and 5.8 for information about the tap position and the tap position message.

5.3 Meter Data—The <METER> Menu

The Meter data items present operating values such as Voltage, Current, Power, etc. on the display screen. Unless otherwise specified, Meter data includes RMS, maximum and minimum values.

To view Meter data, use the Menu Selection keys to view the <**METER**> menu; then use the ▲ and ▼ keys to sequence through the data items.

To view a maximum or a minimum data item, you first view the instantaneous data item and press the Max/Min key. Pressing the Max/Min key once displays the maximum value. To view the minimum value press the Max/ Min key twice. To reset Maximum/Minimum data values, first view the RMS value, then press the Max/Min key, and then the Cancel/Reset key.

5.3.1 Viewing Min/Max Time and Date Stamps

To view the time and date of occurrence for a minimum or maximum data item, first view the desired min/max data item. With the min/max data item displayed, press the Change/Save key to view the associated time and date stamp. While the time and date stamp is in view, if you press the ▼ key, the first metered data item for the menu

will be displayed. Pressing the ▲ key displays the last metered data item. An example for displaying min/max time and date stamps is shown below:

Action	Display Shows
View Vcomp data item in <**METER**> menu.	Vcomp = 121.2 F
Press Max/Min key once.	Vcomp = 124.3 Fmax
Press the Change/Save key before timeout.	061798 21:26:45
Press the ▼ key.	Vld = 122.5F

5.3.2 Viewing the <METER> Menu Data

Table 5.1 summarizes the <**METER**> menu data items. The remainder of the section defines the data items in detail.

Table 5.2 Meter Data Items

<METER> MENU DATA ITEMS	
Vld[1]	Measured rms regulator load voltage
Vs[1]	Measured rms regulator source voltage
Vcomp[1]	Regulator load voltage corrected for line drop using LDC parameters
Ild[1]	Measured rms load current
PF[1]	Power factor
KVA[1]	Apparent regulator power load
KW[1]	Real power measured at the regulator
KVAR[1]	Reactive power measured at the regulator
Freq[1]	Line frequency
KWhr[2]	Forward and Reverse Real energy
KVARhr[2]	Forward and Reverse Reactive energy (lead & lag)

1. Instantaneous, Max, and Min values
2. Time-cumulative value — no Max/Min

Vld (Load Volts)

The Vld data item displays the RMS load voltage. The value displayed is either the basis voltage (nominal 120 V) or the system primary voltage. See Meter Volts as defined in the <**CONFIGURE**> menu in Chapter 4.

Vs (Source Volts)

The Vs data item displays the RMS source voltage. The value displayed is either the basis voltage (nominal 120 V) or the system primary voltage. See Meter Volts in the <**CONFIGURE**> menu, Chapter 4.

Vcomp (Line Drop Compensation Volts)

The Vcomp data item displays the RMS voltage present at the theoretical load center. This is the voltage the microprocessor compares with the voltage set point to determine when tap changes are required. The value displayed is either the basis voltage (nominal 120 V) or the system primary voltage. See Meter Volts in the <**CONFIGURE**> menu, Chapter 4.

Vld,Vs and Vcomp is calculated voltage based on Basis Voltage and U2 secondary or P2 secondary.

V= Raw Voltage * Basis Voltage/Secondary voltage.

Raw voltage – Voltage at Test terminal, Basis Voltage – refers config setting, Secondary –U2 sec or P2 Sec.

Ild (Load Current)

The Ild data item displays the RMS regulator current in amperes. **Note:** the Current Transformer is typically located in the Load Bushing lead. Therefore, under reverse power flow conditions, load current includes regulator excitation current which could be approximately 10% higher or lower than actual load current.

PF Lead, PF Lag (Power Factor)

This is the present line power factor, derived from the fundamental frequencies only, using the relationship

$$PF = \frac{Watts}{Volts * Amps}$$

Three values are recorded for Power Factor: instantaneous, maximum (most leading), and minimum (most lagging or least leading).

kVA (Apparent Power)

The kVA data item displays the present kVA load on the regulator. The CT of a regulator is always located in the "L" bushing lead. The MJ-5 calculates the kVA per Table 5.3.

Table 5.3 Regulator kVA Load

Regulator Type	Forward Power Flow	Reverse Power Flow
ANSI A Straight	kVA = Vld x Ild	kVA = Vs x I("L")
ANSI B (Inverted)	kVA = Vld x Ild	kVA = Vs x I("L")

Note: For reverse power flow, Ild is current flowing into the regulator and will differ from actual load current by the amount of excitation current of the regulator.

kW (Real Power)

The Forward and Reverse kW data items display the real portion of the present kVA load on the regulator.

$$Real\ Power = kW = \frac{1}{n}\sum_{1}^{n} Vn(t) \times In(t)$$

The kW is displayed as a positive quantity when power flow is into the load, or as a negative quantity when power flow is into the source.

kVAR (Reactive Power)

The kVAR data item displays the reactive portion of the present kVA load on the regulator.

$$Reactive\ Power = kVAR = \frac{1}{n}\sum_{1}^{n} V(t) \times I(t+90^{o})$$

+ = lagging, - = leading

Freq (Line Frequency)

The Freq data item displays the line frequency in Hertz (present, max, min).

kWhr F and kWhr R (Forward and Reverse Real Energy)

The Forward and Reverse kWhr data items display Kilowatt Hour values. They are accumulated separately for forward and reverse power flow conditions. kWhr is updated once per second, using the formula:

$$kWHRnew = kWHRold + kW*1/3600(hours)$$

kVARhr F and kVARhr R (Forward and Reverse Reactive Energy)

The kVARhr F and kVARhr R data items display Kilovar Hour values. They are accumulated separately for forward and reverse power flow conditions. The kVARhr is updated once per second, using the formula:

$$kVARnew = kVARold + kVAR*1/3600(hours)$$

The microprocessor computes and accumulates kVARhr values for each of the four quadrants of the voltage/current phase-angle relationships. These parameters are presented as shown in Figure 5.1.

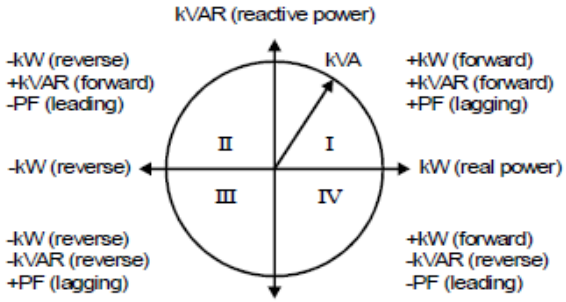


Figure 5.1 Power Quadrant Conventions

5.4 Demand Data— The <DEMAND> Menu

Demand measurements are time integration functions of the metered values. The MJ-5 Control Panel performs demand calculations for the following data items: voltage, current, power factor and power.

Demand data is maintained separately for forward and reverse power flow conditions (see Table 5.4). During forward power flow conditions, the microprocessor does not accumulate reverse measurements. During reverse power flow conditions, the microprocessor does not accumulate forward measurements.

You can select one of two methods of measuring demand: the Sliding Window method and the Thermal Averaging method. See DmdType in Section 4.3.23.

Table 5.4 Demand Data Items

Fdmd Vld[1,2]	Load Voltage demand
Fdmd Vs[1]	Source Voltage demand
FdmdVcomp[1]	Compensated Load Voltage demand
Fdmd Ild[1]	Load Current demand
PFKVAmax	Power Factor @ max KVA
PFKVAmin	Power Factor @ min KVA
Fdmd KW[1]	Real Power demand
FdmdKVAR[1]	Reactive Power demand
FdmdKVA[1]	Apparent Power demand

1. Instantaneous, min and max data available
2. For each Forward Demand Data Item there is a corresponding Reverse Demand Data Item. For example, Rdmd Vld.

To retrieve Demand data, select the appropriate, <**FW DEMAND**> or <**REV DEMAND**>, menu. Then, use the ▲ and ▼ keys to sequence through the Demand data items. To view the minimum and maximum values for a given Demand data item, first view the present value; then use the Max/Min key to display the respective maximum and minimum values recorded since the last reset.

Demand calculations are initialized at the time of system power up, when configuration items are changed, and on any power flow reversal. Un-initialized data items are presented as dashes (—) on the display screen. Demand values remain un-initialized until completion of the first subperiod. Power factor is stored whenever a new kVA maximum or minimum demand value is reached. These Power Factor values are reset when kVA max or kVA min values are reset.

5.5 Event Log - The <EVENT LOG> Menu

The MJ-5 can be set up to record meter data at the time of an "Event." Events can include: power up, parameter changes, tap changes, etc. Use the <**LOG SETUP**> menu to enable the Events you want logged (see Section 4.5).

Table 5.5 describes the data that is to be logged whenever an Event occurs.

Table 5.5 <**EVENT LOG**> Data Items

<EVENT LOG> Data items		
Event:	Event number[1]	NNNNNNN
Date:	Date	NN/NN/NN
Time:	Time	NN:NN:NN
Cause:	Cause of Event (Message, tap change, etc.)	CAUSE
Vld	rms regulator load voltage	NNNN.N
Vsrc	rms regulator source voltage	NNNN.N
Ild	rms regulator load current	NNNN.N
PF	Present Power Factor	N.NN
KWld	Present Real power	NNNNN
KVAR	Present Reactive power	±NNNNN
KVAld	Present Apparent power	NNNNN
Tap	Tap position	NN Raise/lower

1. The Event number is a sequential number used for maintaining and referencing the <**EVENT LOG**>

To access log data, view the <**EVENT LOG**> menu with the Menu Selection keys; then use the ▲ and ▼ keys to sequence through the log entries.

New Events that occur while Events are displayed are saved, but not made available for viewing until you return to the menu level and subsequently scroll into the <**EVENT LOG**> menu again. Meter data for all of the Events can be retrieved via the display screen on the front panel. Data for the 200 most recent Events is stored and can also be retrieved via the front-panel Data Port or the Communication Port.

5.5.1 Viewing Event Data

To quickly go from viewing one Event to viewing the previous or next Event, use the ◄ or ► keys. For example, if the screen being viewed is [Event: 20], press the ◄ key once to view the [Event: 19] screen. From the [Event: 19] screen, press the ► key once to view the [Event: 20] screen again.

5.5.2 Clearing Individual Events from the Event Log

Since you can now view all of the <**EVENT LOG**> data from the front panel, or download it via the data port, it is unnecessary to delete individual <**EVENT LOG**> items. The MJ-5 no longer supports deleting individual log records. If the <**EVENT LOG**> memory is full, the oldest record is overwritten when a new event occurs.

5.6 Interval Log — The <INTERVAL LOG> menu

The MJ-5 Control Panel can be set up to record data at the completion of a predefined interval of time. Use the <**LOG SETUP**> menu to define the time interval and to activate Interval logging (see Section 4.5).

Interval logging occurs when “seconds” is zero on the internal clock. For certain interval period selections, interval logging is tied to the time-of-day. For 15 and 30 minute interval settings, the MJ-5 logs data at even quarter and half-hour increments, respectively. For a one-hour setting, the MJ-5 logs data on the hour. For four and six-hour settings, the MJ-5 logs data synchronized to 12:00:00 midnight.

Table 5.6 describes the data that is logged at the conclusion of each interval.

Table 5.6 Interval Log Data Items

INTERV:	Interval number[1]
DATE:	Interval date
TIME:	Interval time
Vld	Secondary[2] Load voltage — rms, Max, Min, Dmd
Vsrc	Source voltage — rms
Ild	Load current — rms, Max, Min, Dmd
PF	Power Factor — Present, PFKVA max, PFKVA min
KWld	Real power — Present, Max, Min, Demand
KVAld	Apparent power — Present, Max, Min, Demand
Tap =	Tap position
Tapmax =	Maximum tap position
Tapmin =	Minimum tap position
Total ops =	Total tap changes

1. The Interval number is a sequential number used for maintaining and referencing the interval log.
2. Secondary only — even if PRI selected in Meter Volts data item.

If the specified interval elapses while you are viewing <**INTERVAL LOG**> data, the MJ-5 saves the new data, but it is not available for viewing until you return to the menu level and subsequently scroll into the <**INTERVAL LOG**> menu again. Data for all of the Intervals can be viewed from the <**INTERVAL LOG**> menu. Data for the 1000 most recent Intervals is stored and can also be retrieved through the front-panel Data Port or the Communication Port.

5.6.1 Viewing Interval Data

Interval Data Items may be selected from the Interval Log menu using the Change/Save key. Scroll through data items using the ◄ and ► or ▲ and ▼ keys. To exit entries, simply press the Menu key.

5.6.2 Clearing Individual Intervals from the Interval Log

Since you can now view all of the <**INTERVAL LOG**> data from the front panel, or download it via the data port, it is unnecessary to delete individual <**INTERVAL LOG**> items. The MJ-5 no longer supports deleting individual log records. If the <**INTERVAL LOG**> memory is full, the oldest record is overwritten when a new interval log occurs.

5.6.3 Resetting Min/Max Values at Each Interval

In <**LOG SETUP**>, set ResLogMinMax to ON to reset min/max values at the start of each interval. With this feature enabled, MJ-5 logs the min/max values that occur during each interval.

5.7 Operation Counter Data - The <COUNTERS> menu

Operation counters record the stepping operations of the regulator tap changer (see Table 5.7).

Table 5.7 Counter Data Items

Total Ops	The total number of tap changes[2]
Reset	Date of last Elapsed Ops counter reset
Reset	Time of last Elapsed Ops counter reset
Elapsed Ops	Total number of tap changes since last reset[1]
24 HR Ops	Number of tap changes in the past 24 hours[1]
30 Day Ops	Number of tap changes in the past 30 days[1]
MTD Ops	Number of tap changes this month[1]
Last Month	Number of tap changes last month[1]
YTD Ops	Number of tap changes this year[1]
Last Year	Number of tap changes last year1
Tap	Present position of the tap changer[1]
Tap Control	Remote or Local based on the mode setting
Tapmax	Maximum tap position since last reset[1, 3, 4]
Tapmin	Minimum tap position since last reset[1, 3, 4]

1. To reset, use Cancel/Reset key.
2. To change value, use the Change/Save and Scroll keys.
3. Tap position is determined by the "dead reckoning" method (see below)
4. To view, use Max/Min key.

To retrieve Tap Changer data, use the menu Selection keys to access the< **COUNTERS**> menu; then use the ▲ and ▼ keys to sequence through the data.

Dead Reckoning for Siemens Regulators

The control program keeps track of the regulator tap position by means of a "dead reckoning" procedure, analogous to navigational dead reckoning. Dead reckoning must start from a known position. MJ-5 dead-reckoning begins at Neutral (U12 active, if Tap Resync is ON) or when an operator inputs a tap position value. Subsequently, when the microprocessor requests a tap raise/lower (J/K), and the regulator makes the tap change (asserting Operations Count signal U10), the control program updates the tap position value. By this procedure, the MJ-5 maintains continuous tap position information.

If, for some reason, a tap change command is not confirmed within an appropriate period of time, a Message condition is raised and dead reckoning is discontinued until the tap changer once again signals Neutral. Similarly, a Message condition is activated if an Operation count signal is received when no tap change command was issued; or if the U12 PDS lead signals that the tap changer has passed through neutral at a time when the assumed dead reckoning position is not neutral.

Note: For application on other manufacturer's regulators and LTC apparatus, the MJ-5 implements a similar dead reckoning procedure for tap tracking. The details of the tap tracking approach for these applications are included in the Tap Tracking Application Note.

5.8 Alerts—The <Alert> menu

Alerts represent exception conditions. An Alert condition may be presently active, or it may have been active at some earlier time. When an Alert occurs, the MJ-5 stores it in the <**ALERT**> menu, and illuminates the Alert LED Indicator.

5.8.1 Viewing Alerts

If the Alert indicator is flashing, it denotes that an Alert has occurred. Use either the Alert fast path key or the menu and Scroll keys to view the <Alert> menu. Use the down arrow key to scroll through the Alerts.

If the Alert name is flashing, acknowledgment is required.

5.8.2 Acknowledging an Alert

To acknowledge the Alert, press the Cancel/Reset key. If the Alert condition is still active, the Alert name will stop flashing but the Alert indicator will remain on (steady) until the condition clears. If multiple Alerts have occurred, you can step through them, one at a time using the Alert key or the ▲ and ▼ keys. The Alert indicator will continue to flash until all Alerts have been acknowledged.

The conditions listed in Table 5.8 activate ALERT status. The conditions are listed in priority sequence from highest priority at the top to lowest priority at the bottom.

Table 5.8 Alert Data Items

Alert Name	Description	Duration	Ack. Type
Low Current	Low Current reading-- Magnitude below 1% full scale.	Continuous	Auto-clear
Auto Inhibit	Automatic mode inhibited from either terminal block or communication link	Continuous	Auto-clear
Pseudo Manual	A remote tap raise/lower operation has been requested (via Communications Module)	Continuous	Auto-clear
Tap Track Error[6]	The dead reckoning procedure has detected an inconsistency between its assumed tap changer position and the position signaled by the PDS.	Momentary	ACK required
Neutral Signal Error	The MJ-5 senses that the Neutral signal remains active though the tap change input indicates that the tap has moved from Neutral.	Momentary	ACK required
Tap Position ????	The MJ-5 does not know the present tap position (based on the dead reckoning algorithm).	Continuous	Auto-clear
Low PT Threshold	The MJ-5 detects a Vld voltage below the PT Threshold setting.	Continuous	Auto-clear
Over Current	The current exceeds the threshold determined by: I Load Max(%) x I FullLoad	Continuous	ACK required
NV RAM Reset	The non-volatile (battery-backed) Static RAM appears to have lost some or all of its data.	Momentary	ACK required
Low Battery	The back-up battery is below the minimum threshold and should be replaced.	Continuous	Auto-clear
High Voltage	Maximum PT voltage exceeded (145 Volts for U2 and/or P2)	Continuous	ACK required
Not in auto	Auto/Manual switch is in Manual	Continuous	Auto-clear
R Limit Reached	Raise Limit Reached. Tap position has reached or exceeded the value specified in "R Limit" item	Continuous	Auto-clear
L Limit Reached	Lower Limit Reached. Tap position has reached or exceeded the value specified in "L Limit" item	Continuous	Auto-clear
Self Test Fault	The MJ-5 self test found an error condition	Continuous	ACK required

Notes for Table 5.8:

1. Alert status is in effect if any Message condition is active. If the Alert status is the result of more than one condition, the Message Indicator will flash until all Alerts requiring acknowledgment have been acknowledged. Whenever the Alert Indicator is flashing, it is an indication that the contents of the <**ALERT**> menu should be reviewed.
2. Continuous - Condition lasts indefinitely (may persist after Alert is acknowledged).
3. Momentary - Condition lasts briefly.
4. ACK required - The MJ-5 keeps the Alert active until you acknowledge it.
5. Auto-clear - The MJ-5 automatically clears the Alert when the condition ceases.
6. The Tap Track Error alert can be disabled, if desired. See Table 4.2 on page 17.

5.9 Harmonics Data— The <HARMONICS> menu

Harmonics data are calculated for load voltage, source voltage, and load current. The <**HARMONICS**> menu contains the data items listed in Table 5.9:

Table 5.9 <**HARMONICS**> Menu Data Items

Vld THD = NNN.N%
Vs THD =: NNN.N%
Ild THD =: NNN.N%
Show Harm: **ODD**, EV/OD
Show As: %TOTAL, **%FUND**, RMS VAL.
Vld 1st = NNN.N%T
Vld 1st = NNN.N V
Vld 3rd = NNN.N%F
:
Vld 31st = NNN.N% F
Vs 1st = NNN.N%T
Vs 1st = NNN.N V
Vs 3rd = NNN.N%F.
Vs 31st = NNN.N%F
:
Ild 1st = NNN.N%T
Ild 1st = NNNN A
Ild 3rd = NN.N%F
:
Ild 31st:NN.N%F
Bold denotes default

Use the Menu and Scroll keys to view the <**HARMONICS**> menu. Use the ▲ and ▼ keys to step through the data items.

The first set of data items in the <**HARMONICS**> menu are the three Total Harmonics Distortion values for: load voltage (Vld THD: NNN.N%), source voltage (Vs THD: NNN.N%), and load current (Ild THD: NNN.N%). The second set of data items in the <**HARMONICS**> menu are Show Harm: and Show As:. These data items allow you to select the format of the data to be viewed:

Show Harm:	Odd	Show odd harmonics only
	Ev/Odd	Show both even and odd harmonics
Show As:	%TOTAL.	Show harmonics as percentage of total signal magnitude.
	%FUND.	Show harmonics as percentage of the fundamental.
	RMS Val.	Show harmonics as signal magnitude.

Use the ▲ and ▼ keys in the <**HARMONICS**> menu to view the harmonics data. The harmonics data items appear after configuration items Show Harm and Show As. The harmonics data items always include the RMS and % Total values for the fundamental (i.e., the 1st harmonic).

Data for even harmonics is only shown if configuration item Show Harm is set for EV/OD. Data for harmonics above the 1st harmonic are shown as % Total, % Fundamental, or RMS depending on which is selected in the Show As configuration item.

5.10 VRC Status - the <REGULATOR> Menu

The VRC Status items indicate the present level of Voltage Reduction Control (VRC). The VRC Status item is indicated as:

VRC Stat = XX.X%MY where:
XX.X% is the amount of voltage reduction (0.0% to 10.0%)

M is the VRC Mode where:
L = Local
R = Remote
A = Auto (w/Remote Override)

Y is the presently active VRC step for:
Local - not applicable
Remote - 1, 2, or 3
Auto - 1 or 2

This data item can be accessed using the VRC Select fast path key.

6 MJ-5 Control Panel Automatic Mode

This Chapter covers operating principles of the MJ-5 control program and describes the various functions performed by the microprocessor. It contains the information you may need when deciding between the various options described in Chapter 4 (Setting Up the MJ-5 Control Panel) and Chapter 5 (Reading and Interpreting MJ-5 Control Panel Data).

6.1 MJ-5 Control Modes

The regulator control function has four operating modes: local manual control, local automatic control, remote control, and Off. Manual control can only be performed locally. Select the operating mode with the Remote-Auto/ Off/Manual switch as shown in Figure 6.1.

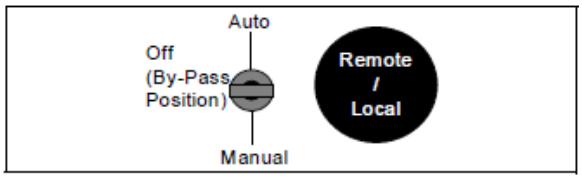


Figure 6.1 Auto/Manual Switch (Shown in Off position)

Manual mode

Place the Auto/Off/Manual Switch in the down position to activate the Manual mode. In Manual mode, you can use the Tap Raise/Lower switch (on the MJ-5 front panel) to control the tap position directly. Status information is available via the remote communications link, but the remote operator cannot change settings or otherwise operate the MJ-5 Control Panel.

Off (By-Pass Position)

No operation of the tap changer can occur: remotely, locally, or automatically.

Auto-Remote mode

With the Auto/Manual switch in the up position, the Remote/Local key may be pressed so that the Remote Disabled LED is off, putting the control Panel into the Auto-Remote mode.

In this mode, the MJ-5 executes its automatic tap control algorithms, unless overridden remotely. Status information is available via the remote communications link. A remote operator can request a tap raise or lower via the communications link, change settings and remotely operate the control program. For direct control via terminal strip connections see Figure 2.3.

When the remote operator initiates the tap raise/lower, the MJ-5 enables its “Pseudo-Manual” operating mode. The Pseudo-Manual alert condition is activated, and local automatic operations are disabled until the remote-commanded tap raise/lower is completed.

The MJ-5 Control Panel remains in the Pseudo-Manual mode for a predefined time period after receipt of the last remote tap raise/lower command. When the time period has elapsed and the MJ-5 Control Panel has Remote Auto Inhibit disabled, the panel resumes its normal automatic control operations. If Remote Auto Inhibit is enabled, it maintains its tap position until it receives another raise/lower command or until Remote Auto Inhibit is disabled.

Auto-Local mode

With the Auto/Manual switch in the up position, if the Remote/Local key is pressed so that the Remote Disabled LED is on, the control Panel will be in the Auto-Local mode. In this mode, the MJ-5 executes its normal tap control algorithm. Status information is available via the remote communications link, but the remote operator cannot change settings or otherwise operate the MJ-5 Control Panel

Table 6.1 summarizes the four operating modes.

Table 6.1 Summary of Control Mode Operation MJ-5

Switch Positions	Manual	Automatic
Remote Control Enabled	1. Automatic Operation Disabled 2. Comm link tap control override 3. Comm Link Raise/Lowers Enabled 4. Comm Link Auto/Manual control Enabled 5. Tap Raise and Lower Switches Enabled	1. Automatic Operation Enabled 2. Comm link tap control override 3. Comm Link Raise/Lowers Enabled 4. Comm Link Auto/Manual control Enabled 5. Tap Raise and Lower Switches Disabled
Remote Control Disabled	1. Automatic Operation Disabled 2. No comm link tap control override 3. Comm Link Raise/Lowers Disabled 4. Comm Link Auto/Manual control Disabled 5. Tap Raise and Lower Switches Enabled	1. Automatic Operation Enabled 2. No comm link tap control override 3. Comm Link Raise/Lowers Disabled 4. Comm Link Auto/Manual control Disabled 5. Tap Raise and Lower Switches Disabled

6.2 Overview of Automatic Control Algorithm

The automatic control algorithm maintains the output voltage within its prescribed limits while following a control hierarchy.

Normal algorithm operation is as follows. When voltage falls outside the allowed range (defined by voltage level set point ± ½ bandwidth), the delay timer is started. If voltage is out of range at the end of the delay period, the tap change motor is energized. When the voltage is back within range, the tap change motor is deactivated. Hysteresis is included to prevent oscillations.

In automatic mode, the control program processor controls the tap changer motor. The control algorithm takes the following into account:

1. Calculated or monitored regulator output voltage
2. Voltage-level set point
3. Bandwidth set point
4. Resistance line drop compensation set point
5. Reactance line drop compensation set point
6. Voltage limit control set points
7. Voltage reduction control set points
8. Monitored load current
9. Load power factor
10. Power flow operating mode
11. Power flow direction.

Because coinciding events might introduce conflicts, an operational hierarchy must be established. This hierarchy is maintained when the unit is under automatic control. Manual mode always takes precedence over automatic control.

Conflicts are resolved according to the following priority scheme (from highest to lowest):

1. Automatic tap change inhibit (implemented Comm Link command).
2. Current inhibit (determined by I % Threshold of configuration setting; as % of full scale CT rating).
3. Current Bias setting and Bias Percent (see Section 6.5.3)
4. Voltage Limit Control (defined in regulator settings).
5. Voltage Reduction Control.
6. “Normal” regulator control operation.

6.3 Voltage Sensing and Correction

Voltage Sensing

The control program monitors the regulator output voltage signal from one of the following sources:

- a voltage transformer, “VT” [also known as a potential transformer or “PT”], integral to the regulator, which is turns-ratio corrected to deliver 120 VAC at the nominal system voltage.
- the utility winding of the regulator, which generally requires correction to deliver 120 VAC at the nominal system voltage.

The control program senses regulator output (i.e., “load”) voltage depending on power flow operating mode (see Table 6.2):

Table 6.2 Regulator Output Voltage Sensing

Regulator Design ANSI Type	Winding Used for Voltage Sensing	
	Forward Power Flow Operation	Reverse Power Flow Operation
A (Straight)	Voltage transformer	Utility winding
B (Inverted)	Utility winding	Voltage transformer

Since the control program routinely senses both the voltage transformer and the utility winding, it is a straightforward process for the control program to select which source is “active” (depending on power flow mode and regulator design).

If a voltage transformer is not installed on the regulator, then the control will calculate the voltage on that side of the regulator based on the utility winding voltage and tap position.

Software Voltage Measurement Correction

The monitored output voltage is scaled appropriately to the nominal basis voltage in two steps. The first voltage scaling is performed through a step-down transformer. The second scaling takes place in the software algorithm after the voltage is converted to a numeric representation. Software scaling corrects the nominal input voltage level to the numeric representation of the basis voltage. The basis voltage value is user configurable. The choices are 115, 120 and 125 V. The default basis voltage is 120 V.

6.4 Voltage Limit Control

The voltage limit control (VLC) function monitors regulator output voltage and compares it to maximum and minimum voltage limit set points. If the VLC function is active, the control program inhibits tap changes that would cause the voltage to go above the VLC upper or below the VLC lower voltage. If VLC is activated while the voltage is outside of the VLC limit range, the tap position is incremented/ decremented until the voltage is within the defined VLC range.

Limiting and/or runback may occur if one of the following happens:

1. The source voltage changes dramatically,
2. The load on the regulator changes significantly, or
3. The VLC function is enabled when the limit conditions are exceeded.

Note: The VLC function uses the Vld (i.e., the load voltage at the regulator) to determine whether or not to limit or runback. The VLC algorithm senses one regulator bushing for forward power flow, and the other regulator bushing for reverse power flow (see Forward/Reverse Operation modes, below).

The maximum voltage limit set point is adjustable from 106.0 volts to 134.0 volts in 0.1 volt steps. The minimum voltage limit set point is adjustable from 106.0 volts to 134.0 volts in 0.1 volt steps. The control program will not allow these limits to be set so that they overlap one another.

If regulator output voltage falls outside limits, VLC acts to return regulator voltage within limits. Return begins immediately, (i.e., without regard to the time delay setting), while avoiding a hunting condition, (i.e., VLC will not force a tap change which would activate the basic control algorithm and force the regulator outside limits once again).

VLC activates when load voltage is within one volt of the upper/lower limit to prevent the voltage from going outside prescribed limits.

6.5 Reverse Power Flow

Systems where power flow reversals occur have unique regulation control requirements. For systems of this type, the MJ-5 senses the reversal and adjusts its operation accordingly. When power flow direction changes, the MJ-5 control algorithm takes the following factors into account:

1. Power Flow direction,
2. Forward or Reverse operating mode, and
3. Power Flow Mode as selected from the <**CONFIG-URE**> menu. These factors are discussed in greater detail below:

6.5.1 Power Flow Direction

The microprocessor determines power flow direction by continually monitoring the real power (kW) reading and the real component of current. The real component of current represents the component of the current which is in phase with the load voltage signal.

The MJ-5 Control Panel indicates forward power flow when the real power (kW) is positive and the real

component of current is greater than 1% of the full scale current.
Reverse power flow is indicated when the real power is negative and the real component of current is greater than 1% of the full scale current. To avoid excessive switching between Forward and Reverse Operation (defined below), the microprocessor delays five seconds after the occurrence of a current flow reversal before switching from forward to reverse, and vice-versa.

As an example, assume current is flowing in the forward direction. When load current magnitude drops through zero and increases to a magnitude that exceeds 1% rated current in the reverse direction, the microprocessor delays five seconds and then considers reverse power flow to be in effect. Reverse power flow remains in effect until current direction becomes forward once again and its magnitude exceeds 1% of rated current in the positive direction for five seconds. At that time, the microprocessor considers forward power flow conditions to have resumed.

Power flow direction is indicated on many of the metering screens. “F” indicates forward power flow; “R” indicates reverse power flow. “F” is shown when: kW > 0 and |Ireal| > 1% (of full scale) for 5 seconds minimum. “R” is shown when: kW < 0 and | Ireal | > 1% (of full scale) for 5 seconds minimum. If the real current magnitude is below the 1% threshold, the last known power flow direction remains in effect. If the real current magnitude is below the 1% threshold after power up or unit reset, the MJ-5 defaults to forward power flow operation.

It is possible for Reverse Power Flow conditions to occur in regulators with no source-side voltage input (e.g., no “Source-Side PT” for Siemens Inverted Regulators). In this case, the MJ-5 uses the calculated source-side voltage for performing reverse power flow regulation. See sections 5.1 and 5.2 for details on source-side voltage calculation.

When determining power flow direction, the system takes into account the current-to-voltage phase relationship associated with the system as specified in the <**CONFIGURE**> menu (System, Utility Polarity, and I [current] Shift parameters).

6.5.2 Forward/Reverse Operation

The MJ-5 Control Panel accommodates power flow reversals by alternating between “Forward” and “Reverse” modes. Because the microprocessor monitors (or derives) the voltage on both sides of the regulator, it can reverse modes by simply reversing its definition of “source” and “load.”

- In Forward Operation mode, the microprocessor senses the “L” Bushing (or derives the “L” Bushing voltage from the “S” Bushing voltage and the knowledge of the tap position) to determine load voltage and controls the tap changer on the basis of the Forward set points (Voltage, Bandwidth, Time Delay, Line Drop Compensation). During Forward Operations, “forward” Meter data is displayed.
- In Reverse Operation mode, the microprocessor senses the “S” Bushing (or derives the “S” Bushing voltage from the “L” Bushing voltage and the knowledge of the tap position) to determine load voltage and controls the tap changer on the basis of the Reverse stipends (Voltage, Bandwidth, Time Delay, Line Drop Compensation).

During Reverse Operations, “reverse” Meter data is displayed. The following parameters determine whether the tap change motor is energized to raise the tap position or to lower it:

1. Power flow direction,

2. Forward/reverse operation,

3. Out-of-band status,

4. Power flow mode (see below for details).

Tables 6.3 and 6.4 on the next page summarize the tap change direction for each Power Flow mode

6.5.3 Current Bias and Bias Percent

This option is only in effect when the power flow mode is Bi-Directional. For this special operation, the Bias percent must be greater than the I Threshold%. *Typically I Threshold % should be set to 0%.*

The operation of this feature is described below, categorized into direction and magnitude of current flow.

Current is greater than the Bias percent (no change in prior functionality):

- Forward Power Flow: tap changes will occur based on the Load bushing voltage.
- Reverse Power Flow: tap changes will occur based on the Source bushing voltage.

Current is less than the Bias Percent (new functionality):

- None: no tap changes will occur.
- Fwd: tap changes will occur based on Load bushing voltage.
- Rev: tap changes will occur based on Source bushing voltage.
- NeutT: tap changer will run to Neutral Tap.

6.5.4 Power Flow Modes

The MJ-5 supports six Power Flow Modes: Forward Locked, Reverse Locked, Bidirectional, Neutral Reverse, Idle Reverse, and Co-generation. Your selection of one of these determines which algorithm the control program uses under reverse power flow conditions.

Table 6.3 Tap Changer Direction

Power Flow Mode	Line Drop Compensation Values	Power Flow Direction Forward	Power Flow Direction Reverse	MJ-5 Internal Operation Forward	MJ-5 Internal Operation Reverse	Tap Change Control See Table 6.4
Bi-Dir	F	•		•		Forward
	R		•		•	Reverse
Neut R	F	•		•		Forward
			•		•	Return to Neutral*
Idle R	F	•		•		Forward
			•		•	None (tap idles)
Co-Gen	F	•		•		Forward
	R (See Table 6.4)		•	•		Forward
F Lock	F	•		•		Forward
	F		•	•		Forward
R Lock	R	•			•	Reverse
	R		•		•	Reverse

* If tap position is not known, Neut R operates same as Idle R.

Table 6.4 Tap Change Control Operation

	Forward	Reverse
"Vcomp" location	"L" Bushing	"S" Bushing
Out of Band High	Lower	Raise
Out of Band Low	Raise	Lower
Voltage Setpoint	Fwd Volts	Rev Volts
Bandwidth Setpoint	Fwd BW	Rev BW
Time Delay Setpoint	Fwd Delay	Rev Delay
Line Drop Compensation (R = Resistance, X = Reactance)	F* Fwd Comp (R) Fwd Comp(X)	R* Rev Comp (R) Rev Comp (X)

*For Co-gen mode when in Reverse Power Flow mode, use Forward Voltage, BW, and Time Delay setpoints, but use Reverse Line Drop Compensation values.

F LOCK (Forward Locked Mode)

This mode of operation is intended for use on systems where reverse power flow is not anticipated. Tap changes are inhibited under reverse power flow conditions.

In this mode, the controller always operates in *forward mode*. The tap changer operates unless reverse current magnitude exceeds the I Threshold % set point, at which time further tap changes are inhibited. The tap changer resumes operation when the reverse current drops below the I Threshold % set point.

In this mode, if power flow does reverse, Demand values are not computed.

View Pwr Flow: F LOCK on the <**CONFIGURE**> menu.

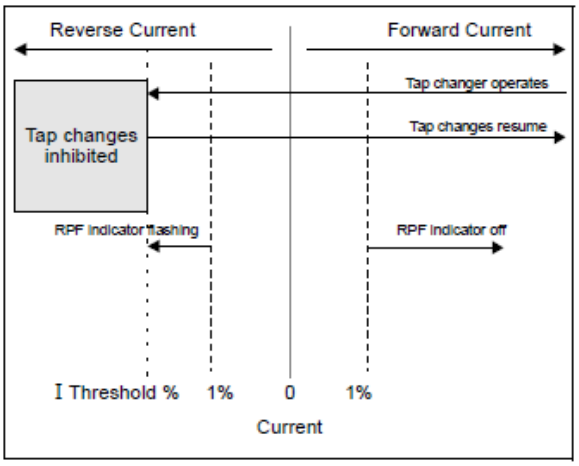


Figure 6.2 Forward Locked Mode

R LOCK (Reverse Locked Mode)

This mode of operation is intended for use on systems where forward power flow is not anticipated. Tap changes are inhibited under forward power flow conditions.

In this mode, the controller always operates in reverse mode. The tap changer operates unless forward current magnitude exceeds the I Threshold % set point, at which time further tap changes are inhibited. The tap changer resumes operation when forward current magnitude drops below the I Threshold % set point.

In this mode, when power flow is Forward, Demand values are not calculated.

View Pwr Flow: R LOCK on the <**CONFIGURE**> menu.

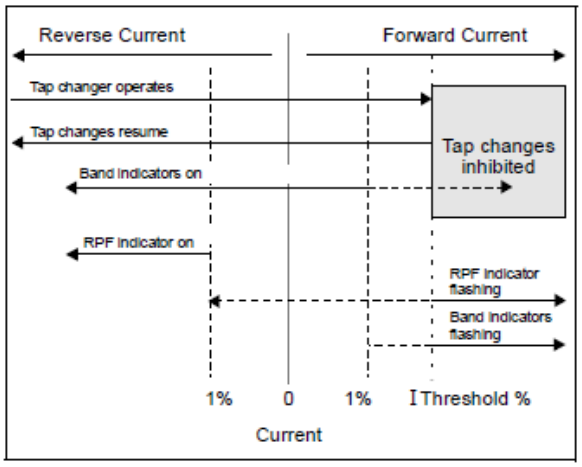


Figure 6.3 Reverse Locked Mode

BI-DIR (Bi-directional mode)

This mode of operation is intended for use on systems where reverse power flow is anticipated and voltage regulation is desired under either forward or reverse power flow conditions.

In this mode, the tap changer operates when current magnitude exceeds the I Threshold % set point. The tap changer operates in forward mode when forward current magnitude exceeds the I Threshold % set point, and in reverse mode when reverse current magnitude exceeds the I Threshold % set point.

I Threshold %, must be set to a minimum of 1%(when I Dir Bias is not in use; i.e. I Dir Bias = None). See Section 6.5.1 for more details.

When I Dir Bias is in use, I Threshold should be set to 0%.

View Pwr Flow: Bi-dir on the <**CONFIGURE**> menu.

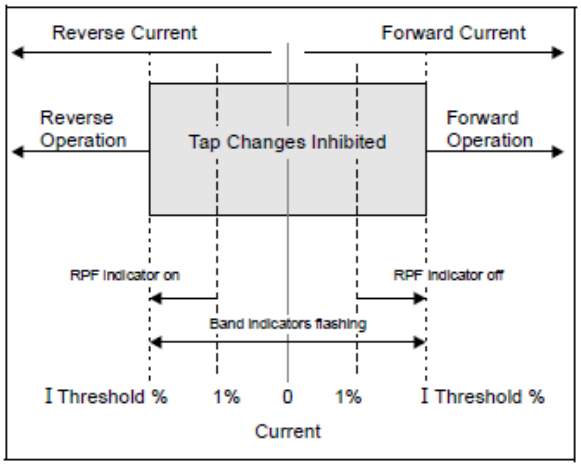


Figure 6.4 Bi-directional Mode.

IDLE R (Idle Reverse)

This mode of operation is intended for use on systems where reverse power flow is an abnormal situation. Under reverse power flow conditions, the regulator idles at the last tap position.

In this mode, the controller always operates in forward mode. When forward current magnitude drops below the I Threshold % set point, tap changes are inhibited and the regulator idles at the last tap position. Tap changer operation resumes when forward current magnitude exceeds the I Threshold % set point.

Select Pwr Flow: IDLE R on the <**CONFIGURE**> menu.

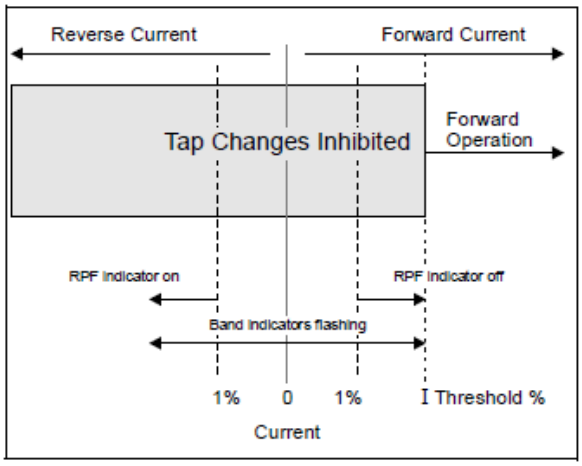


Figure 6.5 Idle Reverse Mode

NEUT R (Neutral Reverse)

This mode of operation is intended for use on systems where reverse power flow is an abnormal situation.

In this mode, the controller always operates in the forward mode. When current magnitude drops below the forward I Threshold % set point, tap changes are inhibited. When the reverse current magnitude exceeds I Threshold % set point for ten seconds, the tap changer resumes operation and returns the tap changer to the neutral position without stopping. The tap changer then remains at the neutral position until forward current magnitude once again exceeds the I Threshold % set point.

If, while the tap changer is returning to neutral, the forward current magnitude increases above the I Threshold % set point, normal forward tap changer operation resumes. Neutral Reverse mode is dependent upon the MJ-5 tap tracking algorithm. If the tap position is unknown to the microprocessor, the tap changer idles at the last held position.

View Pwr Flow: NEUT R on the <**CONFIGURE**> menu.

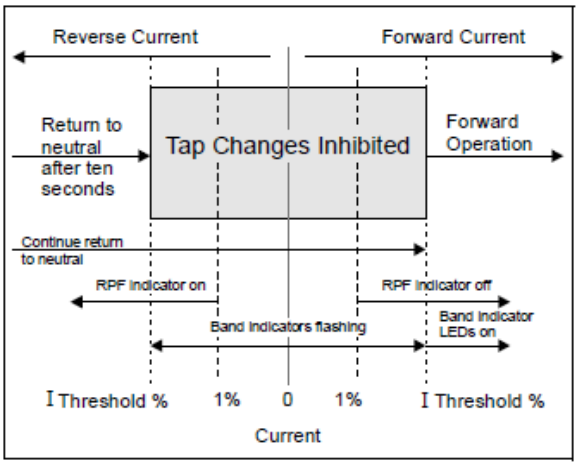


Figure 6.6 Neutral Reverse Mode

CO-GEN (Co-generation)

This mode of operation is for use on systems where power flows from Utility to consumer at certain times and from consumer to Utility at other times. In this mode, the tap changer operates whenever current magnitude (either forward or reverse) exceeds the I Threshold % set point.

In this mode, the controller always operates in Forward mode. Forward Line Drop Compensation values are used when forward current magnitude exceeds the I Threshold % set point. Reverse Line Drop Compensation values are used when reverse current magnitude exceeds the I Threshold % set point. Tap changes are inhibited when current magnitude is between the I Threshold % set points.

View Pwr Flow: CO-GEN on the <**CONFIGURE**> menu.

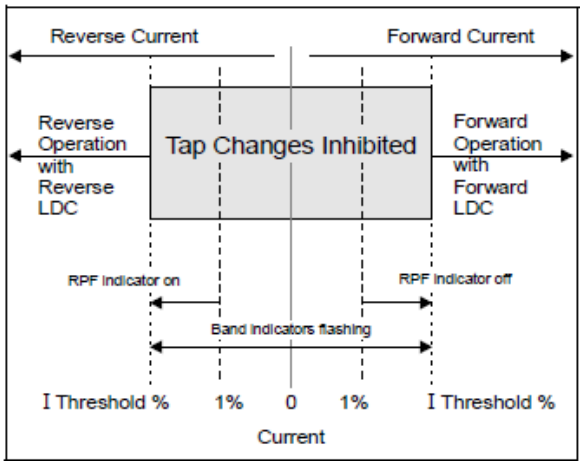


Figure 6.7 Co-generation Mode

7 Software for Communicating with the MJ-5 Control Panel

7.1 Communications Software

Siemens has developed a Windows-based communications software application called MJXplorer. All configuration and data can be downloaded to a PC via the USB Data Port located on the front of the MJ-5 Control Panel, through the RS-232 connection located on the back or through the RJ-45 Ethernet connection also located on the back of the panel. Downloaded data can then be saved in a *.CSV (comma separated variable) format. The file may then be imported to other commonly used software, including spreadsheet applications.

In addition to downloading, MJXplorer software can modify configuration information and upload the information to the MJ-5 Control Panel. The MJXplorer software and operating instructions are available from Siemens. Contact your Siemens Power Transmission & Distribution representative for details.

Another program called DNP Configure can be used to define a custom set of DNP points for a control panel. This program is also available from Siemens. Contact your Siemens representative for details.

All software is available on the Siemens website listed in section 1.8.

8 MJ-5 Control Panel Basic

Troubleshooting

8.1 Introduction

MJ-5 Control Panel service is primarily accomplished at the factory. However, certain basic procedures can be accomplished in the field. This chapter outlines a set of procedures whose major objectives are to:

1. Ensure that the fault is inside the MJ-5 (and not in external connections or connected equipment).

2. Ensure that the fault is not due to improper jumper arrangements or some other user-correctable condition.

3. Determine whether the fault can be locally repaired (e.g., by replacing a fuse).

Troubleshooting approaches depend upon the problem. Among other indicators, you should consider:

- Visual review of the unit.

- Alerts (see Table 8.1 below).

Table 8.1 Alert Messages

Alert Name	What to Check
Low Current	Check E1 and C2 wiring. Check calibration on the Current inputs.
Auto Inhibit	This alert does not indicate a fault condition. It indicates that Automatic Inhibit has been activated (either via the communications link or via the Automatic Inhibit Input terminals
Tap Track Error	May indicate a temporary fault condition (failure to detect a transition on one of several input lines.) Check PDS signals J, K, U10 and U12.
Neutral Sig. Err	May indicate a temporary fault condition (failure to detect a transition on one of several input lines.) This alert could also indicate a problem with the Neutralite™ input signal. Check the Neutral (PDS-U12) input.
Tap Pos ????	May indicate a temporary fault condition (failure to detect a transition within the allowed time period on one of several input lines.) Check the Neutral (PDS-U12) and Operations Counter (PDS-U10) inputs.
Low PT Thresh	This alert does not necessarily indicate an MJ-5 fault condition. Check to see whether this alert condition goes away when both U2 and P2 are above the PT Threshold.
Overcurrent	This alert does not (normally) indicate an MJ-5 fault condition. Ensure that this Alert goes away when an in-range current (0-200 mA) is applied at C2/E1.
NV RAM Reset	May indicate a temporary fault condition. If condition appears repeatedly, replace the unit.
Low Battery	Indicates that it is time to replace the Lithium Battery. If condition persists after a good battery is installed, check that the battery was installed properly. If fault persists, consult the factory.
High Voltage	May indicate a temporary system fault condition. If condition persists when in-range voltages (90-140 VAC) are applied to both PDS-U2 and PDS-P2 inputs, perform calibration.
Not in Auto	Indicates that Remote-Auto/Off/Manual switch is in Manual.
R Limit Reached, L Limit Reached	These alerts indicate that the tap position has reached or exceeded the pre-set threshold. These alerts may occur during normal operation due to system conditions. If these alerts occur when system conditions do not warrant it, their occurrence could indicate an MJ-5 failure. Verify the MJ-5 can automatically raise and lower tap position.
Self Test Fault	This alert indicates a failure of one or more MJ-5 self tests. Consult your Siemens representative for instructions.

8.2 Visual Inspection

Check:

- External Source fuse (if External Source Terminals are used to power the unit)
- Fuse connectors not mated properly
- Jumpers not in their correct positions
- Terminal Strip connectors not mated properly
- Terminal Strip connector jumpers missing or screws not tightened properly

CAUTION

120 volts on terminal block, leads, and inside control panel housing.

May result in minor or moderate injury including equipment damage.

Disconnect all power sources before making connections to the terminal block or opening the control panel housing.

8.3 Troubleshooting Based on Alert Messages

Alert messages can be used to help diagnose both system problems (ones which include both regulator and controller), and internal MJ-5 problems. Table 8.1 provides suggestions for troubleshooting an MJ-5 Control Panel using information from the <**ALERTS**> menu.

Note that faults identified as "temporary" may be due to transient conditions within the system and may not be internal MJ-5 faults.

8.4 Voltage and Current Calibration

The MJ-5 Metering functions are calibrated at the factory. Periodically check calibration, and, if needed, recalibrate the MJ-5:

8.4.1 Checking the U2 Voltage Calibration

Note: You can check the U2 voltage calibration while the panel is installed on a regulator.

To check U2 calibration, apply an AC voltage (in the range of 115 to 135 VAC) from U2 to E. Monitor the Voltage Calibration/Test Terminals with a true RMS voltmeter. View the "U2 Cal" screen on the MJ-5 (i.e., go to <DIAG-NOSTICS> menu and press down arrow once to show "U2 Cal".) Verify that the "U2 Cal" reading matches the applied voltage (within ± 0.5 VAC). If calibration is off, recalibrate (see below).

8.4.2 Checking the P2 Voltage Calibration

Note: If the regulator provides the "source" voltage signal, you can check the P2 voltage calibration while the panel is installed on the regulator. (If the regulator lacks a "source" voltage signal, then there is no need to calibrate the P2 input.)

To check P2 calibration, apply an AC voltage (in the range of 115 to 135 VAC) from P2 to E. Monitor the Voltage Calibration/Test Terminals with a true RMS voltmeter. View the "P2 Cal" screen on the MJ-5 (i.e., go to <DIAG-NOSTICS> menu and press down arrow twice to show "P2 Cal") Verify that the "P2 Cal" reading matches the applied voltage (within ± 0.5 VAC). If calibration is off, recalibrate (see below).

8.4.3 Checking the Load Current Calibration

Note: To check the current calibration, remove the panel from the tap changer apparatus, connect an external ammeter, and apply an external AC current source.

To check C/C2 calibration, apply a current (in the range of 5 to 140 mA) at C2/E1 and verify that C/C2 reads within ±0.5 mA of the applied value (as displayed on external Ammeter connected at C/C2).

8.4.4 Calibrating the U2 Voltage

Connect an external true RMS voltmeter at the front panel "Voltage Calibration/Test Terminal." Apply the nominal calibration voltage (per Table 8.2.) Display the "U2 Cal" screen. To calibrate, press the Change/Save key, then the ▼ or ▲ key to make the value shown on the MJ-5 display agree with the external voltmeter value. When the correct value is displayed, press the Change/Save key to complete the process.

Note: If password protection is in effect, you must enter the password to enable calibration. The default password for the **<DIAGNOSTICS>** menu is "3333".

8.4.5 Calibrating the P2 Voltage

Connect an external true RMS voltmeter at the front panel "Voltage Calibration/Test Terminal." Apply the nominal calibration voltage (per Table 8.2.) Display the "P2 Cal" screen. To calibrate, press the Change/Save key, then the ▼ or ▲ key to make the value shown on the MJ-5 display agree with the external voltmeter value. When the correct value is displayed, press the Change/Save key to complete the process

Note: If password protection is in effect, you must enter the password to enable calibration. The default password for the **<DIAGNOSTICS>** menu is “3333”.

8.4.6 Calibrating the Load Current

Note: To calibrate the current, disconnect the panel from the tap changer apparatus. Remove Terminal Strip jumper at TB1B-9 & 10. Connect an external ammeter, and apply an external AC current source, per Table 8.2. After calibration, replace Terminal Strip jumper at TB1B-9 & 10.

The Load Current (Ild) has calibration set-point, C/C2. Calibrate the set point with an external true RMS ammeter connected at the rear panel (terminal strip contacts TB1B-9 & 10). Connect a (nominal) 0-200 mA AC current source at C/C2 (terminal strip contacts TB1A- 3 & 5).

Apply the C/C2 calibration current (per Table 8.2). Use the Menu and Scroll keys to view the “C/C2” screen. To calibrate, press the Change/Save key, then the ▼ or ▲ key to make the value shown at the MJ-5 display agree with the external ammeter value. When the correct value is displayed, press the Change/Save key to complete the process.

Note: If password protection is in effect, you must enter the password to enable calibration. The default password for the **<DIAGNOSTICS>** menu is “3333”.

Table 8.2 Voltage and Current Calibration

Signal to Calibrate	Test Signal Application Point	Test Signal Measurement Point	Nominal Calibration Signal Magnitude	Tolerance	MJ-5 Data Item <DIAGNOSTICS> Menu	Conditions
U2	U2 to E (TB1A-6 & 4)	Voltage Calibration Terminals	120 VAC (RMS)	±0.5 VAC	U2 Cal	U2/P2 key = U2
P2	P2 to E (TB1A-2 & 4)	Voltage Calibration Terminals	120 VAC (RMS)	±0.5 VAC	P2 Cal	U2/P2 key = P2
C/C2	C2 to E1 (TB1AQ-3 & 5)	C/C2 (TB1B-9-10)	80 mA (RMS)	±0.5 mA	C Cal	Note 1

Note 1: Prior to calibration, disconnect panel from regulator, and remove on-board Terminal Strip jumper at TB1B-9 & 10. After calibration, replace Terminal Strip Jumper at TB1B-9 & 10.

A: Specifications

Operational Requirements

Temperature

Operating: -40°C to +85°C
Storage: -40°C to +85°C

Humidity

Operating: Relative humidity of 5% to 95% non-condensing

Storage: Relative humidity of 5% to 95% non-condensing

(U2 and P2 range)

80 to 145 volts RMS

Frequency

45 to 65 Hz

Accuracy

Metering accuracy*: ±0.5% over the -40°C to +85°C operating range.

* Basic accuracy of the MJ-5 (excludes Potential Transformer or Current Transformer errors).

Electrical transient immunity

The MJ-5 Current Transformer (CT) withstands a sudden open circuit without damage to the control circuit. However, an open CT circuit can result in dangerously high voltage, and should be avoided.

The MJ-5 Control Panel is impervious to electrical transients as defined by the following:

Surge: ANSI/IEEE C37.90.1-2002
All PDS and terminal strip connections

High Energy Surge: ANSI/IEEE C62.41-1980
U2 and P2 inputs only

Not susceptible to upset due to high radio frequency interference (RFI) defined by the following:

RFI Susceptibility: ANSI/IEEE C37.90.2-1987.

B: Physical Installation on Siemens Regulators

Physical installation consists of placing the MJ-5 Control Panel in its weatherproof housing and connecting the Polarized Disconnect Switch to the regulator. Customer supplied external connections to the terminal strip on the back of the unit are made as required. Begin by disconnecting and removing the panel you are replacing.

Switch Settings for MJ-5 (See Chapter 2)

As you prepare to install the MJ-5 Control Panel, the following switch settings should be observed:

Normal/External power switch	OFF
Auto/Manual switch	OFF
Tap Raise and Lower switch	OFF

Polarized Disconnect Switch

A wing-nut-secured, ten-position, male Polarized Disconnect Switch (PDS) provides the interface to the regulator sensing and control circuits.

The PDS is compatible with previous generation Accu-Stat™ controllers. The PDS connections are:

U12 High side of neutral position indicator switch. When closed to ground, indicates tap changer in neutral. (Turns on Neutralite).
P2 AC side of Potential Transformer, if present.
C2 High side of Current Transformer.
E Collective neutral return for the control panel, the Utility winding and PT winding.
E1 Low side of Current Transformer.
U2 AC high side of regulator Tertiary (Utility) winding. Provides:
-Control Panel power source.
-Voltage reference.
-Voltage Phase reference for flow direction,
-Power factor
J Output from the panel to Raise regulator tap position.
K Output from the panel to Lower regulator tap position
U10 High side of Op Counter switch. (closes to ground E)
U11 High side of regulator drag hands reset solenoid (returns to E)

Replacing Older Control Units with the MJ-5 Control Panel

If the original control has modifications such as Auxiliary Transformer, Auxiliary CT, Reverse Power Flow Detector, Voltage Limit Control, or other accessories mounted in the enclosure, special engineering instructions will be required before the existing control is replaced.

Note 1: Some older controllers do not provide the necessary signals to support all MJ-5 functions. (i.e., tap position indication, operations counter, Neutralite, drag hands reset.)

Note 2: The control being replaced may incorporate a jumper between the P2 and U2 terminals on the female (stationary) portion of the PDS. If and only if this jumper is present:

1. Remove the jumper.

2. Remove the P2 lead from the P2 screw terminal. Reconnect the P2 lead to the U2 screw terminal, leaving the P2 terminal vacant.

CAUTION

Connecting of P2 and U2 lines from the regulator will cause a direct short circuit of the two voltage sources.

Will result in severe internal damage.

To Prevent:

Do not connect the P2 and U2 leads to the same terminal.

Note 3: To replace panel types UA-23, UA-24, UA-25 (also type UJ-1 used on S/N's 9-0110-00159, 00163, and 00201) a special adapter mounting kit is required. To make use of this adapter kit (Cat. No. 1670), the MJ-5 Control Panel must be installed complete with its enclosure.

Note 4: To replace panel types UJ-4 and UJ-5 with the MJ-5, replace the ten-pin male portion of the PDS Supplied with the MJ-5 Control Panel with the seven-pin male PDS from the older control. Tape up the three unused leads U10 (operation counter), U11 (drag hand reset) and U12 (Neutralite™). Install a jumper wire from C1 to E on the female portion of the PDS. For this installation, the MJ-5 will not track the tap position and will not update the operations counters.

Note 5: To replace controls other than those named, refer to the factory for special engineering instructions.

Note 6: Regardless of the panel type being replaced, the MJ-5 Control Panel must be configured to operate with the particular regulator on which it is being installed (see Chapter 4).

Replacing existing MJ-5 Control Panels

To replace an already-installed MJ-5 Control Panel, the procedure is similar to that described above.

Polarized Disconnect Switch

Plug the PDS from the new MJ-5 into the female PDS in the control enclosure.

Terminal Strip Connector

External devices are wired to a terminal strip connector at the back of the MJ-5 Control Panel. See Appendix K for pin-outs and signal descriptions.

WARNING

Hazardous voltage will be present on various control leads when regulator is energized.

Could result in death or serious injury including equipment damge from contact with live linve conductors.

To prevent:

Remove fuses before by-passing the regulator and leave to fuses out while the regulator is bypassed.

Field Maintenance:

The MJ-5 is a state-of-the-art controller utilizing complex circuits and sophisticated components for the detection, processing and display of regulator parameters and the precise control and operation of the tap changer. Field maintenance is not recommended as special equipment and instrumentation are required for the proper calibration, testing and checking of the controller operation. It is strongly recommended that MJ-5 controller repair, testing, and calibration be performed only by Siemens authorized repair facilities.

WARNING

Use of unauthorized parts and/or unqualified personnel in the repair of this equipment

could result in death or serious injury including electrical damage to equipment.

To Prevent:

Only authorized personnel should work on this equipment including installation, operation and maintenance.

C: Regulator Control Diagrams

Typical Control Diagrams - For Sample Reference Only

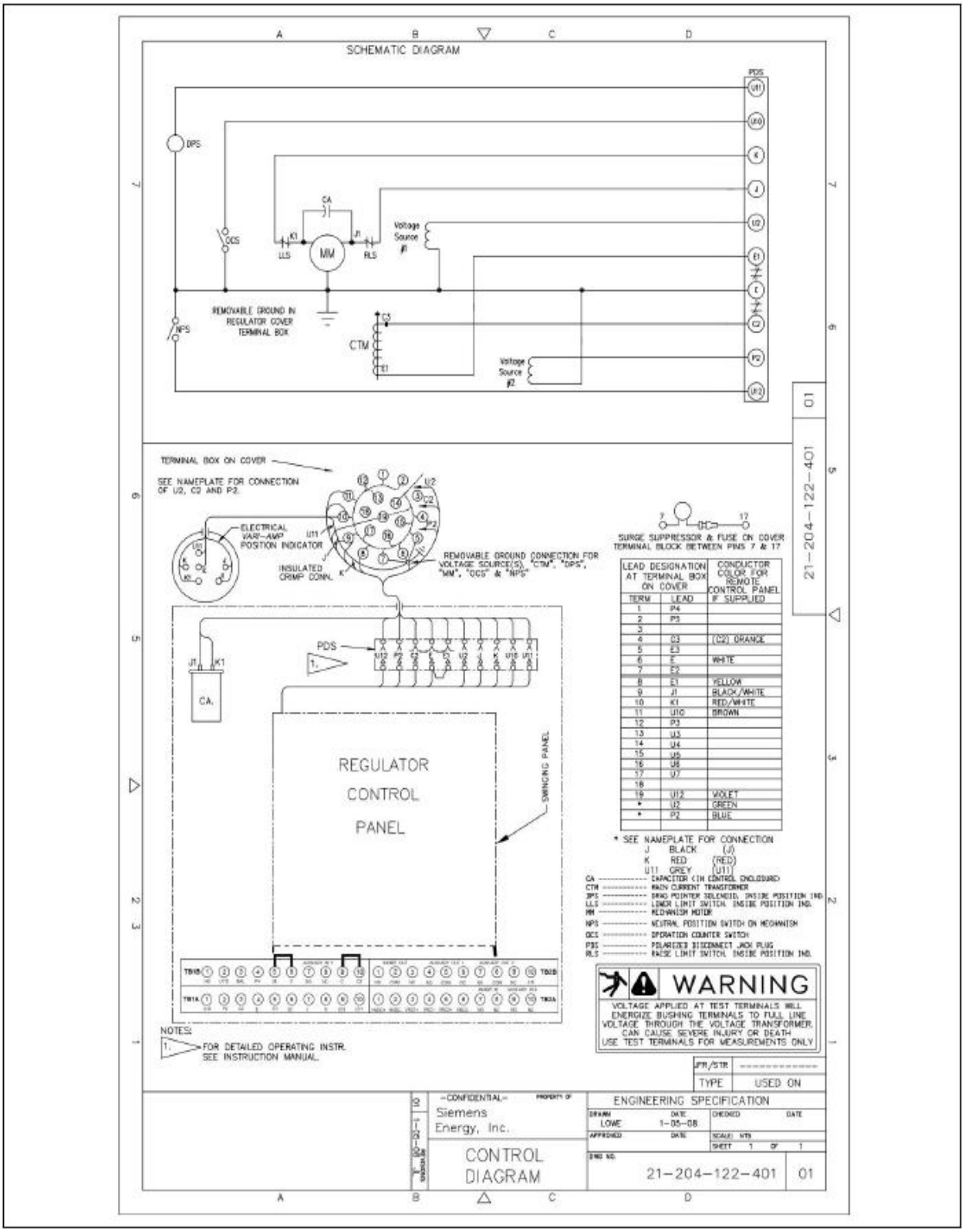


Figure C.1 ANSI Type 'A' (Straight) Regulator Control Diagram

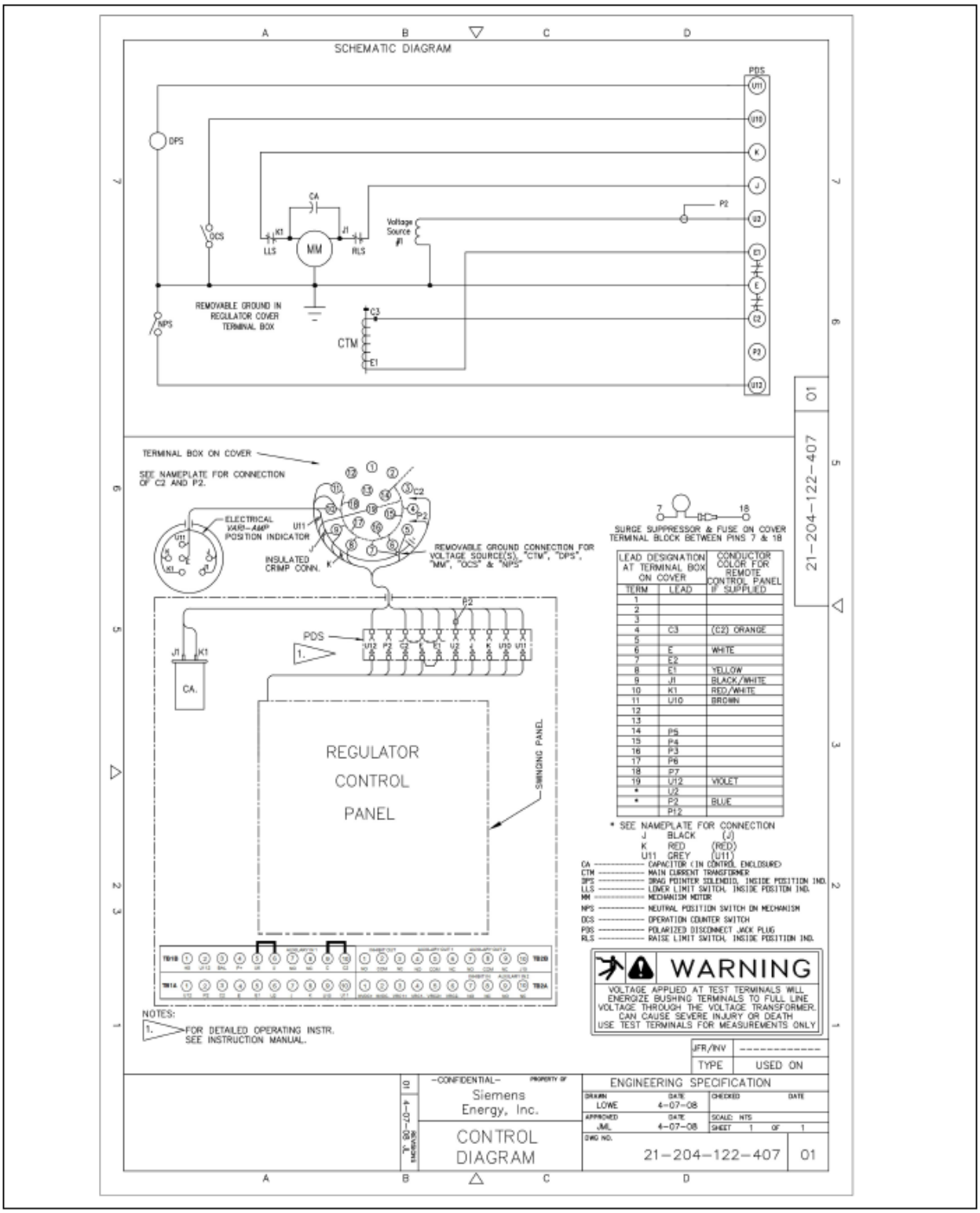


Figure C.2 ANSI Type 'B' (Inverted) Regulator Control Diagram

D: Menu Parameters

D.1 <CONFIGURE> menu: Leading and Lagging Regulators

The following steps will help you determine which of the two regulators in a Delta configuration is “leading” and which is “lagging” on an open Delta installation:

1. Disable automatic control of tap changer as follows: Set Raise/Lower tap switch to OFF. Set Remote/Auto/ Manual switch on both controllers to Manual.

2. Use the Configuration Keys to temporarily set both controllers to System type = WYE. This will be corrected in step 7.

3. Ensure that there is load current on the line. Load current must be of sufficient magnitude to cause a definite response of the line drop compensation circuit. Normally, 25% of the regulator setting will be adequate.

4. Adjust both front panel controls to the same settings:

Bandwidth	2.0 V
Voltage Level	120 V
Time Delay	0 Seconds
Resistance Volts	0 V
Reactance Volts	(+) 12

5. Set the Remote/Auto/Manual switch to AUTO on both controllers.

6. Allow both regulators to run and come to rest in band. The regulator whose tap position is closest to maximum is the “lagging” regulator. The other regulator is the “leading” regulator.

Note: The amount of tapchange excursion can be made more or less, if desired, by appropriate adjustment of the reactance volts setting.

7. Use the Configuration keys to set the System type to Delta Lead for the leading regulator and to Delta Lag for the lagging regulator, as determined in step 6.

D.2 <REGULATOR> menu: Line Drop Compensation

There are several methods used to determine line drop compensation settings, The “Load Center” method is probably the most commonly used and most clearly illustrates the procedure.

1. Using knowledge of the distribution feeder and the tables below, establish the conductor resistance and reactance per mile of feeder.

EXAMPLE: Conductor 4/0 ACSR, Regular Flat Spacing at 24 inches.

$$D = \sqrt[3]{24 \times 24 \times 48} = 30 \text{ inches}$$

R=0.592 ohms/mile X=0.692 ohms/mile

2. Determine compensation multiplier, k, as

- Single phase

$$k = 2.0 x \frac{\text{Current Transformer Rating}}{\text{Voltage Transformer Ratio}}$$

- Wye Connected

$$k = 1.0 x \frac{\text{Current Transformer Rating}}{\text{Voltage Transformer Ratio}}$$

- Delta Connected

$$k = 1.73 x \frac{\text{Current Transformer Rating}}{\text{Voltage Transformer Ratio}}$$

EXAMPLE: The regulators involved are 3 - 333 kVA at 7.2 kV configured in a wye-connected three phase bank. (The CT primary for this regulator is 400 A.)

$$k = 1.0 \frac{400}{7200/120} = 6.67$$

3. Determine the Line Drop Compensation Settings

Resistive Compensation Setting = k x line length (mi) x resistance (ohms/mi)

Reactive Compensation Setting = k x line length (mi) x reactance (ohms/mi)

EXAMPLE: The line is 3 miles long.

Resistance Setting = 6.67 x 3 x 0.592 = 12V

Reactance Setting = 6.67 x 3 x 0.692 = 14V

Table D.1 Line Drop Compensation Table - Distribution Line Resistance and Reactance

Ohms per Conductor per Mile at 60 Hz

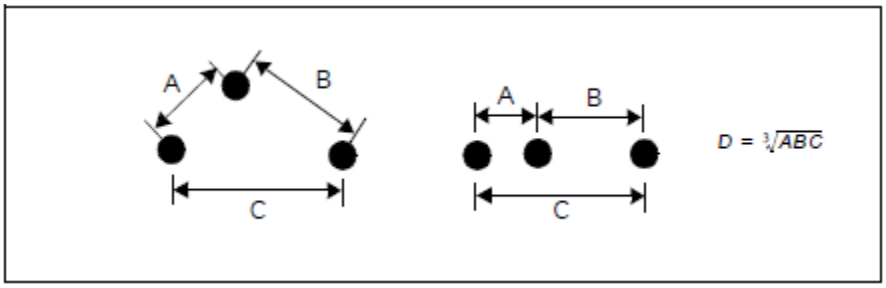
Copper - Hard Drawn

Cond. Size	Res. at 50°C	Reactance (See Note 1) Distance "D" Between Centers of Conductors							
MCM		18"	24"	30"	36"	42"	48"	54"	60"
1000	.0685	.449	.484	.511	.533	.552	.568	.593	.595
750	.0888	.466	.501	.529	.550	.569	.585	.600	.612
600	.1095	.481	.516	.543	.565	.584	.600	.615	.627
500	.1303	.492	.527	.554	.576	.595	.611	.626	.638
400	.1619	.507	.542	.569	.591	.610	.626	.641	.653
350	.1845	.515	.550	.577	.599	.618	.634	.649	.661
300	.215	.525	.560	.587	.609	.628	.644	.659	.671
250	.257	.536	.571	.598	.620	.639	.655	.670	.682
AWG									
4/0	.303	.546	.581	.603	.630	.649	.665	.630	.692
3/0	.382	.554	.589	.616	.638	.657	.673	.688	.700
2/0	.481	.581	.616	.643	.665	.684	.700	.715	.727
1/0	.607	.595	.630	.657	.679	.698	.714	.729	.741
1	.757	.609	.644	.671	.693	.712	.728	.743	.755
2	.964	.623	.658	.685	.707	.726	.742	.757	.769
4	1.518	.648	.683	.710	.732	.751	.767	.782	.794
6	2.41	.677	.712	.739	.761	.780	.796	.811	.823
8	3.80	.714	.749	.776	.798	.817	.833	.848	.860

Aluminum - Steel Reinforced

Cond. Size	Res. at 50°C	Reactance (See Note 1) Distance "D" Between Centers of Conductors							
MCM		18"	24"	30"	36"	42"	48"	54"	60"
1272.0	.0851	.421	.456	.483	.505	.524	.540	.555	.567
954.0	.1128	.439	.474	.501	.523	.542	.553	.573	.585
795.0	.1373	.450	.485	.512	.534	.553	.569	.584	.596
556.5	.1859	.469	.504	.531	.553	.572	.588	.603	.615
477.0	.216	.479	.514	.541	.563	.582	.598	.613	.625
397.5	.259	.490	.525	.555	.574	.593	.609	.624	.636
336.4	.306	.500	.535	.562	.584	.603	.619	.634	.646
266.8	.385	.514	.549	.576	.598	.617	.633	.648	.660
AWG									
4/0	.592	.630	.665	.692	.714	.733	.749	.767	.776
3/0	.723	.670	.705	.732	.754	.773	.789	.804	.816
2/0	.895	.690	.725	.752	.774	.793	.809	.824	.836
1/0	1.12	.705	.740	.767	.789	.808	.824	.839	.851
2	1.69	.714	.749	.776	.798	.817	.833	.848	.860
4	2.57	.708	.743	.770	.792	.811	.827	.842	.854
6	3.98	.722	.757	.784	.806	.825	.841	.856	.868

Note: 1. 60 Hertz reactance in ohms per mile of each conductor of a single phase, or of a three phase, symmetrical triangular spacing. For other arrangements of conductors see below. The reactance for other frequencies is F/60 times the table values. Reactance values for copper wire are for concentric standard copper conductors. Reactance values for aluminum cable conductors are approximately correct.



The Siemens Line Drop Calculator software application simplifies the calculation of these parameters. Simply enter the system values and the application automatically calculates the resistive and reactive components for you. Enter these values in the <**REGULATOR**> menu, and the MJ-5 automatically compensates for the line drop when adjusting the output voltage of the regulator.

Contact your Siemens representative about obtaining this application. You may also download this application from the Siemens web site (see **Section 1.8**). After arriving at the website, select **Products**, and then the **Voltage Regulator** item. This application is available on the Download page.

Table D.2 Line Drop Compensation Table - Compensation Multipliers

Regulator Operating Data		Circuit Connection		
Operating KV (Volt. Trans. Ratio	Current Rating	Single	Delta	Wye
19.9	50	.60	.52	.30
(166/1)	100	1.20	1.04	.60
	167	2.40	2.08	1.20
	200	2.40	2.08	1.20
14.4	50	.83	.72	.42
(120/1)	100	1.67	1.44	.83
	200	3.34	2.88	1.67
	300	5.01	4.32	2.49
	400	6.68	5.78	2.52
13.8	50	.87	.75	.44
(115/1)	100	1.74	1.50	.87
	150	2.61	2.25	1.31
	200	3.48	3.00	1.74
7.62	50	1.57	1.36	.79
63.5/1)	75	2.36	2.04	1.18
	100	3.15	2.72	1.57
	150	4.72	4.08	2.36
	219	7.87	6.82	3.94
	328	12.60	10.90	6.30
	438	12.60	10.90	6.30
	548	12.60	10.90	6.30
7.2	50	1.67	1.44	.83
(60/1)	75	2.50	2.16	1.25
	100	3.34	2.89	1.67
	150	5.00	4.33	2.50
	219	8.34	7.22	4.17
	328	13.33	11.55	6.67
	438	13.33	11.55	6.67
	548	13.33	11.55	6.67

Regulator Operating Data		Circuit Connection		
Operating KV (Volt. Trans. Ratio)	Current Rating	Single	Delta	Wye
5.0	100	5.00	4.33	2.50
(40/1)	150	7.50	6.49	3.75
	200	10.00	8.66	5.00
	250	17.50	15.15	8.75
	334	17.50	15.15	8.75
	500	35.00	30.30	17.50
	625	35.00	30.30	17.50
	668	35.00	30.30	17.50
	835	35.00	30.30	17.50
4.16	100	5.76	4.98	
(34.7/1)	150	8.64	7.48	4.32
	200	11.53	9.97	5.76
	250	20.20	17.48	10.10
	334	20.20	17.48	10.10
	500	40.40	34.96	20.20
	625	40.40	34.96	20.20
	668	40.40	34.96	20.20
	835	40.40	34.96	20.20
2.5	200	20.00	17.30	10.0
(20/1)	300	30.00	25.96	15.00
	400	40.00	34.60	20.00
	500	70.00	60.55	35.00
	668	70.00	60.55	35.00
	1000	140.00	121.10	70.0
	1250	140.00	121.10	70.0
	1332	140.00	121.10	70.0
	1665	140.00	121.10	70.0

D.3 <CONFIGURE> menu: Transformer Polarity

The relative polarity between the Utility (Tertiary or TV) winding and the Current Transformer (CT) must be specified in the <**CONFIGURE**> menu Utility Pol: parameter. This section describes the method for determining the correct specification (NORM or REV) from examination of the Regulator nameplate.

D.3.1 Single-Phase Regulators

D.3.1.1 Single-Phase Inverted Design Regulators (ANSI type B)

The Utility transformer polarity is always normal for Single- Phase Inverted Design Regulators. Specify Utility Pol:NORM.

D.3.1.2 Single-Phase Straight Design Regulators(ANSI type A) without forced air cooling

The Utility transformer polarity for Single-Phase Straight Design regulators can be determined from the regulator nameplate schematic diagram. The Utility winding taps are labeled Un -- Ux, E2.

If the Un - - Ux taps are to the left of E2 with no taps to the right of E2, and the polarity mark is on one of the U taps, specify Utility Pol: NORM (see Figure D.1).

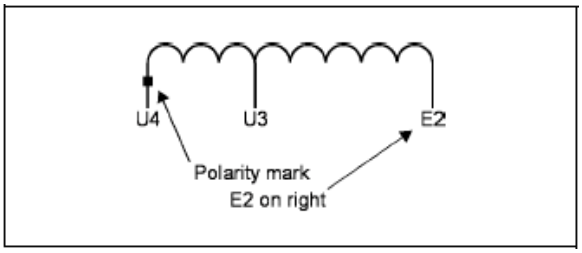


Figure D.1 Single-Phase Straight Design - Taps to the Left of E2

If the Un - - Ux taps are to the right of the E2, and the polarity mark is on the E2 tap, specify Utility Pol: REV (see Figure D.2).

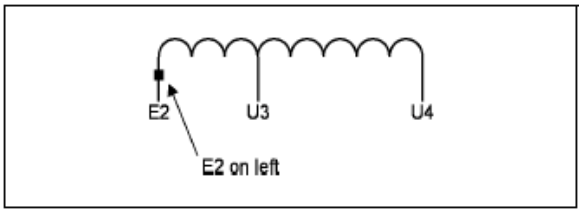


Figure D.2 Single-Phase Straight Design - Taps to the Right of E2

D.3.1.3 Single-Phase Straight design regulators (ANSI type A) with forced air cooling

For these regulators, the Utility winding not only provides power to the controller — it also provides power for the forced air fan(s). The E2 tap is located between the Un - - Ux terminals on the regulator's nameplate schematic. The U5 tap is normally used for fan voltage and can be either to the left or to the right of E2. To determine whether the polarity is 'normal' or 'reverse', you must examine both the schematic diagram and the connection table on the nameplate. From the connection table, determine the tap to which U2 should be connected.

- If the tap to which U2 is connected and the polarity mark are to the left of E2 on the schematic, set Utility-Pol:NORM.
- If the tap to which U2 is connected is to the right of E2 on the schematic, set UtilityPol:REV.

Examples

For both of the examples on the next page, use the nameplate connection table shown in Table D.3:

Table D.3 Nameplate for Single-Phase Straight Regulator with Cooling Fan

Single Phase Straight Regulator with Cooling Fan									
Load Volts +/-10%	Volt Tran Sec Conn P2 to	Control Panel P to P14 to		Basis Volts	Aux Volts Motor Conn U2 to Volts		Fan Connection		
							U21 to	**U15 to**	**Volts**
14400	P3 - 120	20	20	120	U3	126	U3	U7	240
13200	P4 - 120	20	20	120	U4	126	U53	U7	242
7200	P5 - 120	20	20	120	U6	126	U6	U8	240

From the table, the system load voltage is 7200 volts; therefore, U2 would be connected to U6. Now check the connection diagram:

EXAMPLE 1 (ref: Table D.3)

In Figure D.3 below, U6 is to the left of E2. If your regulator nameplate looks like this, the proper specification is Utility Pol:NORM.

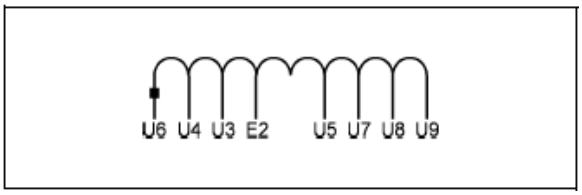


Figure D.3 U6 to the Left of E2

EXAMPLE 2 (ref: Table D.3)

In Figure D.4 below, U6 is to the right of E2. If your regulator nameplate looks like this, the proper specification is Utility Pol:REV.

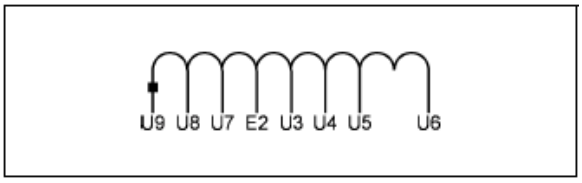


Figure D.4 U6 to the Right of E2

D.3.2 Three-Phase Regulators

Three-phase regulators may have either one or multiple utility windings.

D.3.2.1 Single Utility Winding

A single utility winding provides power for the control, the motor and the cooling fan. This utility winding may have the polarity mark at the Un — Ux terminals or at the U5 terminal, as shown in the examples of Figure D.5.

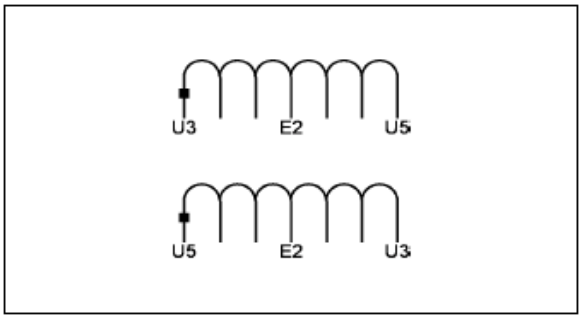


Figure D.5 Three-Phase Regulator with a Single Utility Winding

To determine whether the polarity is ‘Normal’ or ‘Reverse,’ examine the connection table and schematic diagram.

- If U2 is connected to a “U” terminal which is to the left of E2, then UtilityPol:NORM (see Figure D.6).
- If U2 is connected to a “U” terminal which is to the right of E2, then UtilityPol:REV (see Figure D.7).

D.3.2.2 Multiple Utility Windings

Regulators with more than one utility winding utilize the "A" phase utility winding for control and motor power, and the "B" and "C" phase windings for fan(s) power. For this case, use the Single phase procedure, defined above for the "A" phase winding.

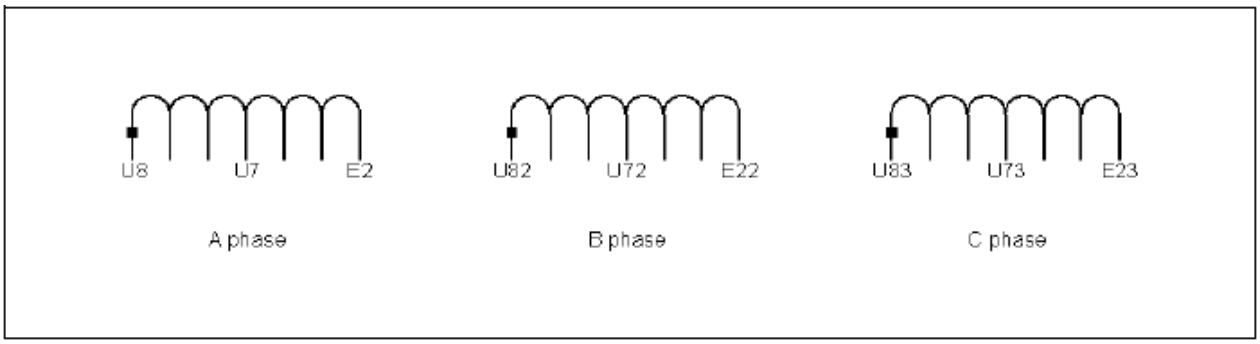


Figure D.6 U2 Connects to a "U" Terminal (U7 or U8) which is to the Left of E2

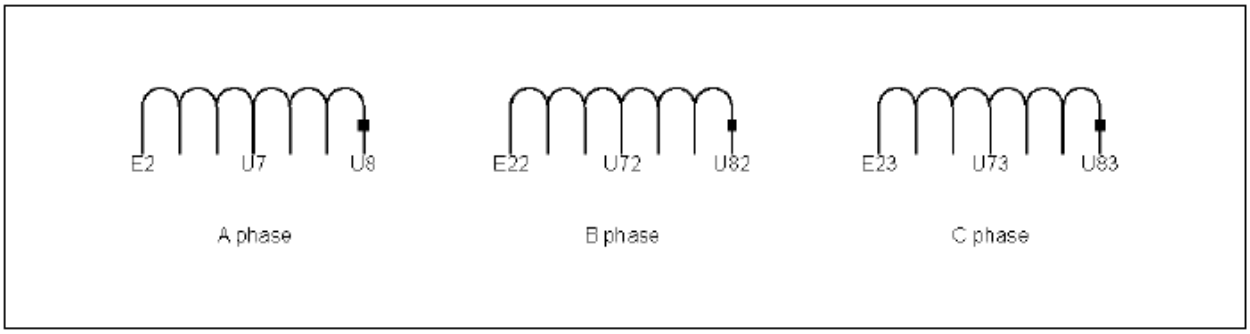


Figure D.7 U2 Connects to a "U" Terminal (U7 or U8) which is to the Right of E2

E: Hazards of Bypassing a Regulator off Neutral

DANGER

Operating regulator while bypassing will result in explosion.

Will cause death, serious injury, or property damage.

Place regulator in neutral position before bypassing and disable control panel.

Proper regulator bypassing procedure is of critical importance. Regulators that are not in the neutral position when bypassed frequently fail. This failure is the result of extremely high circulating current inside the regulator caused by what is, effectively, a short circuit being placed across the series winding. The result of such a failure can be catastrophic.

Methods of Determining Neutral Tap Position

Since the tap changing mechanism is submerged in a tank full of oil, some external means of determining tap position is mandatory. Methods most commonly used include:

- The regulator tap Position Indicator provides first line indication of the neutral position. On modern regulators, the tap changing mechanism drives the regulator Position Indicator through gears or flexible shafts to provide an accurate, reliable indication of the regulator tap position.

- The MJ-5 Control Panel is equipped with a neutral indicating light (Neutralite). A switch mounted on the tap changing mechanism actuates the light circuit. The circuit is activated when the regulator is in the neutral position. A test switch on the MJ-5 Control Panel can be used to verify proper operation of the Neutralite.

The Position Indicator and the Neutralite should all indicate neutral before you attempt to bypass the regulator.

Methods other than the ones described above are also used; however, the ones described above are the most common and are recommended.

The regulator must be placed in neutral before bypassing. If there is any doubt as to the location of neutral, the line should be dropped before bypassing the regulator.

Deactivating the Control Panel Before Bypassing

Consult your voltage regulator instruction manual for bypassing instructions.

To eliminate the possibility of inadvertent (and possibly catastrophic) tap operations during bypassing operations, it is mandatory that you completely disable the control panel.

DANGER

Operating regulator while bypassing will result in explosion.

Will cause death, serious injury, or property damage.

Place regulator in neutral position before bypassing and disable control panel.

Disable the MJ-5 control panel as follows:

1. Disconnect the Polarized Disconnect Switch (PDS)

   or

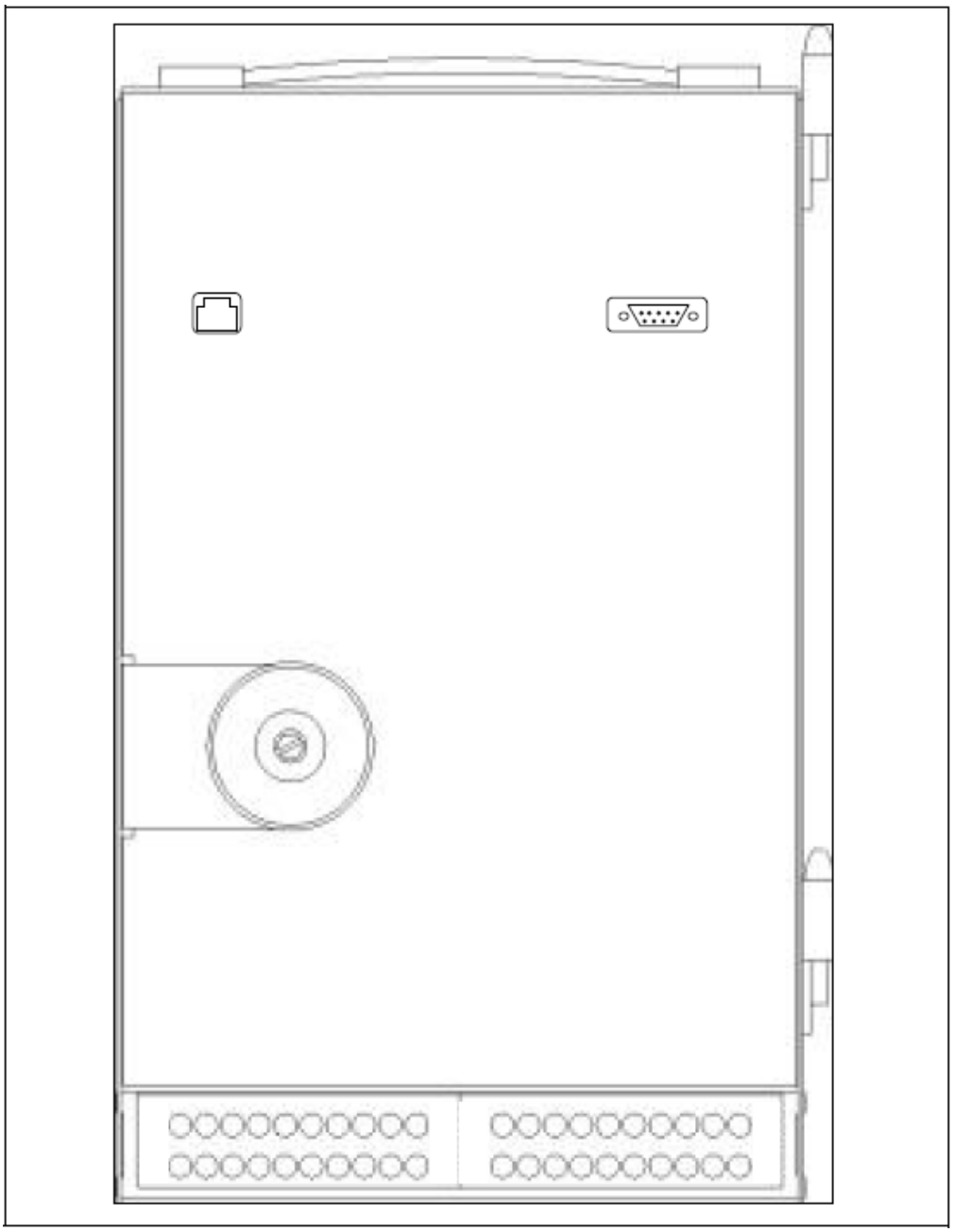
2. Remove all MJ-5 fuses (Power, Sensing, and External Power); place MJ-5 power switch in Off position; place Remote/Off/Manual switch in Off position; and place the Tap Raise/Lower switch in Off position.

F: Communications Module Installation

The MJ-5 Communications Module is mounted directly to the Main Processor board.

Refer to the MJ-5*Communications Module Installation Manual.*

Figure F.1



Appendix G: Menu Structure Quick Reference

Meter	FW Demand	Rev Demand	Counters	Regulator	Configure	Adv Configure	Alerts
Vld **MIN/MAX**	FW-Vld **MIN/MAX**	REV-Vld **MIN/MAX**	Tot-Ops **Op Count**	FWD Volt **Volt Level**	Tap Chngr	Meter Volts	1st Alert Alert Select
Vsrc **MIN/MAX**	FW-Vs **MIN/MAX**	REV-Vs **MIN/MAX**	Rsdate	FWD BW **Bandwith**	RegType	I Threshold %	
Vcomp **MIN/MAX**	FW-Vcmp **MIN/MAX**	REV-Vcmp **MIN/MAX**	RsTime	FWD Delay **Time Delay**	System	I Shift	Last Alert
IId **MIN/MAX**	FW-IId **MIN/MAX**	REV-IId	Elapsed Ops	FWDComp(R) **Resistance**	DeltaPwr	I Load Max	Alerts:
PF **MIN/MAX**	PF-KVAMAX	PF-KVAMAX	24hrops	FWDComp(X) **Reactance**	UtilityPol	PT Threshold	Low Current
KVA **MIN/MAX**	PF-KVAMIN	PF-KVAMIN	30daysops	REV Volt	VprMax	Time	Auto Inhibit
KW **MIN/MAX**	FW-KW **MIN/MAX**	REV-KW **MIN/MAX**	MTD	REV BW	U2 PT	Date	Tap track error
KVAR **MIN/MAX**	FW-KVAR **MIN/MAX**	REV-KVAR **MIN/MAX**	LastMnt	REV Delay	P2 PT	Format	Neutral signal error
Freq **MIN/MAX**	FW-KVA **MIN/MAX**	REV-KVA **MIN/MAX**	YTDOps	REV Comp (R)	CTRatio	Daylight Savings	Tap Position
KWHR-F			Lastyr	REV Comp (X)	IFullLd	Dmd Type	Low PT Thresh
KVARHR-F			Tapcont	VRC Stat **VRC Select**	PwrFlw	Dmd Time	Overcurrent
KVARHR-F			Tap pos **MIN/MAX**	VRC Mode	BaseVolt	Dmd Subperiods	NV RAM Reset
KWHR-R				Alt Delay	NeutOvrun	Min/Max t.o.	Low Battery
KVARHR-R				VRC1In	ResetMin/Max	Screen t.o.	High Voltage
KVARHR-R				VRC2In	Swversion	Quick t.o.	Not in Auto
				Local VRC %	Memo 1	QuickDispTim	R Limit reached
				VRC Stage 1	Memo 2	AutoVari-Amp	L Limit reached
				VRC Stage 2		SoftVari-Amp	Pseudo Manual
				VRC Stage 3		Tap Alert	
				VRC Remote		Alert M	
				MJ3AVRC%		Alert C	
				AtVRCset 1		Alert S	
				AtVrcset 2		Tap Resync	
				AutoVRC 1%		AutoComInh	
				AutoVRC 2%		Lower Led	
				VLCEnable **VLC Select**		P2 Calc	
				VLCUpper		U2/P2 Out	
				VLCLower		I Dir Bias	
						Bias %	
						Remote BTN	
						Macntrl	

Appendix G: Menu Structure Quick Reference

Log Setup	Event Log	Interval Log	Harmonics	Communications	Maintenance	Diagnostics	Passwords
Log Event	Event NNNNN	Interval NNNNN	Vld Thd	DatPortBaud	ConsOv	U2 Cal	Enter PW
Tap Event	Date	Date	VsThd	Data Parity	MaintainRcds?	P2 Cal	End session ?
Neut Event	Time	Time	Ild Thd	DataPortAddr	TapChTy	C Cal	Level 1
Event-R	Vld	Vld	Show Harm	Reg ID	Bal Wind	R/LONTime	Level 1 PW
Event-L	Vsrc	Vsrc	Show as	Protocol	Range of Reg	R/LofTime	Config
VLC Event	Ild	Ild	Vld 1st	CommBaud	Con_AB	FixRLonT	Config PW
VRC Event	PF	PF	……	CommParity	Con_0	TapchgTout	Regulator
PwrFlwEvent	KW	PF KVA Max	Vld 31st	CommAddr	Con_1	Tap In	Reg PW
PwrCyc Event	KVA	PF KVA Min	Vsrc 1st	Resync Time	Con_2	Tap InType	Meter
Config Event	KVAR	KW	……..	TxEnDelay	Con_3	Tap In Pulse	Meter PW
Alert Event	Tap Pos	KVAR	Vsrc 31st	DnpDlConfirm	Con_4	PreTapTime	Demand
Clear Event Log?		KVA	Ild 1st	SW repeat	Con_5	Post Tap Time	Demand PW
Clear Intrvl Log?		Tap	……	HostAddr	Con_6	NeutralIn	Alert
Log Interval		Tap Max	Ild 31st	CMUnsolicited	Con_7	Neutral Count	Alert PW
Res Min/Max		Tap Min		AutoInhEnable	Con_8	PhaDeg	Counters
Log Min/Max		Total OPS		DNP set	OPCNT_A	CCInput	Counters PW
Intrvl				Deadband CL-1	OPCNT_B	MAC	Log Set UP
Save Logs?				Deadband CL-2	OPCNT_0	InitDataPort	Log Set UP PW
Upload Config?				Deadband CL-3	OPCNT_1	U	EV/INTV
Upload HMI?				CommType	OPCNT_2	P	EV/INTV PW
Upload Meter?				IP config	OPCNT_3	C	Harmonics
Save Config?				IP-192:168:001:200	OPCNT_4		Harm PW
Restore Config?				NM-255:255:255:000	OPCNT_5		Comm
Auto Save Logs?				GW-000:000:000:000	OPCNT_6		Comm PW
Auto Save Time				TCP port	OPCNT_7		MNTN
				DNP Version	OPCNT_8		MNTN PW
				SL	OP_Dur		Diagnostics
				SL2			Diagnos PW
				VCMode			
				AutoInhbTout			

H: MJ-5 Firmware Versions

This version of the MJ-5 Installation and Operation Manual describes the MJ-5 firmware Version 4.46:25.

I: Terminal Strip Wiring

Figure I.1 below shows the external connections for the MJ-5 terminal strip when connected to a Siemens Regulator

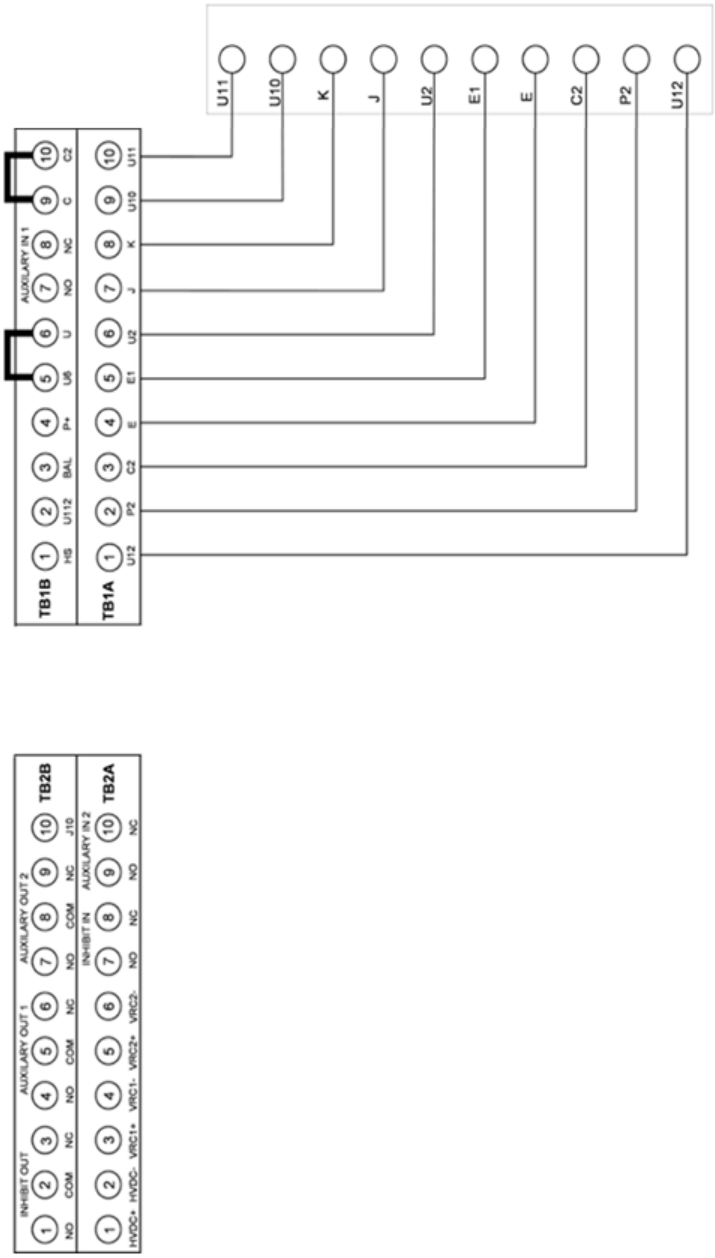


Figure I.1 Terminal Strip Connections for Siemens Regulator

J: Terminal Strip Connections

Table J.1 below describes the connections for terminal strip TB1A.

Table J.1 Connections for Terminal Strip TB1A

Pin Number	Signal Name	Description	I/O / Power
1	U12*	High side of neutral position indicator. When closed to AC ground ("E"), indicates tap changer is in neutral position. Turns on Neutralite.	Input
2	P2*	Potential Transformer output (if present).	Power/Sense
3	C2*	High side of Current Transformer. [C2 terminal at TB1B-10 is normally externally jumpered to C at TB1B-9.]	Input
4	E*	Neutral return for Control Panel, PT, and Utility winding. Chassis ground.	Ground
5	E1*	Low side of Current Transformer.	Ground
6	U2*	High side of Utility (Tertiary) winding. Control Panel derives "Normal" power from this signal. Provides voltage phase reference for power flow direction.	Power/Sense
7	J*	Terminal J - Tap Changer Motor Raise signal.	Output
8	K*	Terminal K - Tap Changer Motor Lower signal.	Output
9	U10*	High side of Operation Counter switch. Closes to E. Indicates when a tap change has occurred.	Input
10	U11*	High side of Regulator Drag Hands Reset solenoid. Returns to E. Used to reset the drag hands of the Tap Position Dial mounted on the regulator.	Output

* indicates standard "Polarized Disconnect Switch (PDS)" signals. For Siemens regulators, these ten signals connect to the corresponding pins of the PDS connector block.

Appendix J: Terminal Strip Connections

Table J.2 below describes the connections for terminal strip TB1B. See Table 2.5 for complete descriptions of these terminal connections. See Figure 2.3 for simplified schematic drawing of remote control connections.

Table J.2 Connections for Terminal Strip TB1B

Pin Number	Signal Name	Description	I/O / Power
1B	HS	For Cooper Regulators Only. "Hold Switch" connection. Applies power to tap changer to complete tap change after "Hold Switch" contact makes.	Power
2B	U112	For Cooper Regulators Only. Neutral Position Indication. When closed to AC hot, indicates tap changer is in neutral position. Turns on Neutralite.	Input
3B	BAL	This signal is actually E (AC return). The intended application of this signal is in conjunction with +P to permit the MJ-5 sense voltages to be adjusted by the value present on an external transformer winding. The transformer winding is inserted into the MJ-5 circuit at +P and BAL.	Ground
4B	+P	This signal connects to one side (the "ground" side) of the MJ-5 sense transformers. See description for BAL.	Input
5B	U6	This signal provides AC power for both Remote and Manual tap control operations. This circuit provides AC power to the common of the Tap Raise/Lower switch when the Remote-Auto/Off/Manual switch is in the Manual position. This circuit provides the AC power to the Rem R and Rem L terminal block contacts when the Remote-Auto/Off/Manual switch is in the Remote position. It is normally jumpered to U at the terminal block, but it can be connected to an external AC source. [Alternatively, an external relay contact can be placed between the U and U6 contacts for external control of the MJ-5 manual and remote operations.]	Power
6B	U	This is the signal from U2, after the power switch (assuming the switch is in the "Normal" position.) This signal is normally jumpered to U6 at the terminal block unless an external circuit is used to feed U6.	Power
7B & 8B	AUXIN1+ & AUXIN1-	Auxiliary input contact pair. For future definition.	Contact Closure Input
9B &10B	C & C2	C & C2 (TB1B-9 & 10) provide access to the regulator current path for connecting auxiliary apparatus (e.g., an external current meter.) The current ranges from 0 to 640 mA nominal, into a low impedance load. C &C2 as shipped from the factory have a jumper across the terminal strip pins. [The terminal strip jumper needs to be removed if external equipped is connected.] **Caution: Open circuiting the C&C2 connections may damage the regulator Current Transformer (CT). Keep C&C2 shorted unless connected to an appropriate external current-handling device.**	Current

Table J.3 below describes the connections for terminal strip TB2A

Table J.3 Connections for Terminal Strip TB2A

Pin Number	Signal Name	Description	I/O / Power
1 &2			
3A & 4A	VRC1+ & VRC1-	These contacts are used to activate VRC (both MJ-3A™ mode and MJ-X mode). They are also used for External Line Drop Compensation Polarity Control.	Contact closure (Input)
5A & 6A	VRC2+ &VRC2-	These contacts are used to activate VRC Enable 2 for MJ-X mode. They are also used for Alternate functions: Alternate Time Delay and Low External Battery.	Contact closure (Input)
7A & 8A	INHIB IN+ & INHIB IN-	INHIB IN directly disables the MJ-5 motor control relays. Through the microprocessor, this signal asserts Automatic Inhibit of motor Raise/Lower operations, and activates the Auto Inhibit Indicator.	Contact closure (Input)
9A & 10A	AUXIN2+ & AUXIN2-	Auxiliary input contact pair. For future definition.	Contact Closure Input

Table J.4 below describes the connections for terminal strip TB2B

Table J.4 Connections for Terminal Strip TB2B

Pin Number	Signal Name	Description	I/O / Power
1B	INHIB NO	Normally-open pin of Inhibit Out relay. Inhibit Out is activated (closed) whenever the MJ-5 automatic mode operation is inhibited by either the Automatic Inhibit Input or by Communication link.	Output
2B	INHIB C	Common pin of Inhibit Out relay. Inhibit Out is activated (closed) whenever the MJ-5 automatic mode operation is inhibited by either the Automatic Inhibit Input or by Communication link.	Output
3B	INHIB NC	Normally-closed pin of Inhibit Out relay. Inhibit Out is activated (closed) whenever the MJ-5 automatic mode operation is inhibited by either the Automatic Inhibit Input or by Communication link.	Relay Output
4B	AUXOUT1 NO	Normally-open contact of Auxiliary Relay 1.	Output
5B	AUXOUT1 C	Common contact of Auxiliary Relay 1.	Output
6B	AUXOUT1 NC	Normally-closed contact of Auxiliary Output Relay 1. (See TB2B-6.)	Relay Output
7B	AUXOUT2 NO	Normally-open contact of Auxiliary Relay 2.	Output
8B	AUXOUT2 C	Common contact of Auxiliary Relay 2.	Output
9B	AUXOUT2 NC	Normally-closed contact of Auxiliary Output Relay 2. (See TB2B-9.)	Relay Output
10B	J10	Spare connection for future application.	

K: MJ-5 Operating Procedures

Use the following instructions as a quick reference for performing many of the standard MJ-5 operating procedures.

View Instantaneous Load Voltage (Vld)

1. Press Menu key twice
2. Press Down Arrow once
3. Read voltage (Vld) on display

View/Set Forward Voltage Level Value

1. Press Voltage Level Fast-Path key
2. Read Voltage Level on display
3. Press Change/Save key - right hand digit will flash
4. Press Left Arrow key to move left on display or Right Arrow key to move right on display
5. Press Up/Down Arrow key to increase or decrease desired voltage on display - flashing digit will change
6. Press Change/Save key again to save the new Voltage Level

View/Set Bandwidth Value

1. Press Bandwidth Fast-Path key
2. Read Bandwidth on display
3. Press Change/Save key - right hand digit will flash
4. Press Left Arrow key to move left on display or Right Arrow key to move right on display
5. Press Up/Down Arrow key to increase or decrease desired bandwidth on display - flashing digit will change
6. Press Change/Save key to save the new Bandwidth setting

View/Set Time Delay Value

1. Press Time Delay Fast-Path key
2. Read FWD time delay on display. For REV time delay press the Time Delay button again.
3. Press Change/Save key - right hand digit will flash
4. Press Left Arrow key to move left on display or Right Arrow key to move right on display
5. Press Up/Down Arrow key to increase or decrease time delay on display - flashing digit will change
6. Press Change/Save key to save the new time delay value

View/Reset Max/Min Values

1. View Meter value or tap position
2. Press Max/Min key once
3. Read maximum and minimum values on display
4. To reset maximum and minimum values on display, press Cancel Reset key once

View/Set Line Drop Compensation Values

1. Press Resistance Fast-Path key
2. Read resistive compensation voltage (R) on display
3. Press Change/Save key - right hand digit will flash
4. Press Left Arrow key to move left on display or Right Arrow key to move right on display
5. Press Up/Down Arrow key to increase or decrease compensation voltage on display - flashing digit will change
6. Press Change/Save key to save the new resistive compensation voltage value
7. Press Resistive Fast-Path key again
8. Read Reverse resistive compensation voltage (R) on display
9. Repeat steps 3 to 6 above to set the resistive compensation voltage
10. Press Reactance Fast-Path key
11. Read the Forward reactive compensation voltage (X) on display
12. Repeat steps 3 to 6 above to set the Forward reactive compensation voltage
13. Press Reactance Fast-Path key again
14. Read Reverse reactive compensation voltage (X) on display
15. Repeat steps 3 to 6 above to set the Reverse reactive compensation voltage

View Operation Counter Values

1. Press Operation Counter Select Fast-Path key (Op Count)

2. Read Total Ops count on display

3. Press Op Count key repeatedly to step through remaining counter values

View Messages

1. Press Alert Fast-Path key

2. Read and note active alerts on display

3. Press Alert key repeatedly to step through remaining active alerts

4. While viewing alerts, press Cancel Reset key to acknowledge an alert

5. Note: Acknowledging alert does not clear the fault that caused the alert

Configure the Control Panel

1. Press Menu key twice

2. Press Right Arrow key five times to view the <**CONFIGURE**> menu

3. Press Up/Down Arrow key to display the desired item.

4. Press Change/Save key

5. Press Left Arrow or Right Arrow to step through digits in numeric values

6. Press Up/Down Arrow to toggle through text choices or to increase or decrease numeric values

7. Press Change/Save key to save the new value

8. Repeat steps 3 through 7 for all desired configuration items

View/Set the Clock (Time and Date)

1. Press Menu key twice

2. Press Right Arrow key six times to view the <**ADV CONFIGURE**> menu

3. Press Down Arrow until the TIME item is displayed. It will be in Military time.

4. Press Change/Save key - the left hand digit will flash

5. Press Up/Down Arrow key to increase or decrease the value

6. Press Left Arrow to step to next digit.

7. Press Change/Save key to save the new time

8. Press Down Arrow key to display the DATE item

9. Press Change/Save key - the left hand digit will flash

10. Press Up/Down Arrow key to increase or decrease the value

11. Press Right Arrow to step to the next digit to be changed

12. Press Change/Save key to save the new date

    NOTE: The date format (MM/DD or DD/MM) may be changed using the DtFormat menu item in Adv Configure menu.

Using a Voltmeter to Calibrate U2 or P2

Note: Do not use voltage readings at the Voltage Calibration (Test) terminals as an indication of the regulated load voltage

1. Connect true-RMS-reading voltmeter to Voltage Calibration (Test) terminals

2. Press U2 P2 key to display U2 (or P2) Cal item on the display.

3. If voltmeter reading is not the same as U2 (or P2) Cal item, press Change

4. At password prompt, press Up/Down Arrow key to enter first digit of password (See Manual Chapter 4)

5. Press Right Arrow key to step through remaining digits and enter values

6. Press Change/Save key to submit password

7. If password is correct, press Change/Save key – right hand digit will flash

8. Press Up/Down Arrow key to increase or decrease value until U2 (or P2) Cal value is equal to the voltmeter value

9. Press Change/Save key to save the new calibration value

10. See Manual Chapter 6 for additional calibration procedures

Set Tap Position

1. Display Tap= in <**COUNTERS**> menu

2. Press Change/Save key

3. Press Up/Down Arrow key until reading matches regulator Position Indicator value

4. Press Change/Save key to save new value.

L: RETROFITTING AN MJ5, MJ-XL or MJ-4A CONTROL PANEL ONTO A CL-6 SERIES COOPER VOLTAGE REGULATOR

Retrofit Kit Contents

- Instructions and drawing 21-204-112-001
- Cooper Hinges (2), part 21-116-601-229
- Cooper phoenix connector wiring harness (1), part 21-204-112-001
- Metal Bracket (1), part 21-116-601-230
- Nylon spacer (1)
- Panel locking screw (1)
- Philips-head screws (6)
- Fuses: 6A(2), 0.75A(1)

Mounting Instructions

According to the Cooper (McGraw-Edison) Voltage Regulator Instruction Manual (S225-10-10, 12/00), the control panel may be removed while the voltage regulator is energized.

Removing the Cooper Control Panel

Follow the Cooper (McGraw-Edison) instruction manual for removing the control panel, which should include, but is not limited to the following steps.

1) Make sure the Cooper control panel is not in the process of changing the tap position.
2) Turn supervisory switch to **OFF**, turn Auto/Remote-Off-Manual switch to **OFF**, wait 10 seconds.
3) Turn control panel power (Internal-Off-External Switch) to the **OFF** position.
4) Remove all fuses from the Cooper control panel.
5) Unscrew the thumbscrews holding the Cooper control panel in place, and swing the control panel outward.
6) Close (push in) the current shorting switch “C” located at the back of the control panel enclosure. This shorts out the secondary of the regulator CT.

Warning! Push the C shorting switch closed before attempting to disconnect the control. Failure to do so will open the regulator CT circuit and may produce a flashover in the control.

7) Open (pull out) the disconnect switch “V1” (and “V6” if present). These switches are located at the back of the control panel enclosure. This de-energizes terminal board “TB2”.
8) Disconnect the control from the back panel at “TB2” (located at bottom of Cooper control enclosure).
9) Disconnect the control ground lead from the back of the Cooper control enclosure.
10) Remove the Cooper control panel from the hinges and set the control panel aside.

Appendix L: Retrofitting onto CL-6 Cooper

Installing the MJ- Control Panel

As a guide, follow the Siemens MJ- instruction manual.

1) Turn MJ- power switch to OFF and remove fuses before starting installation.
2) On MJ-, remove wiring from bottom terminal block to remove PDS plug and wires from the control panel.
3) Install retrofit wiring as labeled to MJ- (table below) and tighten all screws, including those not used. On the MJ- terminal block, terminal P2A-1 starts at the left side of the bottom terminal block.
4) Check labeling on phoenix connector plug on retrofit wiring to be sure it matches labeling on Cooper phoenix connector receptacles at bottom of the control enclosure.
5) Remove hinges from left side of MJ- and remove magnet and bracket from right side.
6) Install retrofit hinges on right side of MJ- to match Cooper hinge pins.
7) Install retrofit kit latch onto left side of MJ- to match Cooper cabinet threaded hole.
8) Hang MJ- retrofit hinges onto Cooper hinge pins to mount MJ- into Cooper control enclosure.
9) Connect the MJ- to the back panel at “TB2”, located at the bottom of the back panel.
10) Push closed the disconnect switch, V1 (and V6 if present) to energize MJ- and check all voltages.
11) Pull open the current shorting switch, C.

Warning! Do not pull open the current shorting switch, C, until both ends of the interconnecting cable are secure. Failure to do so could open the regulator CT secondary causing a flashover to the control.

12) Swing the MJ- control panel closed. Tighten the panel locking screw.
13) Install fuses and turn power on.

Configuring the MJ- Control Panel

1) For “Regulator Type”, select “Inverted”
2) For “Util Winding Pol”, select “Normal”
3) For Cooper regulators without a differential PT, enter the control winding (E) voltage in “U2PT” and “P2PT” screens.
4) For Cooper regulators with a differential PT, enter the control winding (E) voltage in “U2PT” screen, and enter the differential transformer voltage ratio in the “P2PT” screen. Set the power flow mode to “BI-DIR.”
5) For Tap Changer type, enter “COOP QD” for Quick Drive (“COOP SD” is for spring drive; “COOP DD” is for direct drive).

Note: The control winding (E) voltage, differential transformer voltage, CT ratio, “I Full Load,” “I Load Max,” and other parameters may be read from the regulator nameplate.

Cooper Regulator Connection Notes:

1) The control cable signals comprise the "Cooper Retrofit Cable" which connects between the Cooper regulator (back panel) and the MJ- control panel.
2) The MJ- contains all the necessary interface circuits for connecting directly to the Cooper regulator back panel – **no external circuit board is needed.**
3) "TB-2" refers to the Terminal Block 2 – located inside the Cooper control panel enclosure.
4) For Cooper regulators, (Cooper) TB-2 "VS" provides the "L" bushing voltage.
5) For Cooper regulators, the "S" bushing voltage is derived from the (optional) "differential PT."
6) The connection from (Cooper) TB-2 "V7" to (MJ-) P2A "P2" is only needed if the regulator has a differential PT (for detecting the "S" bushing voltage).

MJ- Name	MJ- Terminal	Cooper Terminal	Description
HS	P2A-1	HS	Operation Counter
U112	P2A-2	NL	Neutral Pos. Switch
U2	P2A-8	VS	Sensing Voltage
C2	P2A-5	C3	Current Polarity
E	P2A-6	G	Voltage Ground
E1	P2A-7	C1	Current Ground
N/A*	*	VM*	Motor Voltage*
J	P2A-9	R3	Raise Output
K	P2A-10	L3	Lower Output
U11	P2A-12	DHR	Drag Hand Reset

* Typically, VM will be jumpered to VS inside the Cooper Control box.

Optionally, the jumper from P2B -11 to P2B-12 can be removed from the MJ- and VM can be connected to P2B-11, U6 to provide a separate motor voltage to the MJ.

M: RETROFITTING AN MJ-XL or MJ-4A/MJ5 CONTROL PANEL ONTO A COOPER VOLTAGE REGULATOR (CL-5 and earlier)

Retrofit Kit Contents

- Instructions and drawing 21-116-601-233
- Cooper Hinges (2), part 21-116-601-229
- Cooper fanning strip wiring harness (1), part 21-116-601-233
- Metal Bracket (1), part 21-116-601-230
- Nylon spacer (1)
- Panel locking screw (1)
- Philips-head screws (6)
- Fuses: 6A(2), 0.75A(1)

Appendix M: Retrofitting onto a CL-5 Cooper

Mounting Instructions

According to the Cooper (McGraw-Edison) Voltage Regulator Instruction Manual (S225-10-10, 12/00), the control panel may be removed while the voltage regulator is energized.

Removing the Cooper Control Panel

Follow the Cooper (McGraw-Edison) instruction manual for removing the control panel, which should include, but is not limited to the following steps.

1) Make sure the Cooper control panel is not in the process of changing the tap position.
2) Turn supervisory switch to **OFF**, turn Auto/Remote-Off-Manual switch to **OFF**, wait 10 seconds.
3) Turn control panel power (Internal-Off-External Switch) to the **OFF** position.
4) Remove all fuses from the Cooper control panel.
5) Unscrew the thumbscrews holding the Cooper control panel in place, and swing the control panel outward.
6) Close (push in) the current shorting knife-blade switch "C" located at the back of the control panel enclosure. This shorts out the secondary of the regulator CT.

Warning! Push the C shorting switch closed before attempting to remove the fanning strip. Failure to do so will open the regulator CT circuit and may produce a flashover in the control.

7) Open (pull out) the voltage knife-blade switch "V1" (and "V6" if present). These switches are located at the back of the control panel enclosure.
8) Loosen the screws on the interconnecting terminal block (located at bottom of Cooper control enclosure).
9) Remove the fanning strip free from the terminal block.
10) Disconnect the front panel ground lead from the back of the Cooper control enclosure.
11) Remove the Cooper control panel from the hinges and set the control panel aside.

Installing the MJ- Control Panel

As a guide, follow the Siemens MJ- instruction manual.

1) Turn MJ- power switch to OFF and remove fuses before starting installation.
2) On MJ-, remove wiring from bottom terminal block to remove PDS plug and wires from the control panel.
3) Install retrofit wiring as labeled to MJ- (table below) and tighten all screws, including those not used. On the MJ- terminal block, terminal P2A-1 starts at the left side of the bottom terminal block.

4) Check labeling on fanning strip on retrofit wiring to be sure it matches labeling on Cooper terminal strip at bottom of control enclosure.
5) Remove hinges from left side of MJ- and remove magnet and bracket from right side.
6) Install retrofit hinges on right side of MJ- to match Cooper hinge pins.
7) Install retrofit kit latch onto left side of MJ- to match Cooper cabinet threaded hole.
8) Hang MJ- retrofit hinges onto Cooper hinge pins to mount MJ- into Cooper control enclosure.
9) Slide fanning strip under screws of terminal block (located on back side of Cooper enclosure) and tighten all screws. Double check that all conductors of the cable are installed correctly and secured tightly at both ends.
10) Push closed the disconnect switch, V1 (and V6 if present) to energize MJ- and check all voltages.
11) Pull open the current shorting switch, C.

Warning! Do not pull open the current shorting switch, C, until both ends of the interconnecting cable are secure. Failure to do so could open the regulator CT secondary causing a flashover to the control.

12) Swing the MJ- control panel closed. Tighten the panel locking screw.
13) Install fuses and turn power on.

Configuring the MJ- Control Panel

1) For “Regulator Type”, select “Inverted”
2) For “Util Winding Pol”, select “Normal”
3) For Cooper regulators without a differential PT, enter the control winding (E) voltage in “U2PT” and “P2PT” screens.
4) For Cooper regulators with a differential PT, enter the control winding (E) voltage in “U2PT” screen, and enter the differential transformer voltage ratio in the “P2PT” screen. Set the power flow mode to “BI-DIR.”
5) For Tap Changer type, enter “COOP SD” for spring drive or “COOP DD” for direct drive.

Note: The control winding (E) voltage, differential transformer voltage, CT ratio, “I Full Load,” “I Load Max,” and other parameters may be read from the regulator nameplate.

Cooper Regulator Connection Notes:

1) The control cable signals comprise the “Cooper Retrofit Cable” which connects between the Cooper regulator (back panel) and the MJ- control panel.
2) The MJ- contains all the necessary interface circuits for connecting directly to the Cooper regulator back panel – **no external circuit board is needed.**

3) “TB-2” refers to the Terminal Block 2 – located inside the Cooper control panel enclosure.
4) For Cooper regulators, (Cooper) TB-2 “VS” provides the “L” bushing voltage.
5) For Cooper regulators, the “S” bushing voltage is derived from the (optional) “differential PT.”
6) The connection from (Cooper) TB-2 “V7” to (MJ-) P2A “P2” is only needed if the regulator has a differential PT (for detecting the “S” bushing voltage).

MJ- Name	MJ- Terminal	Cooper Terminal	Description
HS	P2A-1	HS	Operation Counter
U112	P2A-2	NL	Neutral Pos. Switch
U2	P2A-8	VS	Sensing Voltage
C2	P2A-5	C3	Current Polarity
E	P2A-6	G	Voltage Ground
E1	P2A-7	C1	Current Ground
N/A*	*	VM*	Motor Voltage*
J	P2A-9	R3	Raise Output
K	P2A-10	L3	Lower Output
U11	P2A-12	DHR	Drag Hand Reset

* Typically, VM will be jumpered to VS inside the Cooper Control box.

Optionally, the jumper from P2B -11 to P2B-12 can be removed from the MJ- and VM can be connected to P2B-11, U6 to provide a separate motor voltage to the MJ-.

N: RETROFITTING AN MJ5, MJ-XL or MJ-4A CONTROL PANEL ONTO A GE REGULATOR WITH A SM3 CONTROL PANEL

Retrofit Kit Contents

- Instructions and drawings 21-204-071-401
- GE Hinges (2)
- PDS plug (1)
- 6-point terminal block (1)
- Crimp lugs (5)
- Terminal lugs (17)
- Mounting Plate (1)
- DIN Rail (1)
- Metal Bracket (1)
- Latch (1)
- 0.625” Philips-head screws (2)
- 0.25” Philips-head screws (6)
- 0.375” Philips-head screws (4)
- Lock washers (12)
- Hex nuts (2)
- Washers (4)
- Cable Tie base (2)
- Cable Tie (7)
- Wire labels (1 set)

Removing the GE SM3 Control Panel:

Follow the GE instruction manual for removing the control panel, which should include, but is not limited to the following steps.

1) Take the Voltage Regulator out of Service.
2) Remove the GE plug from the bottom of the voltage regulator Position Indicator (this shorts the CT and opens the PT).
3) Remove the GE circuit board (“Disconnect Assy.”) from the back of the control enclosure. Make a note of where the jumper(s) are at the J1-J2, J3-J4, & J5-J6 positions. This information will be used to help connecting the proper PT ratio later.
4) Unplug the existing Buchanan terminal block. Leave the wires connected to this terminal block for now.
5) Remove the pins from the hinges on the right side of the GE front panel (keep the pins for step 12 (Installing). Cabinet should now be empty except for the Buchanan terminal block with the wires connected from the Position Indicator.
6) Remove the SM3 Control Panel from the enclosure.
7) Take the existing hinges from this SM3 panel and mount them to the right side of the MJ- Control Panel.

Rewiring the GE Control Box (Refer to 21-204-071-401):

1) Mount the Siemens PDS receptacle (using the DIN rail, Item #3) to the two studs about 25% of the distance from the top on this enclosure. Two welded studs will have to be removed to mount this assembly. Install this per View "A" – "A". Tighten. Note that there is a space left behind the DIN rail so that you may route the wires behind the PDS terminal.

2) Then mount the PT Terminal Block Assembly (Item #4, Part # 21-116-295-501) in the upper right hand corner of the control enclosure. This will be used to connect the internal PT wires. Then you can easily connect the appropriate PT voltage to the P2 terminal on the PDS plug.
3) Wire the BLK (J1), RED (J3), ORG (J5) wires to this PT Terminal Block. Refer to the GE SM3 wire list on 21-204-071-401. Use the wire lugs provided. Suggestion: Do NOT cut the wires too short.
4) Now wire the appropriate wires to the female PDS terminal you mounted in the enclosure. Use the Lugs provided in the Kit. Refer to the GE SM3 wire list on 21-204-071-401. Suggestion: Do NOT cut the wires too short.
5) Crimp the "Dead End" lugs provided in the Kit to each wire left over. DO NOT crimp more than ONE wire to a lug.
6) Reconnect the GE plug to the bottom of the voltage regulator position indicator. From now on, removing the Siemens PDS plug will short the CT without removing the GE plug.
7) Place Voltage Regulator in Service or place appropriate voltage on the Bushings to test the PT ratio.
8) Read the voltages on the PDS receptacle inside the cabinet. If voltages are correct (120VAC from U2 to E) , install MJ- panel as below.

Installing the MJ- Control Panel:

1) Remove the hinges from the Siemens MJ- control panel (left side) and install the capture strip included in the retrofit kit on the left side of the panel.
2) Install the retrofit hinges (or the removed hinges from the SM3 panel) on the right side of the MJ- panel.

3) Install the MJ- control panel to the GE cabinet using the pins removed from the hinges in step 4 (Removing) above.
4) Connect PDS plug on the MJ- to PDS receptacle in cabinet and tighten wing nuts.

Configuring the MJ- Control Panel

1) For "Util Winding Pol", select "Normal"
2) For "Tap Changer Type", select "GE"
3) For "Regulator Type", select "Inverted" (regardless of regulator's actual type)
4) Enter the control winding voltage ratio in "P2PT" screen and the "U2PT" screen.

Note: The control winding (E) voltage, transformer voltage, CT ratio, "I Full Load," "I Load Max," and other parameters may be read from the regulator nameplate.

O: RETROFITTING AN MJ5, MJ-XL or MJ-4A CONTROL PANEL ONTO A GE TYPE VR-1 OR ML-32 VOLTAGE REGULATOR

Retrofit Kit Contents

- Instructions and drawings 21-116-601-240 & 21-116-681-003
- GE Hinges (2)
- GE PDS plug wiring harness (1)
- Metal Bracket (1)
- Philips-head screws (6)
- Lock washers (2)
- Hex nuts (2)
- Washers (4)

Removing the GE Control Panel

Follow the GE instruction manual for removing the control panel, which should include, but is not limited to the following steps.

1) Remove GE plug from bottom of voltage regulator position indicator (CT shorts).
2) Look to see which terminal on the terminal block has jumper to NN9 (could be NN20, NN21, or NN22). It is **VERY IMPORTANT** to jumper NN9 to this same terminal in step 7 below. It determines the voltage applied to the panel.
3) Remove all wires from the bottom of the terminal strips inside the cabinet, including the jumper to the cabinet ground and the jumper from NN9 to NN21 (or 20 or 22). Make sure that no wires remain connected to the bottom of either terminal block. No wires will be disturbed on the top of either terminal block.
4) Remove GE circuit board from back of cabinet and remove pins from hinges on right side of the GE front panel (keep pins for step 11). Remove front panel. Cabinet
5) should now be empty except for two (2) terminal blocks and the wires on the top of each.

Installing the MJ- Control Panel

1) Connect wires from Siemens GE retrofit wiring harness to the bottom of each terminal block, making sure each wire marker matches the terminal block “NN” number (See table below).
2) Connect the jumper wire from NN26 to the ground stud in the cabinet.
3) Connect the jumper wire from NN9 to the terminal noted in step 2 above (either NN20, 21 or 22).
4) Mount the Siemens PDS receptacle (using the DIN) rail to the two studs below the terminal blocks. Install a flat washer, then the DIN rail, then another flat washer, lock washer, and nut. Tighten.
5) Reconnect the GE plug to the bottom of the voltage regulator position indicator. From now on, removing the Siemens PDS plug will short the CT without removing the GE plug.

6) Read voltages on the PDS receptacle inside the cabinet. If voltages are right, install MJ- panel as below.

Installing the MJ- Control Panel

7) Remove the hinges from the Siemens MJ- control panel (left side) and install the capture strip included in the retrofit kit. Install the retrofit hinges on the right side of the MJ- panel.
8) Install the MJ- control panel to the GE cabinet using the pins removed from the hinges in step 4 above.
9) Connect PDS plug on the MJ- to PDS receptacle in cabinet and tighten wing nuts.

GE Terminal #	MJ-	Notes	Description
NN31	U12	(switches gnd)	Neutral Pos. Switch
---	P2		---
NN23	C2		Load Current Pol.
NN26	E	Jumper to cabinet gnd stud	Ground
NN10	E		Ground
NN24	E1		Load Current Non-Polarity
NN9	U2	Jumper to NN20, 21, or 22)	Load Potential
NN27	J	(switches hot)	Raise Output
NN28	K	(switches hot)	Lower Output
NN30	U10	(switches gnd)	Operation Counter
NN29	U11	(switches hot)	Drag Hand Reset
NN20*	---	See steps 2 and 7	
NN21*	---	See steps 2 and 7	
NN22*	---	See steps 2 and 7	
NN32	---	No connection	

Configuring the MJ- Control Panel

1) For “Util Winding Pol”, select “Normal”
2) For “Tap Changer Type”, select “GE”
3) For “Regulator Type”, select “Inverted” (regardless of regulator’s actual type)
4) Enter the control winding voltage ratio in “P2PT” screen and the “U2PT” screen.

Note: The control winding (E) voltage, transformer voltage, CT ratio, “I Full Load,” “I Load Max,” and other parameters may be read from the regulator nameplate.

P: MJ-X Tap Tracking:

Fine Adjustments and Troubleshooting

How Tap Tracking Works

The control panel has an algorithm built into it that senses different inputs, controls various outputs, and monitors tap changes in order to maintain the status of the tap position on the voltage regulator.

In short, tap tracking typically involves the control sensing that an operation has occurred (the op counter has incremented) and then deciding whether it had been Raising or Lowering in order to increase or decrease the tap position in memory. If the Op Count signal is not working or being sensed properly whether it is due to a problem in the regulator tank, the control panel hardware, or the sensing time in the algorithm, then the control panel will not be able to track tap position. Likewise, if the control sees an operation count occur, but cannot determine if the regulator had raised or lowered, then it will generate an error.

MJ4A/MJ5 completely overhauled the tap tracking algorithm, making substantial improvements. The new tap tracking algorithm is robust and flexible, but there are still times when due to normal wear and tear or slight differences within manufacturing tolerances of the regulators that the control panel could have trouble tracking tap position. In this case, some slight adjustments to the tap control timing can be made.

Mj5 adjust the Tap position automatically and continues to operate. In the event that the Tap position does not match the position indicator, passing the Neutral position will sync the Tap position with the Position indicator.

Tap Track Errors

There are two tap tracking alerts that may be generated on the MJ- control: (1) Tap Pos ??? and (2) Tap Track Err. The “Tap Pos ???” alert means that the Tap Position is unknown by the control panel. To correct this problem, go to the <COUNTERS> menu and scroll up or down to the “Tap =” screen. Press the Change key and use the Up/Down arrows to make the Tap Position in memory match the position indicated by the regulator and then press the Save key.

There are 3 possible causes for this error In Mj4A: (1) “TapPosHold” under <ADV CONFIGURE> is set to “Temp” and the control power was lost (set to “PERM” to correct; in version 3.08 and above this menu item was removed and PERM is hard coded in the firmware); (2) Tap Resync is turned ON under <ADV CONFIGURE> and the neutral signal status conflicted with the Tap Position in memory for more than 10 seconds; (3) the control panel was

powered off for an extended period of time and both the super capacitor and Lithium battery (which back up the tap position value) were discharged completely

The second alert is the Tap Track Err. When viewing this alert, press the left arrow key repeatedly. On the right side of the screen two character error codes will appear. There could be between one and four of these codes. Note that the codes could have been generated all at once or at any time since the alert was last cleared. The codes are:

UX /* Tap Change Unexpected */

RS /* Unexpected Neutral, Resync */

TT /* Tap Track Errors, generic error */

OD /* Tap Change Over Due */

For 3.07 and up:

UX: occurs if algorithm can't tell direction tap change occurred or if operation count increases without calling for a raise or lower

RS: occurs when neutral signal is **on** and tap pos is **not** neutral; panel resets tap position to neutral if Tap Resync is turned on

TT: occurs if Tap Resync is on and bad neutral signal and tap position combo persists for more than 10 seconds

OD: occurs if "tap_chg_ctr" goes down to zero. tap_chg_ctr = R/LOnTime + TapChgT/O

For 3.06* (and probably earlier versions):**

UX: occurs if op count increments without a raise or lower signal sent (**)

RS: occurs when neutral signal present and tap pos is not neutral; panel resets tap position to neutral

TT: occurs if can't tell tap change direction w/ algorithm (**) or if it times out while going from/to neutral without sensing tap change (i.e., operation counter doesn't increase) (**) or if bad neutral signal and tap position combo persists

OD: occurs if "tap_change_timeout_counter" reaches zero; e.g., op count switch does not toggle within this many seconds after a raise/lower command. (20 sec for Siemens; 12 sec for GE/Coop SD; 2 sec for LTC/Coop DD; 0.5 sec for LTC 0.5)

***will lose tap pos if bad neutral signal, tap pos in memory combo lasts > XX sec or as noted above by (**)

Settings Related to Tap Tracking

- <CONFIGURE> → **TapChgr**: the type of tap changer the control is installed on. Changing this setting will reinitialize all of the advanced tap changer settings in the diagnostics menu to their defaults.
- <CONFIGURE> → **NeutOvRun**: keeps the tap changer on for a period of time after moving into neutral. This is active for Siemens tap changers only. Set to 2.0 for TLG mechanisms; 1.7 for TLH mechanisms (typically above 400A). If in doubt, use 2.0 sec.
- <ADV CONFIGURE> → **Tap Alert**: Enable/Disable tap tracking alerts.
- <ADV CONFIGURE> → **TapPosHold**: PERM will retain tap position in memory after a power down. TEMP will purposely lose tap position after a power down. In version 3.08 and up, this setting has been removed and the tap position is *always* retained in memory after a power down.
- <ADV CONFIGURE> → **Tap Resync**: when turned on, the panel will compare the neutral signal with the tap position in memory and resynchronizes when the regulator passes through neutral (if necessary). If there is a problem with the neutral signal timing or the neutral light switch in the regulator tank, then turning this **on** will result in the control losing its tap position and it will not resync. If turned **off**, the control will track tap position correctly regardless of the neutral signal.
- <DIAGNOSTICS> → **R/LOnTime**: maximum time to keep the tap changer motor running before pausing for R/LOffTime.
- <DIAGNOSTICS> → **R/LOffTime**: pause between tap changes for this amount of time.
- <DIAGNOSTICS> → **TapChgT/O**: if the control runs the tap changer motor for R/LOnTime and no operations count occurs, then after this many more seconds a Tap Track Err OD alert is generated.
- <DIAGNOSTICS> → **TapIn**: defines the operations count signal input line
- <DIAGNOSTICS> → **TapInType**: defines the operations counter type
- <DIAGNOSTICS> → **TapInPulse**: defines the minimum amount of time that an operations count signal must be present in order for the operations counter to increment (applies to Pulse type operations counters only).
- <DIAGNOSTICS> → **PreTapTime**: measures load voltage before tap change
- <DIAGNOSTICS> → **PostTapTime**: measures load voltage after tap change
- <DIAGNOSTICS> → **NeutralIn**: defines the neutral signal input line
- <DIAGNOSTICS> → **NeutralCount**: defines the number of different Neutral positions (for use with LTC's only)
- <COUNTERS> → **Tap=**: the tap position stored in the control's memory

How to Fine Tune Tap Tracking

If you have tap tracking problems, there are some steps to systematically make adjustments to the settings in order to improve the performance of the tap tracking algorithm. First, identify any Tap Track Err trouble codes. Second, verify whether or not the tap position in memory under the <COUNTERS> menu is correct. Third, operate the voltage regulator up or down a few steps out of band and let it make automatic tap changes to come back in band.

When running the tap changer, there are a few things to make note of:

- Does the Total Operations counter increase with each and every tap change?
- Does the Raise or Lower light on the MJ-XL turn on while the tap changer motor is running?
- How quickly does the Op Counter increase after the tap change is complete?
- Observe the "Tap=" screen under <COUNTERS> during the tap change operations. When does it track properly and when does it not? Is there a difference between Auto/Manual operations or between Raise/Lower operations?

If the control doesn't count operations, check the signal from the voltage regulator to be sure it is functional; without an op counter, no regulator control can track tap position. The MJ-X^L has tiny CT's on the circuit board to sense current to the motor in the raise and lower direction. When the current exceeds a threshold, the Raise or Lower LED will illuminate. If it isn't lighting up during a tap change, or is turning off before the tap change occurs, then the control could have trouble tracking the direction of the tap change. If the operations counter takes a long time to increment, the operations count switch in the tank might be worn and need replacement. For pulse type counters, the TapInPulse may just need to be adjusted.

Tap Changer Variations

For Siemens tap changers, the default settings should be OK and typically require no adjustment. In some cases, you may increase "R/LOnTime" from the default of 8.0 seconds to a higher value if you find that tap changes are taking longer than 8.0 seconds and Tap Track Err OD alerts are being generated. Siemens tap changers use a toggle type operations counter; there will be ~120VAC on U10 on odd positions and ~0VAC for even positions. The neutral signal (U12) will have ~120VAC for all non-neutral positions and ~0VAC on neutral.

GE tap changers have a pulse type operations counter that is closed for a fraction of a second immediately after a tap change completes. GE's neutral signal will have ~120VAC for all non-neutral positions and ~0VAC on neutral. Occasionally, it may be necessary to adjust the TapInPulse to increase or decrease the sensitivity of the operations counter sensing.

Cooper has had three different tap changer designs: the Spring Drive, the Direct Drive, and the Quick Drive (similar to Direct Drive). Cooper's neutral signal will have ~0VAC for all non-neutral

positions and ~120VAC on neutral. Occasionally, it may be necessary to adjust the TapInPulse to increase or decrease the sensitivity of the operations counter sensing. Cooper tap changers have a Hold Switch circuit rather than an actual Op Counter switch. Once the tap change initiates from the control, the Hold Switch circuit picks up and completes the tap change. Changing the R/LOnTime and TapInPulse settings is the best way to improve the tap tracking if you are experiencing problems on a Cooper mechanism. Because of Hold Switch, the accuracy of tracking tap position when making manual tap changes depends upon how long the operator holds the Raise/Lower switch in position before releasing it. After manual operations, it is always a good idea to verify (and possibly adjust) the tap position in memory by going to "Tap =" under the <COUNTERS> menu.

Suggested Alternate Settings from Customer Experience

Although the default settings for each type of tap changer have been tested and are defined according to our knowledge of each tap changer type, sometimes adjustments to the algorithm are made to improve performance. Below are some various settings for different tap changer types that some customers have used to improve performance on troublesome regulators.

Cooper Spring Drive

- TapChgr = COOP SD; <DIAGNOSTICS> TapInPulse = 0.12; all other settings are defaults
- TapChgr = COOP QD; <DIAGNOSTICS> R/LOnTime = 1.0; TapInPulse = 0.12; all other settings are defaults
- TapChgr = COOP SD; <DIAGNOSTICS> TapInPulse = 0.12; R/L OnTime = 3.5, R/L Off time = 5.0; Tap Chg T/O = 5.0; Fixed R/L OnTime = Yes; all other settings are defaults

Cooper Direct Drive

- TapChgr = COOP DD; <DIAGNOSTICS> TapInPulse = 0.15; all other settings are defaults

Recommendation for tap track errors with the Cooper SD Tap Changer:

Decrease R/L ON-Time to less than the time it takes to make one full tap change (i.e. from 8 raise to 7 raise). R/L Off-Time + R/L ON-Time should be greater than the time it takes to make one full tap change.

The reason for this issue is that Cooper tap changers have a Holding switch and does not need to be monitored throughout the whole operation.

Appendix Q: Tap Control Setup

Q: Tap Control Setup

Overview
The new algorithm is intended to be both robust and universal. It should also be simple to use for the majority of applications.

The current selections for Tap Changer Type invoke a similar algorithm as previously implemented, with increased reliability and more flexibility.

The addition of “Custom” for the Tap Changer Type will allow for any of the configurable values to be modified.

To keep the new algorithm largely transparent, the configuration items are listed under the Diagnostics menu.

Improving Robustness
The new algorithm is more robust in that it will allow more flexibility in signal timing and it will pool all the known data to make the best determination of tap action.

Tap change control
The tap change control has been modified to control a generic tap changer. The generic tap change is depicted in Figure 1 - Tap Change Controller. Configurable parameters (in the diagnostics menu) are R/L On Time, R/L Off Time, Tap Change Timeout, Pre Tap Time, and Post Tap Time.

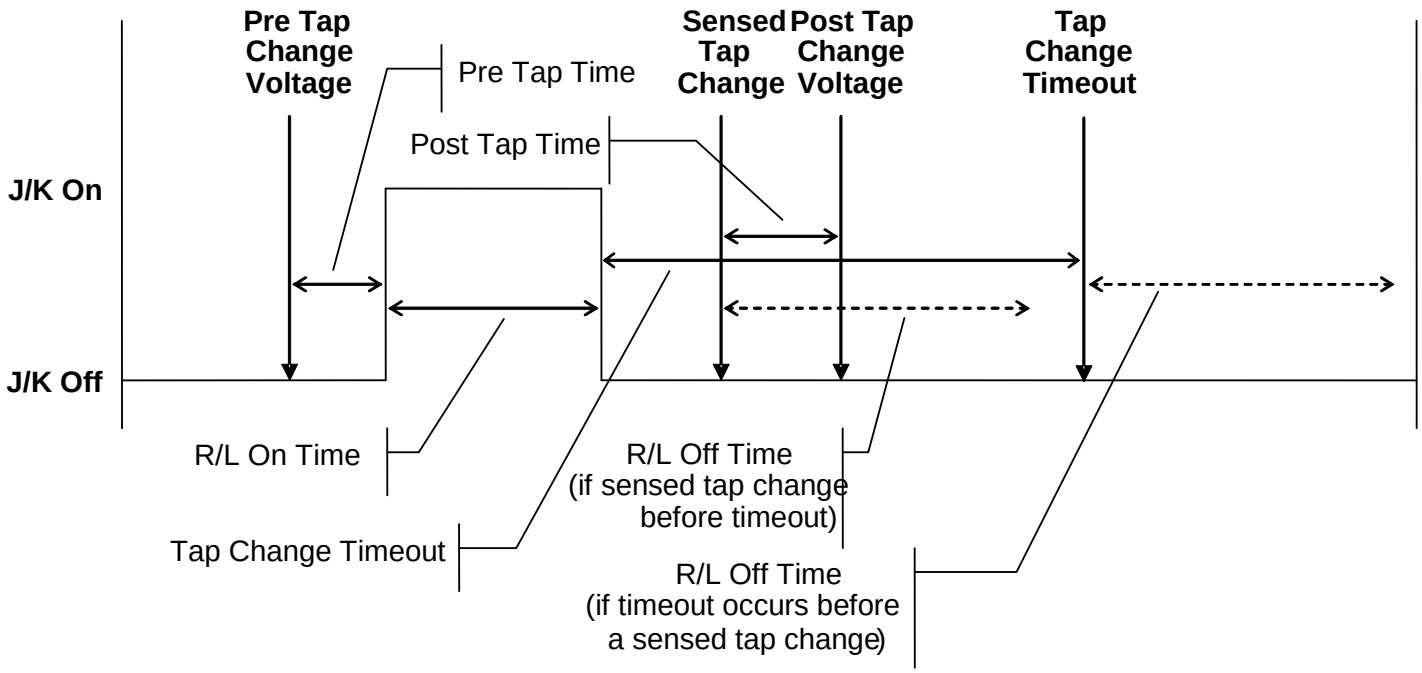


Figure 1 - Tap Change Controller

When an automatic or pseudo-manual (remotely requested) tap change begins, the J or K output is turned on and the timer for the R/L On Time is started. The J/K output is turned off when the R/L On Time expires or a tap change is sensed, whichever occurs first. Note that R/L On Time specifies the maximum time the J/K outputs will remain on during a single tap change. The Tap Change Timeout timer begins when R/L On Time is completed if a tap change has not yet been sensed. If a tap change has still not been sensed by the end of the Tap Change Timeout timer, a "Tap Track Err" will be generated. When a tap change is sensed or a tap change timeout occurs, another timer is started for the R/L Off Time. Subsequent tap changes will not be started until this timer expires

Signal Timing Flexibility

The important timing parameters related to tap control and tap tracking are configurable. There are ten configurable items and they are located in the <Diagnostic> menu. They are as follows

Parameter	Values	Description
R/L On Time:	0.0 to 9.9 (seconds)	Specifies how long to turn on the R/L (J/K) signals to effect a tap change.
R/L Off Time:	0.0 to 9.9 (seconds)	Specifies how long to keep the R/L off between tap changes – provides duty cycle control.
Tap Change T/O	0.0 to 9.9 (seconds)	Specifies how long to wait for a tap change to be sensed before declaring a Tap Track Err.
TapIn Signal:	U10 HS	Specifies which input to use for operations count/tap tracking
TapInType:	TOGGLE PULSE	Specifies what the tap input signal does for each tap change
TapInPulse:	0.00 to 4.99 (seconds)	Specifies pulse time if Tap In Type is "pulse".
PreTapTime:	0.0 to 9.9 (seconds)	Time prior to tap change to sample voltage for voltage-change direction monitoring
PostTapTime:	0.0 to 9.9 (seconds)	Time after tap change to sample voltage for voltage-change direction monitoring

Neutral In:	U12 U112 NONE	Specifies which input is used for Neutral. Set to "NONE" if tap changer lacks Neutral signal.
NeutralCount:	1 to 4	Specifies how many tap positions there are for "neutral". For certain LTC makes, there are 2 or more positions that are "neutral".

Note: Depending upon which changer is selected some of the configurable items may be locked from changes.

Accumulating Input Data
The new algorithm will assimilate available data to make the best possible determination of tap position. While the previous algorithm relied mainly on the motor signal current sensing for direction indication, the new algorithm monitors and utilizes the following information:

1) Motor relay output (for automatic operations)
2) Motor signal current sensing
3) The change in load voltage ("delta-V").

Using the new algorithm
To use the new algorithm the user will select the tap changer type from the <Configure> menu, under "TapChngr." Once a tap type is selected some of the choices on the <Diagnostic> menu will become locked because those features cannot be changed for that given type of regulator. If "Custom" is selected then all tap configuration items on the <Diagnostic> menu become unlocked. The tap changer choices are:

- **Siemens**

Synchronization	**Tap Change Indication**	**Tap Direction Indication**	**Active <Diagnostic> Menu Items**
Neutral Sense (U12) closes to E; tap position may be set at front panel	Op Count (U10) toggles (between "U" and "E")	Monitor current of "J" and "K", Motor relay output, ΔV	• R/L On Time • R/L Off Time: • TapChgT/O • TapInPulse • PreTapTime • PostTapTime

- **GE**

Synchronization	**Tap Change Indication**	**Tap Direction Indication**	**Active <Diagnostic> Menu Items**
Neutral Sense (U12) closes to E; tap position may be set at front panel	Op Count (U10) quick pulse ("E" to "U" to "E")	Monitor current of "J" and "K", Motor relay output, ΔV	• R/L On Time • R/L Off Time: • TapChgT/O • TapInPulse • PreTapTime • PostTapTime

- **LTC**

Synchronization	Tap Change Indication	Tap Direction Indication	Active <Diagnostic> Menu Items
initial tap position set at front panel	Op Count (U10) pulses (“E” to “U” to “E”)	Monitor current of “J” and “K”, Motor relay output, ΔV	• R/L On Time • R/L Off Time: • TapChgT/O • TapInPulse • PreTapTime • PostTapTime

- **COOP DD**

Synchronization	Tap Change Indication	Tap Direction Indication	Active <Diagnostic> Menu Items
Neutral Sense (U12) closes to E; tap position may be set at front panel	Hold Switch (HS) current pulses (off to on to off)	Monitor current of “J” and “K”, Motor relay output, ΔV	• R/L On Time • R/L Off Time: • TapChgT/O • TapInPulse • PreTapTime • PostTapTime

- **COOP SD**

Synchronization	Tap Change Indication	Tap Direction Indication	Active <Diagnostic> Menu Items
Cooper Neutral Sense (U112) closes to U; tap position may be set at front panel	Hold Switch (HS) current pulses (off to on to off)	Monitor current of “J” and “K”, Motor relay output, ΔV	• R/L On Time • R/L Off Time: • TapChgT/O • TapInPulse • PreTapTime • PostTapTime

- **LTC.5**

Synchronization	Tap Change Indication	Tap Direction Indication	Active <Diagnostic> Menu Items
initial tap position set at front panel	Op Count (U10) pulses (“E” to “U” to “E”)	Monitor current of “J” and “K”, Motor relay output, ΔV	• R/L On Time • R/L Off Time: • TapChgT/O • TapInPulse • PreTapTime • PostTapTime

- **CustomTap**
  100% configurable, all <Diagnostic > menu configurations unlocked

Default Values

Due to storage limitations, once a tap changer is selected, the default values are set. The MJ-XL has no method of recalling the previous value(s) for another changer type. In short, once the changer type is changed the modified Configuration will be wiped from memory and replaced with the default values. The default values are as follows:

Parameter	Siemens	GE	COOP SD	COOP DD	LTC (D-Star)	LTC .5
R/L On Time:	8.0	8.0	8.0	0.5	5.0	0.5
R/L Off Time:	0.0	3.0	3.0	3.0	2.0	3.0
Tap Change T/O:	0.0	3.0	3.0	3.0	3.0	3.0
TapIn Signal:	U10	U10	HS	HS	U10	U10
TapInType:	TOGGLE	PULSE	PULSE	PULSE	PULSE	PULSE
TapInPulse:	0.00	0.02	0.02	0.60	1.00	0.6
PreTapTime:	0.2	0.5	0.5	0.5	0.2	0.5
PostTapTime:	1.2	0.5	0.5	0.5	1.2	0.5
Neutral In:	U12	U12	U112	U112	NONE	NONE
NeutralCount:	1	1	1	1	1	1

Symbols

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

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