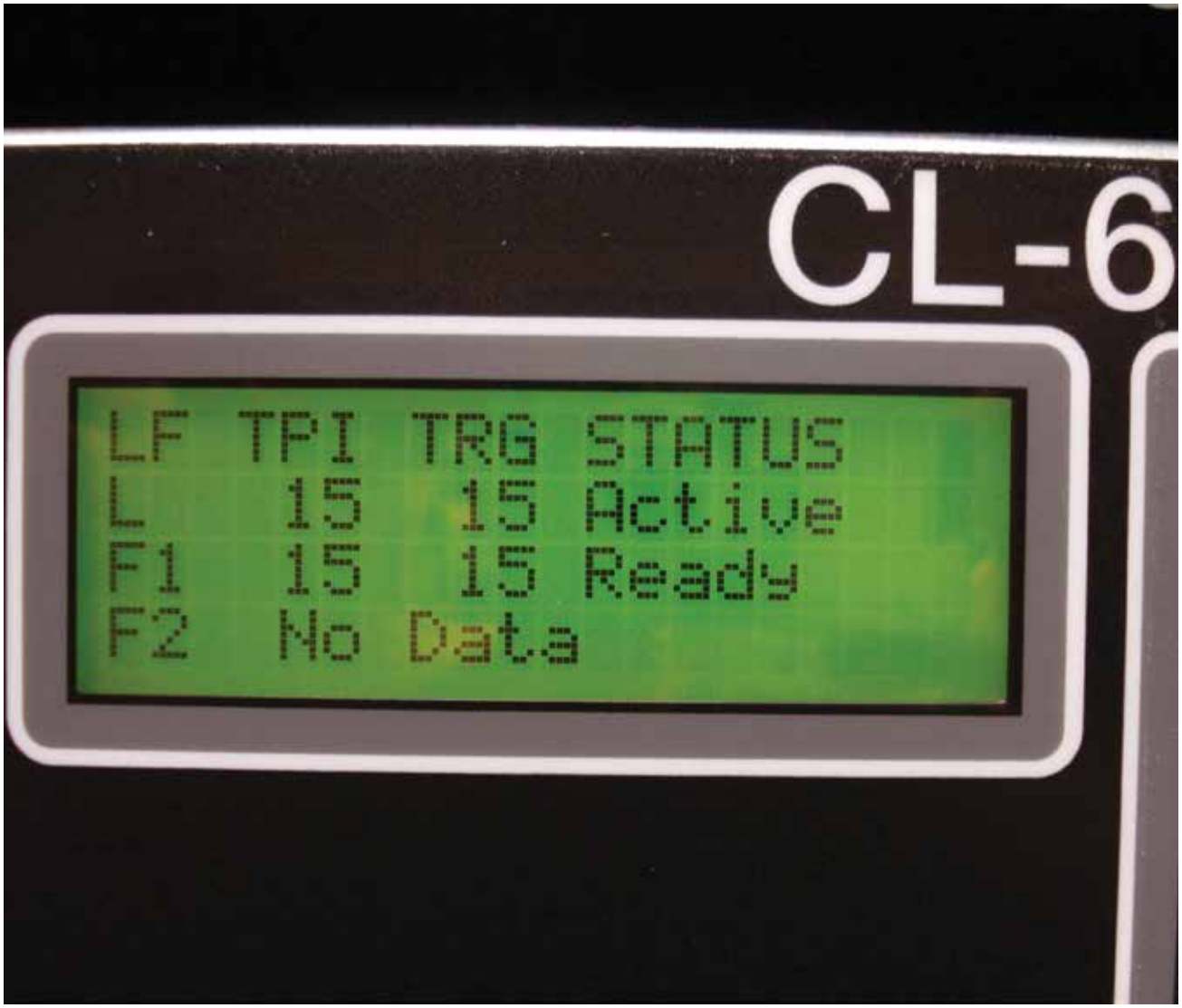
Leader/follower scheme installation and operation guide



Powering Business Worldwide

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Contents

Safety for life

Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high voltage lines and equipment, and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

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.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage. G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage. G122.2

Product information

Introduction

Service Information MN225023EN provides the installation and operation instructions for Eaton's Cooper Power™ series CL-6 series regulator control.

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment. Read and understand the manuals detailing the installation and operation of the regulator and the regulator control used with the regulator. Refer to Service Information *S225-11-1 CL-6 Series Control Installation, Operation, and Maintenance Instructions* for information on the CL-6 series voltage regulator control. Refer to *MN25008EN VR-32 Voltage Regulator with Quik-Drive™ Tap-Changer Installation, Operation, and Maintenance Instructions* for information on the voltage regulator with Quik-Drive tap-changer. Refer to Service Information *S225-10-10 VR-32 Voltage Regulator and CL-5 Series Control Installation, Operation and Maintenance Instructions and Parts Replacement Information* for information on the voltage regulator and CL-5 series control.

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or process described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, please contact your Eaton representative.

Acceptance and initial inspection

This kit is thoroughly inspected at the factory. It is in good condition when accepted by the carrier for shipment.

Upon receipt of the regulator kit, a thorough inspection should be made for damage, evidence of rough handling, or shortages. Should this initial inspection reveal evidence of rough handling, damage, or shortages, it should be noted on the bill of lading and a claim should immediately be made with the carrier. Also, notify your Eaton representative.

Handling and storage

Be careful during handing and storage of equipment to minimize the possibility of damage. If the regulator kit is not to be placed into immediate use, store the kit where the possibility of damage is minimized.

Quality standards

ISO 9001 Certified Quality Management System

Description

The Communications module accessory kit provides an interface for digital communication using the 2179 or DNP 3.0 protocol. For more information on the 2179 protocol refer to *Reference Information R225-90-9 Ordinal Points Assignments for Communications Protocol 2179 for use with CL-6 Series Regulator Controls* and *Reference Information R280-90-12 Serial Communications Protocol Data 2179*. For more information on the DNP 3.0 protocol refer to *Reference Information R225-90-10 Data Dictionary Assignments for Communications Protocol DNP3 for use with CL-6 Series Regulator Controls* and *Reference Information R225-90-11 Device Profile Document for Communications Protocol DNP3 for use with CL-6 Series Regulator Control*.

Leader/follower scheme overview

Leader/follower scheme

The Leader/Follower Scheme is an electronic scheme designed to keep two or three individual single-phase step voltage regulators on the same mechanical tap position. This is primarily used by utilities and others needing threephase voltage regulation at the expense of a balanced load voltage center with unbalanced loading. A fiber optic intelligent loop scheme is used between controls providing the communications necessary between phases to initialize a tap change and provide positive feedback in maintaining those equal tap positions. As a result of the communications between all phases, access to certain data from all phases is available at the display of all controls involved as well as through the use of Eaton's Cooper Power series ProView® NXG software.

This scheme can also be used for paralleling substation voltage regulators with a set of power transformers used for increasing capacity and providing a backup for maintaining regulated power.

Basic operation

The basic operation involves designating one of the regulators as the Leader device, and the other, one or two, regulators as the follower devices. The Leader device will control the voltage regulation, and the settings on the circuit; the Follower regulators will then be kept on the same tap as the Leader device. The Leader device will use standard voltage regulator settings to determine the need for tapping. Once the Leader device determines the need for tapping it will send a signal to the Follower devices of its intention of tapping, then send a signal to tap to its connected mechanism. Once the tapping has taken place the Leader device will check to ensure the Follower devices have also tapped by checking their new tap position. After the tapping has occurred and all regulators are on the same tap position, the Leader device goes through the normal process to determine if additional tap changes are necessary. If one of the Follower devices fails to make a tap, for whatever reason, the Leader device will step back to the previous tap position. It will then re-initiate the tapping command. If after three attempts (this number is adjustable) a follower device continues to fail to tap, the

Leader device will cease additional tapping commands and lock all regulators in the same position until the regulators are reset. More operation details are provided at the end of this guide.

Definitions

A number of general terms are used in this document, e.g. communications, timeout, retry, etc. These terms may have different meanings in different scenarios. For clarification, the following definitions are used in this document.

Term	Definition
Operating Group	Group of controls that are physically associated with each other by means of Hardwired (traditional Analog SCADA) or Digital (Digital SCADA using traditional control protocols) connections.
LoopShare Communications (LSComms)	Method of communications that allows up to three devices to communicate and share operational and system data.
Leader	Single Device/Control that will be the primary in decision-making processes involving tap change operations of an operating group.
Follower	Device/Control that will take commands involving tap-change operations from the Leader device of the operating group.
Apparatus	The single phase voltage regulator (control supply and regulation system) with which the Device/Control will interact.
Paralleling	Combining two or more pieces of apparatus on the same phase to increase Load Capacity output.
Ganged	Combining two or three, threephase connected, apparatus to allow for in-step voltage regulation operation.
Leader/Follower Data Table (LFDT)	Shared Data Table of operating information passed between all controls in an operating group.
Target Tap (LFTT)	Tap position designated by Leader as the new target position for all connected devices.
Ready State (LFRS)	Follower Status associated with devices ability to follow Leader device in tap-change operations.
Active State (LFAS)	Leader Status associated with all systems, communications and operations, functioning properly.
Loss of Communications (LOC)	Condition where the Leader device, based upon a nonresponse from a connected Follower device, determines that communications within connected Operating Group is not functioning.
Unable To Operate (UTO)	Condition where Leader device, upon completion of a Tap instruction to Follower device, senses the Follower device did not complete a tap change operation as specified. UTO will also occur if the Leader Fails To Tap.
Tap Wait Timer (LFTW)	Timer associated with a delay at each device between forwarding LFDT and initializing its own tap-change operation.
Communications Wait Timer (LFCW)	Timer associated with delay at each device between receiving and forwarding an updated LFDT.
Communications Timeout (LFTO)	Timer associated with the normal expected communications response time of the connected devices.
Tap Timeout (LFTO)	Timer associated with the normal expected tapping confirmation response time of connected devices.
Retry Timer (LFRT)	Timer associated with Leader re-initialization of LFDT following either a LOC or UTO condition within the Operating Group.
Retry Count (LFRC)	Parameter associated with the number of tries the Leader device will attempt to re-initialize the LFDT following a UTO condition within the Operating Group.

Leader/follower applications

The CL-6 regulator control panel traditionally operates in an autonomous mode with each individual control making decisions with regard to the proper operation of the connected apparatus for Single-phase Regulation of Utility Voltage Distribution systems. The Leader/Follower feature will allow devices in an operating group to act together when making adjustments to apparatus output voltage. Operating groups would be one of two defined system configurations.

Three-phase ganged operation

On a given distribution feeder, on a three phase output, utilities may gang two (Open Delta) or three (Closed Delta, Wye) apparatus together. In this configuration utilities would require all apparatus to stay in step to provide "balancing" of the output voltage. Apparatus would be of similar design and specification and will be in close proximity to each other, typically in the same substation or on the same platform.

Paralleling operation

For the purpose of handling a larger capacity of load, or for providing a backup to a high priority load, the Leader/Follower feature can be used to parallel two banks of voltage regulators with a set of power transformers. In this application, two voltage regulators located on each phase are paralleled by tying their common outputs together (i.e. Load "L" bushing to "L" bushing) thereby increasing their

load output capacity, effectively regulating the voltage of a bus or feeder. It is necessary for the transformers and the voltage regulator apparatus of the two banks to be of similar design and specification. The Leader/Follower feature maintains Locked-Step operation to eliminate the possibility of high reactive circulating current within the loop due to a voltage imbalance.

Note: For more information on applications see *Reference Information R225-01-1 Leader/Follower Scheme for Voltage Regulator Controls*.

Leader/follower method description

The control system will utilize a loop of digital communication to allow for interoperability of all devices in a defined operating group. One device of this operating group would be designated the "Leader", the others would be designated as "Followers". It should be noted that the communication loop will directly impact timing and functions associated with successive tapping in normal operating modes, as configured at FC 400 on both Leader and Follower devices.

Functional

Leader

Once activated, the defined Leader device will make voltage regulation decisions and perform tap operations by monitoring load voltage of its own apparatus. The Leader device will inhibit all tap operations when it can not verify its own status or Follower function.

Follower

Once activated, the defined Follower devices will be responsible for tap operations on their connected apparatus. The Follower devices will only perform tap operations when instructed to do so by the Leader.

Physical

To implement the Leader/Follower scheme, all CL-6 regulator controls must be outfitted with a dedicated fiber optic/RS-232 communication module. Furthermore, the communication modules of each control must be linked in a fiber loop using fiber optic cabling (not included with communication module). Communications will utilize channel #2 or #3 (#3 is the default). The channel used is dependent upon which port is used between the CL-6 regulator control and the communication module. If another communication module is being used for SCADA communication, the open port/channel must be used for the Leader/Follower scheme. Unlike other fiber loop applications, the communication modules must be set to non-echo.

For more information on the fiber optic/RS-232 communication module and creating the fiber loop, please refer to Service Information *MN225020EN Fiber-Optic/ RS-232 Communications Module Installation and Operation Instructions*.

Communications

Controls within the operating groups will communicate via Digital communications. LoopShare Communications (LSComms) method will utilize 2179 broadcast message functionality to pass Leader/Follower Data Table (LFDT) from one control to the next. LoopShare Communications must be enabled on all connected devices before the Leader/Follower Scheme can be activated. See Table 1 for an example of the LFDT message. The Leader control will be responsible for initializing the LFDT. Each control in the loop will be responsible for updating its portion of the LFDT before passing the table along. Once the LFDT table is initialized, it will loop through the group continuously until the feature is disabled at one of the controls. All devices will expect to see the LFDT within the time designated by its LoopShare Communications TimeOut Timer (LSTO). If LSTO expires with no receipt of the LFDT the Leader device will enter the L/F Loss of Communication (LOC) state and start the Leader/Follower Retry Timer (LFRT). The Leader device will retry initializing the LFDT from LOC state each time the LFRT expires.

Leader

The defined Leader device will initialize the LFDT and pass the table along once the LoopShare Communications (LSComms) feature is enabled. The Leader device Table 1will begin to regulate the voltage when the following conditions are met:

1. Leader/Follower feature is enabled and the control is in Auto Ready state (Control switch in Auto/Remote)
2. After confirming that all Follower devices are in the Leader/Follower Ready State (LFRS)

Once the conditions are met, the Leader device will inform the Follower devices of its intention to perform a tapping operation via its Target Tap (LFTT) parameters of the LFDT, Table 1. After sending LFDT with an intention to tap indicated, the Leader device will wait (as designated by its Leader/Follower Tap Wait Timer (LFTW)) and then initiate its tapping operation. The Leader device will read status of the Follower devices from the LFDT when it is received back from last Follower device. After the Leader/Follower Tap TimeOut Timer (LFTO) expires the Leader device will expect successful Operating Group synchronization. If Operating Group synchronization is not accomplished, the Leader device reverts to Unable To Operate (UTO) state and will return the operating group to the prior tap position. The Leader device will retry initializing the LFDT from the UTO state (configured by Leader/FollowerRetry Count (LFRC) and the LFRT). If after the last retry, the devices have still not synchronized, the Leader device will latch in the Unable To Operate (UTO) state and give indication of tap operation inhibit.

Follower

Follower devices will be responsible for providing status of their LFRS state. LFRS indication will be a function of any and all inputs that effect tapping operation at the Follower device. Upon receipt of the LFDT, the Follower device will update its own portion of the table.

Table 1. Initial LFDT Sample

Device	Parameter	Sample Value	Cross Ref.
Leader (L)			
L	Time and Date stamp	10/01/08 17:30:48	FC 050
L	Ready State	Ok	
L	Present Tap Position (TPI)	+8	FC 012
L	Target Tap Position (TTPL)	+9	
L	Target Tap Position F1 (TTP1)	+9	
L	Target Tap Position F2 (TTP2)	+9	
L	Low Band Edge Indicator	On	OOB-L LED
L	High Band Edge Indicator	Off	OOB-H LED
L	Comp Voltage Secondary	118.7	FC 008
L	Load Voltage Secondary	118.7	FC 006
L	Source Voltage Secondary	112.6	FC 007
L	Load Current Primary	72.6	FC 009
L	Power Factor	1.00	FC 013
Follower 1 (F1)			
F1	Time and Date stamp	10/01/08 17:30:48	FC 050
F1	Ready State	Ok	
F1	Present Tap Position (TPI)	+8	FC 012
F1	Target Tap Position (TTPL)	+9	
F1	Target Tap Position F1 (TTP1)	+9	
F1	Target Tap Position F2 (TTP2)	+9	
F1	Low Band Edge Indicator	On	OOB-L LED
F1	High Band Edge Indicator	Off	OOB-H LED
F1	Comp Voltage Secondary	118.7	FC 008
F1	Load Voltage Secondary	118.7	FC 006
F1	Source Voltage Secondary	112.6	FC 007
F1	Load Current Primary	72.6	FC 009
F1	Power Factor	1.00	FC 013
Follower 2 (F2)			
F2	Time and Date stamp	10/01/08 17:30:48	FC 050
F2	Ready State	Ok	
F2	Present Tap Position (TPI)	+8	FC 012
F2	Target Tap Position (TTPL)	+9	
F2	Target Tap Position F1 (TTP1)	+9	
F2	Target Tap Position F2 (TTP2)	+9	
F2	Low Band Edge Indicator	On	OOB-L LED
F2	High Band Edge Indicator	Off	OOB-H LED
F2	Comp Voltage Secondary	118.7	FC 008
F2	Load Voltage Secondary	118.7	FC 006
F2	Source Voltage Secondary	112.6	FC 007
F2	Load Current Primary	72.6	FC 009
F2	Power Factor	1.00	FC 013

Upon receipt of the LFDT containing Intention to tap from the Leader device, Follower devices will update its own portion of the table with intention to perform a tapping operation. The Follower device will then pass the LFDT and wait the LFTW timeout period before initiating a tapping operation.

Leader/follower scheme setup and operation

Due to the complexity of the Leader/Follower feature, configuration of some settings can only be performed using ProView NXG software. See Table 3 for summary of feature parameters.

Control functions

Function codes

The following functions can be changed via the control panel keypad or by using ProView NXG software.

Table 2. Function Codes

Function Code	Name	Description	Values	Default Value
400	LoopShare Communications	This will turn On or Off LoopShare Communications	On or Off	Off
401	LoopShare Comms State	This is the state of LoopShare Communications	Active or Inactive	
402	LoopShare Comms Port	This is the Port LoopShare is using	COM2 or COM3	COM3
403	LoopShare Coms Table Assignment	This is the device in the LoopShare Table	Device 1, 2, or 3, or Passive	Passive
404	LoopShare Coms Tx Delay	This is the delay between the time a device receives an updated LFDT and when the device passes it along.	0 to 10000	0
405	LoopShare Coms Timeout	LoopShare timeout time	1 to 60	3
410	Leader/Follower	This will turn On or Off Leader/Follower	On or Off	Off
411	Leader/Follower State	This is the state of the Leader/Follower function	Active or Inactive/ Ready or Not Ready	
413	Leader/Follower Designation	This is the Leader/Follower table designation	Leader, Follower 1, or Follower 2	Follower 1
414	Follower Devices Configured	The number of Follower devices	1 or 2	One
415	Leader/Follower Tap Wait Timer	The length of time in milliseconds the device waits between receiving a signal to tap and actually tapping	0 to 10000	0
416	Leader/Follower Timeout	The length of time in seconds before the Leader returns to starting tap position if a Follower device does not tap	1 to 60	10
417	Leader/Follower Retry Delay	The length of time in seconds before the Leader retries a tap if one failed	5 to 60	5
418	Leader/Follower Retries	The number of tap retries before the Leader stops retrying taps	1 to 10	3

Leader/follower setup

LoopShare functions:

400 Turns LoopShare on. This starts the communication between the connected devices.

401 Indicates Loop/Share is Active. This is a status and not a configuration setting.

402 LoopShare port. Default is Comm 3.

403 LoopShare Device. The Leader must be set as Device 1.

404 LoopShare Time delay. This is the delay before the device continues the communication. Default is 0 and is typically unchanged.

405 LoopShare Comms Timeout. This is the length of time a non-communicating device says active before it goes inactive. Default is three (3) seconds. Should not be less than three (3) seconds.

Leader/follower functions:

410 Turns Leader/Follower function on.

Note: The Leader/Follower function, although it uses LoopShare, is a separate function so both must be turned on.

411 Indicates Leader/Follower Scheme is Active. This is a status not a configuration setting.

413 Designation in the Leader/Follower table. The Leader device also needs to be Device 1 in the LoopShare table FC 403.

414 Follower Devices. Enter the number of follower devices 1 or 2.

415 Leader/Follower Tap Wait Timer. This is the amount of time after the control gets a signal to tap before it actually taps. Note: This function allows a user to set up the individual devices to emulate a three-phase device by having all three individual devices operate nearly simultaneously. If the Comms baud rate is set at 38400 BPS, the following Tap Wait Timer settings will provide near simultaneous operation.

Leader – 700 milliseconds

Follower 1 - 200 milliseconds

Follower 2 - 0 milliseconds

416 Leader/Follower Timeout. The default value is three (3) seconds. This is the length of time in seconds for all Follower devices to reach the Leader's target tap position prior to the Leader device tapping back to the previous tap position.

417 Leader/Follower Retry Timer. The default value is five seconds. This is the time delay between when the Leader device taps back to its previous tap position from a failed tapping attempt and when it taps a second time.

418 Leader/Follower Retries. The default value is three. This is the number of retries the Leader device will make on a failed tapping operation before it stops tapping and goes inactive.

HMI operation and description

Update - metering-PLUS "Load Current"

An additional "Auto Tap Blocked" parameter is provided for the Metering-PLUS™ key for Load Current. Blocked indication for the Leader device will be either "L/F UTO" (Unable To Operate) or "L/F Inactive". Blocked indication for Follower devices will be "L/F Follow".

```
Load Current 103 Fwd
Current Threshold  2
Mode  Locked Forward
Blocked:L/F Inactive
```

New - metering-PLUS (>*Diagnostics>_Metering PLUS) "L/F Status"

Leader/Follower status is accessible by pressing the down arrow in the "Tap Position" Metering-PLUS display. On all configured devices the display will show present tap position, target tap position and current status of Leader and Follower devices. Display will show "- LS INACTIVE -" in place of shared data when LoopShare Communications is Inactive.

```
LF TPI TRG Status
L  -12 -12 Inactive
F1 -13 -12 Ready
F2 -13 -12 Not Ready
```

New - metering-PLUS (>*Diagnostics>_Metering PLUS) "LoopShare Regulation"

LoopShare Regulation metering data is accessible by pressing the down arrow in the "L/F Status" in the Metering-PLUS display. On all configured devices display will show present tap position, Secondary Compensated Voltage, and Band-Edge indication of all devices in Active LoopShare Communications group. Display will show "- LS INACTIVE -" in place of shared data when LoopShare Communications is Inactive.

```
Reg TPI  CompV BandE
D1  -12  122.5 High
D2  -16  118.5 Low
D3  -14  120.0 Off
```

New - metering-PLUS (>*Diagnostics>_Metering PLUS) "LoopShare Secondary Volts"

LoopShare Secondary Volts metering data is accessible by pressing the down arrow from the "LoopShare Regulation" Metering-display. On all configured devices display will show present Secondary Source Voltage, the Secondary Load Voltage, and Secondary Compensated Voltage of all devices in Active LoopShare Communications group. Display will show "- LS INACTIVE -" in place of shared data when LoopShare Communications is Inactive.

```
sV Src   Load  Comp
D1 120.0 120.0 120.0
D2 120.0 120.0 120.0
D3 120.0 120.0 120.0
```

New - feature menus selection (>*Features>*>Leader/ Follower)

```
 *Tap To Neutral
 *SOFT-ADD-AMP
>*Leader/Follower
 *Communications
```

LED

The Leader/Follower Feature will affect function of "Auto Tap Blocked" LED as follows.

Leader

The Leader device will activate "Auto Tap Block" LED when inhibited. This can be due to the following conditions:

1. Latched Follower device is out of sync condition
2. Unable to Operate (UTO)
3. Inability to establish communications, LOC

In the Metering-PLUS "Load Current" display, line four will display "L/F UTO" or "L/F LOC" for "Blocked" determination.

Follower

Follower devices will activate "Auto Tap Block" LED when the feature is enabled. In Metering-PLUS "Load Current" display, line four will display "L/F Follow" for "Blocked" status.

Toggle switch

Feature will be dependent on proper switch positions as follows.

Supervisory switch

Leader/Follower function will work independent of position of Supervisory switch.

Control function switches

Communications of LFDT between connected devices will be independent of position of Control Function Switches.

Tapping of mechanism to maintain Leader/Follower function, by definition, will require Auto/Manual Control Switch to be in the "Auto/Remote" position on both the Leader and Follower devices.

Compact flash

All Leader/Follower configurations will be transferred via standard "Save" and "Load" functions.

Advanced features

Leader/Follower status and configuration will be accessible through some of the Advanced Features of the control. In addition, the operation of a given Advanced Feature may be affected by configuration of the Leader/Follower feature.

Tap-to-neutral

When Leader/Follower Feature is enabled, the Leader device will execute Tap-to-Neutral commands but will wait the configured LFTW timer. It will also verify Follower device operation for each tap. In the event the Leader device cannot verify Follower device compliance to Tap-to-Neutral command, the sequence will be deactivated and the Leader device will return to the last known good tap position. When Leader/Follower Feature is enabled, Follower devices will ignore independent Tap-to-Neutral commands.

Soft-Add-Amp

When Leader/Follower Feature is enabled, the Follower devices will ignore Soft -Add -Amp™ settings.

Preventative maintenance tapping (PMT)

When Leader/Follower Feature is enabled, either PMT mode forces the Leader to go inactive. When the Leader/Follower Feature is enabled, either PMT mode force the Follower devices to a "Not Ready" status.

Status alarm

Statuses of Leader/Follower states will be available as a configured status alarm. They will also, by definition, be available as Event outputs and Programmable I/O Inputs.

Leader/follower state

Status of Leader/Follower state, Leader = "Inactive", Follower = "Not Ready", will be available as configured status alarms.

Unable to operate

Leader device latched Unable To Operate condition will be available as a configured status alarm.

Loss of communications

Leader device Loss/Lack of Communications condition will be available as a configured status alarm.

Programmable I/O

Leader/Follower Feature configuration, turn "On" or turn "Off", will be available as a configurable output.

Communications

Leader/Follower status and all configuration items are accessible through all existing communications channels with all resident protocols.

Leader

Protocol assignment of LoopShare Communications port as assigned via Function Code 402, (COM1/COM3 (FC 060), COM2 (FC 160)) will need to be set to "2179". Leader shall be configured with Communications Baud Rate (COM1/COM3 (FC 061), COM2 (FC 161)) to match that of Follower devices.

Follower

Protocol assignment of LoopShare Communications port as assigned via Function Code 402, (COM1/COM3 (FC 060), COM2 (FC 160)) will need to be set to "2179". All Follower devices shall be configured with Communications Baud Rate (COM1/COM3 (FC 061), COM2 (FC 161)) to match that of the Leader device.

Software

Leader/Follower Feature is configured through a Leader/Follower Advanced Feature window in ProView NXG software.

Table 3. Configuration Values

Parameter	Values or Range	Default Value	Unit	Cross Ref.
LSComms State	Active = 0, Inactive = 1	N/A		FC 401
Leader L/F Tap State (LFTAS)	Active = 0, Inactive = 1	N/A		FC 411
Follower L/F Tap State (LFTRS)	Ready = 0, Not Ready = 1	N/A		FC 411
LSComms Configuration	On, Off	Off		FC 400
LSComms Port	COM2, COM3	COM3		FC 402
LSComms Table Position	1, 2, 3	2		FC 403
LSComms Wait Timer (LSCW)	0 to 10000	0	mSec	FC 404
LSComms TimeOut Timer (LSTO)	1 to 60	3	Sec	FC 405
L/F Tap Configuration	Off, On	Off		FC 410
L/F Mode	Normal, TBD	(future)		FC412
L/F Designation	Leader, Follower 1, Follower 2	Follower 1		FC 413
L/F Follower Devices Configured	One, Two	One		FC 414
L/F Tap Wait Timer (LFTW)	0 to 10000	0	mSec	FC 415
L/F Tap TimeOut Timer (LFTO)	1 to 60	3	Sec	FC 416
L/F Retry Timer (LFRT)	5 to 60	5	Sec	FC 417
L/F Retry Count (LFRC)	1 to 10	3		FC 418

Specific operation considerations

Tapping commands received through communications

Design considerations allow for Digital SCADA commands to be accepted through additional connected communications.

Leader

The Leader device will execute tapping commands received by way of communications. The Leader device will wait the configured LFTW timer and verify response of all Follower devices. In the event a Follower device does not accomplish a tap change, the Leader device will return to prior tap position.

Follower

Follower devices will not execute tapping commands received directly, unless they are issued by the Leader device.

Manual reset of TPI through local HMI (FC 012)

Design consideration is given to the possibility of Leader/ Follower internal Tap Position Indicator (TPI), function (FC 012), being manually reset.

Leader

When TPI is reset on the Leader device it will force the Follower devices to synchronize at the newly indicated tap position. In the event that the Follower devices are unable to match the newly indicated tap position, the Leader device will synchronize to the Follower devices' positions.

Follower

When TPI is reset on any Follower device, that Follower device will immediately tap to its LFTT position.

Out-of-synch condition (FC 012 is invalid)

Design consideration is given to the possibility of Leader/ Follower functionality being impacted by one of the devices loosing proper tap position as per its internal TPI function (FC 012) being invalid.

Leader

The Leader device will enter the Inactive state (LFAS = Inactive) when its TPI becomes invalid and will cease in its attempts to operate Follower devices.

Follower

Follower devices will enter the Not Ready state (LFRS = Not Ready) when its TPI becomes invalid and will not attempt to operate if instructed to do so by the Leader device.

Leader fails to tap

In the event that the Leader device, in its attempts to operate its own mechanism, senses that operation did not complete (No sensing of Holding Switch current) it will issue an Untap command to the Follower devices and then enter the UTO condition. The Leader device will then proceed to the Retry operation as configured by LFRT and LFRC.

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