



Instruction Book

**M-2001C (Comprehensive)
Tapchanger Control**

BECKWITH  **CO. INC.**
ELECTRIC

Digital Tapchanger Control M-2001C

**Digital Tapchanger Control
for Transformers and Regulators**



Comprehensive Model Shown

- LTC transformer, substation regulator, and line regulator control provides reliable operation with expanded capabilities
- Available in four models; Comprehensive, Base-T, Base-RS and Base-R
- Adapter panels to retrofit popular industry tapchanger controls
- Ten on-board communication protocols
- Count Window - Works even with noisy operation counter contacts
- Field-updatable programming
- Reverse power detection/operation
- Demand metering/Data Logging with Date/Time Stamp
- Entire control configuration prints out from TapTalk®
- SCAMP™ (SCADA Controllable Auto/Manual Pushbutton) Adapter Panel Auto/Manual Switch State can be changed by a SCADA command pushbutton
- Overcurrent protection
- SCADA HeartBeat
- Manual HeartBeat Timer
- LDC with R & X or Z-compensation
- Increased Bandwidth to 10 Volts
- Ethernet port optional
- Supports terminal mode for modem communications in TapTalk
- Transformer paralleling by circulating current, external master-follower circuitry, or Δ VAR® methods
- Standard LCD display (rated -20 to +70 degrees Celsius.) Vacuum Fluorescent display optionally available (rated -40 to +80 degrees Celsius)
- Optional Control Power Backup Input for Fiber Optic loop-through communication
- M-2829 TapPlot® for Windows™ Analysis Software allows the plotting, printing and analysis of Tap Information

*Industry Leader Since 1969
Made in the USA*

Comprehensive Version Features

The Comprehensive version includes all M-2001C features and can be used for LTCs or regulators where SCADA communications are desired.

- Adjustable Bandcenter
- Adjustable Bandwidth
- Line Drop Compensation, R and X Compensation
- Time Delay, Definite and Inverse
- InterTap Time Delay
- Selectable Outputs, Continuous or Pulsed
- Reverse Power Operation, for Transformer LTC and Single-Phase Regulator applications
- CT to VT Phasing Correction
- Real-Time Metering of measured and calculated parameters
- Demand Metering with selectable time interval
- Drag Hands Operation
- Adjustable Line Overcurrent Tapchange Inhibit
- Voltage Limits
- Tap Position Limits
- Runback
- Three independent Voltage Reduction Steps
- Sequential and Non-Sequential Operation
- SCADA HeartBeat
- Manual HeartBeat Timer
- VT Ratio Correction
- Self-Test Alarm Output Contacts
- User Programmable Alarm Contacts
- Operations Counter
- Resettable Operations Counter
- Harmonic Analysis through TapTalk®
- Tap Position Record
- Auto/Off/Manual Switch Status
- A or B Regulator Type Selection
- Alarm Contact Outputs (2)
- Control Voltage Input
- Motor Power Input
- Line Current Input
- Raise Output
- Lower Output
- 20 Character by 2 Row LCD Display
- Tap Position Knowledge by:
 - Contact KeepTrack™
 - Shaft Coupled KeepTrack™
 - Resistor Divider KeepTrack™
 - Motor Direct Drive KeepTrack™
- M-2029A TapTalk Communications Software
- M-2829 TapPlot® Tap Analysis Software
- Adapter Panel Auto/Manual Switch Type Selection
- Front RS-232 Communications Port COM2
- External Inhibit of Auto Tapchange
- Circulating Current Paralleling Method
- Front Panel LEDs for Out-of-Band **Raise**, Out-of-Band **Lower**, Reverse Power Flow **Rev Pwr** Detected, CPU **OK**, Line Drop Compensation **LDC** In Effect, Voltage Reduction **V/RED** in Effect, Auto Operation Block **MANUAL**, SCADA Control blocked **LOCAL** and Com1 **TX** and **RX**.
- Circulating Current Input
- Voltage Reduction 1 & 2 Inputs (Binary) (3 Steps Total)
- Neutral Position Detect (Binary)
- Counter Input (Binary)
- Seal-in/Switch Status Input (Binary)
- Non-Sequential/SCADA Block Input (Binary)
- Seal-in Output
- COM1 (top) RS-232, RS-485 and Fiber Optics
- Communication Protocols include BECO 2200, BECO 2179, Cooper 2179, Cooper 2179A, GP-2179, GP DNP3.0, DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0 and MODBUS.

Comprehensive Optional Features

- Paralleling Δ VAR® Methods
- Vacuum Fluorescent Display (rated –40 to +80 degrees Celsius.)
- Ethernet Port COM3 (10 Mbps) is available through an RJ-45 jack on the top of the control. This port supports DNP over TCP/IP, BECO 2200 over TCP/IP, MODBUS over TCP/IP, and IEC 61850/UCA 2.0 over TCP/IP.
- Control Power Back-Up Input – input (+12 V dc) for backup of Fiber Optic loop-through communication

Comprehensive Accessories

- M-2025B(D) Current Loop Interface Module-Current-To-Voltage analog converter for tap position sensors
- M-2026 AC-DC Control Power Backup Supply
- M-2027 Control Power Backup Supply - AC Only
- M-2948 Tap Position Sensor

Base-T Version Features

The Base-T version of the M-2001C is designed for transformers. It uses one COMM port (Com2) for communications.

- Adjustable Bandcenter
- Adjustable Bandwidth
- Line Drop Compensation, R and X Compensation
- Time Delay, Definite and Inverse
- InterTap Time Delay
- Selectable Outputs, Continuous or Pulsed
- Reverse Power Operation, for Transformer LTC and Single-Phase Regulator applications
- CT to VT Phasing Correction
- Real-Time Metering of measured and calculated parameters
- Demand Metering with selectable time interval
- Drag Hands Operation
- Adjustable Line Overcurrent Tapchange Inhibit
- Voltage Limits
- Tap Position Limits
- Runback
- Three independent Voltage Reduction Steps
- Sequential and Non-Sequential Operation
- VT Ratio Correction
- Self-Test Alarm Output Contacts
- User Programmable Alarm Contacts
- Operations Counter
- Resettable Operations Counter
- Harmonic Analysis through TapTalk®
- Tap Position Record
- Auto/Off/Manual Switch Status
- A or B Regulator Type Selection
- Alarm Contact Outputs (2)
- Control Voltage Input
- Motor Power Input
- Line Current Input
- Raise Output
- Lower Output
- Tap Position Knowledge by:
 - Contact KeepTrack™
 - Shaft Coupled KeepTrack™
 - Resistor Divider KeepTrack™
 - Motor Direct Drive KeepTrack™
- 20 Character by 2 Row LCD Display
- M-2029A TapTalk Communications Software
- M-2829 TapPlot® Tap Analysis Software
- Front Panel LEDs for Out-of-Band **Raise**, Out-of-Band **Lower**, Reverse Power Flow **Rev Pwr** Detected, CPU **OK**, Line Drop Compensation **LDC** In Effect, Voltage Reduction **V/RED** in Effect and Auto Operation block **MANUAL (LOCAL** and Com1 **TX** and **RX** LEDs are NOT functional on BASE-T Versions).
- Includes BECO 2200 protocol on COM2 port
- Circulating Current Paralleling Method
- Front RS-232 Communications Port COM2
- External inhibit of Auto Tapchange (non-sequential)
- Circulating Current Input
- Voltage Reduction 1 & 2 Inputs (Binary) (3 Steps Total)
- Neutral Position Detect (Binary)
- Counter Input (Binary)
- Seal-in/Switch Status Input (Binary)
- Non-sequential/SCADA Block Input (Binary)
- Seal-in Output

Base-T Optional Features

- Vacuum Fluorescent Display (rated –40 to +80 degrees Celsius.)
- ΔVAR® Paralleling Methods
- Control Power Back-Up Input – input (+12 V dc) for backup of Fiber Optic loop-through communication

Base-T Accessories

- M-2025B(D) Current Loop Interface Module-Current-To-Voltage analog converter for tap position sensors
- M-2026 AC-DC Control Power Backup Supply
- M-2027 Control Power Backup Supply - AC Only
- M-2948 Tap Position Sensor

Base-RS Version Features

The Base-RS version of the M-2001C is designed primarily for regulators, but can also be applied to LTCs where SCADA communication is required. It provides one SCADA COMM port (COM1) as either an optional RS-485 or fiber optics port for communications.

- Adjustable Bandcenter
- Adjustable Bandwidth
- Line Drop Compensation, R and X Compensation
- Time Delay, Definite and Inverse
- InterTap Time Delay
- Selectable Outputs, Continuous or Pulsed
- Reverse Power Operation, for Transformer LTC and Single-Phase Regulator applications
- CT to VT Phasing Correction
- Real-Time Metering of measured and calculated parameters
- Demand Metering with selectable time interval
- Drag Hands Operation
- Adjustable Line Overcurrent Tapchange Inhibit
- Voltage Limits
- Tap Position Limits
- Runback
- Self-Test Alarm Output Contacts
- Three independent Voltage Reduction Steps
- Sequential and Non-Sequential Operation
- SCADA HeartBeat
- Manual HeartBeat Timer
- VT Ratio Correction
- Tap Position Knowledge by Motor Direct Drive KeepTrack™ method
- Operations Counter
- Resettable Operations Counter
- Harmonic Analysis through TapTalk®
- Tap Position Record
- Auto/Off/Manual Switch Status
- A or B Regulator Type Selection
- Control Voltage Input
- Motor Power Input
- Line Current Input
- Raise Output
- Lower Output
- 20 Character by 2 Row LCD Display
- M-2029A TapTalk Communications Software
- M-2829 TapPlot® Tap Analysis Software
- Adapter Panel Auto/Manual Switch Type Selection
- Front Panel LEDs for Out-of-Band **Raise**, Out-of-Band **Lower**, Reverse Power Flow **Rev Pwr** Detected, CPU **OK**, Line Drop Compensation **LDC** In Effect, Voltage Reduction **V/RED** in Effect, Auto Operation Block **MANUAL**, SCADA Control blocked **LOCAL** and Com1 **TX** and **RX**.
- Includes BECO 2200 protocol on COM2 port
- Front RS-232 Communications Port COM2
- Voltage Reduction 1 & 2 Inputs (Binary) (3 Steps Total)
- Non-Sequential/SCADA Block Input (Binary)
- Neutral Position Detect (Binary)
- Counter Input (Binary)
- Seal-in/Switch Status Input (Binary)
- Seal-in Output
- Communication Protocols include BECO 2200, BECO 2179, Cooper 2179, Cooper 2179A, GP-2179, GP DNP3.0, DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0 and MODBUS.

Base-RS Optional Features

- Vacuum Fluorescent Display (rated –40 to +80 degrees Celsius.)
- Control Power Back-Up Input – input (+12 V dc) for backup of Fiber Optic loop-through communication
- COM1 (top) RS-485 or Fiber Optics

Base-RS Accessories

- M-2026 AC-DC Control Power Backup Supply
- M-2027 Control Power Backup Supply - AC Only

Base-R Version Features

The Base-R version of the M-2001C is designed primarily for regulators, but can also be applied to LTCs where no SCADA communication is required. It uses one COMM port (COM2) for communications.

- Adjustable Bandcenter
- Adjustable Bandwidth
- Line Drop Compensation, R and X Compensation
- Time Delay, Definite and Inverse
- InterTap Time Delay
- Selectable Outputs, Continuous or Pulsed
- Reverse Power Operation, for Transformer LTC and Single-Phase Regulator applications
- CT to VT Phasing Correction
- Real-Time Metering of measured and calculated parameters
- Demand Metering with selectable time interval
- Drag Hands Operation
- Adjustable Line Overcurrent Tapchange Inhibit
- Voltage Limits
- Tap Position Limits
- Runback
- Three independent Voltage Reduction Steps
- Sequential Operation
- VT Ratio Correction
- Tap Position Knowledge by Motor Direct Drive KeepTrack™ method
- Operations Counter
- Resettable Operations Counter
- Harmonic Analysis through TapTalk®
- Tap Position Record
- Auto/Off/Manual Switch Status
- A or B Regulator Type Selection
- Control Voltage Input
- Motor Power Input
- Line Current Input
- Raise Output
- Lower Output
- 20 Character by 2 Row LCD Display
- M-2029A TapTalk Communications Software
- M-2829 TapPlot® Tap Analysis Software
- Front Panel LEDs for Out-of-Band **Raise**, Out-of-Band **Lower**, Reverse Power Flow **Rev Pwr** Detected, CPU **OK**, Line Drop Compensation **LDC** In Effect, Voltage Reduction **V/RED** in Effect and Auto Operation block **MANUAL (LOCAL** and Com1 **TX** and **RX** LEDs are NOT functional on BASE-R Versions).
- Includes BECO 2200 protocol on COM2 port
- Front RS-232 Communications Port COM2
- Voltage Reduction 1 & 2 Inputs (Binary) (3 Steps Total)
- Neutral Position Detect (Binary)
- Counter Input (Binary)
- Seal-in/Switch Status Input (Binary)
- Seal-in Output

Base-R Optional Features

- Vacuum Fluorescent Display (rated –40 to +80 degrees Celsius.)
- Control Power Back-Up Input – input (+12 V dc) for backup of Fiber Optic loop-through communication

Base-R Accessories

- M-2026 AC-DC Control Power Backup Supply
- M-2027 Control Power Backup Supply - AC Only

Features

■ **NOTE:** Not all features are included in all versions.

Bandcenter: Adjustable from 100 V to 135 V in 0.1 V increments.

Bandwidth: Adjustable from 1 V to 10 V in 0.1 V increments.

Line Drop Compensation: R and X compensation. Adjustable from –24 V to +24 V in 1 V increments. Z compensation available with adjustment of voltage raise from 0 V to +24 V, in increments of 1 V.

Time Delay: Definite; adjustable from 1 second to 120 seconds, in 1 second increments. Inverse; adjustable from 1 second to 120 seconds, in 1 second increments.

InterTap Time Delay: Used to introduce time delay between tap operations when control is in sequential mode; adjustable from 0 to 60 seconds in 1.0 second increments. Counter input required.

Selectable Outputs: Continuous or pulsed. Normally, an output (raise or lower) signal is maintained when the voltage remains outside the band. A pulsed output length is programmable from 0.2 to 12 seconds, in increments of 0.1 second.

Reverse Power Operation:

Transformer LTC Application: Can be set to Ignore, Block, Regulate Rev, Return To Neutral or Distributed Generation operation with reverse power (when using positive tap position knowledge).

Single-Phase Regulators: If Motor Direct Drive KeepTrack™ is applicable, unit may be set to "Return to Neutral" or "Regulate Reverse". The Regulate Reverse feature allows separate setpoints and regulation in the reverse direction without the installation of source-side VTs, otherwise it can be set to Ignore, Block or Distributed Generation.

CT to VT Phasing Correction: Adjustable from 0° to +330° in 30° increments.

Real-Time Metering: The following measured and calculated values are available in real-time:

- Local Voltage
- Load kVA, or MVA
- Load Center Voltage (Compensated Voltage)
- Load kW, or MW
- Line Current
- Load kVAr, or MVAr
- Power Factor
- Line Frequency

Demand Metering: Time interval selected as 15, 30, or 60 minutes.

Drag Hands Operation:

The following "drag-hand" values are stored with date and time stamping and are averaged over 32 seconds:

- Minimum Local Voltage
- Maximum Local Voltage

The following "drag-hand" values are stored with date and time stamping and are calculated over the demand time interval (15, 30, or 60 minutes) as selected by the user:

- Maximum Primary Line Current
- Maximum Load kW, or MW
- Maximum Load kVAr, or MVAr
- Maximum Load kVA, or MVA (and Power Factor at time of Maximum Load kVA, or MVA)

Line Overcurrent Tapchange Inhibit: Adjustable from 200 mA to 640 mA of line current for 200 mA CT or 1.0 A to 3.2 A for 1 A CT display and 5.0 A to 16.0 A for 5 A CT display. External auxiliary CT required for 1.0 A and 5 A CT inputs.

Voltage Limits, Tap Position Limits, and Runback: Overvoltage and Undervoltage limits are independently adjustable from 95 V to 135 V in 0.1 V increments. Upper and lower tap position limits may be set by user, with tap position knowledge active. An adjustable deadband (above the overvoltage limit) of 1 V to 4 V is available, which is used to set the runback limit.

Voltage Reduction: Three independent steps, each adjustable from 0% to 10% in 0.1% increments of the bandcenter setpoint. Also included is a Voltage Reduction Turn Off Timer feature that when the timer is set from 1 to 999 minutes (0 minutes = disabled), it will turn off any Voltage Reduction invoked (via Comms) after the time expires.

Inhibit of Auto Tapchange: Blocks automatic tapchanger operation in response to external contact closure or software setting.

Sequential or Non-Sequential Operation: Non-sequential operation resets the time delay upon momentary external contact closure at the non-sequential input.

Paralleling Methods:

Circulating Current: The circulating current method is standard, and may be implemented using separate balancing equipment such as the Beckwith Electric M-0115A Parallel Balancing Module. Consult with factory for use with existing external master-follower circuitry.

ΔVAR®: When specified, the ΔVAR1 method may be implemented by using separate balancing equipment such as the M-0115A Balancing Module. The ΔVAR2 method does not require the use of the M-0115A Balancing Module and is only applicable when paralleling two transformers.

For all methods of paralleling except ΔVAR2, overcurrent protection, such as that provided by the M-0127A Overcurrent Relay, is recommended.

VT Ratio Correction: VT correction from –15 V to +15 V in 0.1 V increments.

Self-Test Alarm Output Contacts: Alerts operator to loss of power or malfunction of control. When the control is configured for SCAMP Pushbutton Auto/Manual Switch Type, this output is not available.

User-Programmable Alarm Contacts: Alerts operator to one or more of the following system conditions: Communications Block Invoked, Block Raise Voltage Limit Exceeded, Block Lower Voltage Limit Exceeded, Voltage Reduction (any step) Invoked, Reverse Power Flow Condition Detected, Line Current Limit Exceeded, Tap Block Raise in Effect, and Tap Block Lower in Effect.

Tap Position Knowledge

Transformer LTC: The optional M-2025B(D) Current Loop Interface Module receives a tap position signal from a tap position sensor (M-2948) or Incon 1250B Rotary Position Sensor and outputs to the M-2001C through a bottom port.

Single-Phase Regulators: In most applications, tap position information can be maintained by means of Motor Direct Drive KeepTrack™ logic.

Operations Counter: A software counter increments by one count per either an open/close/open contact operation (X1) or an open/close or close/open contact operation (X2), and is preset by the user. A count window mode registers any activity as a valid input within the count window time setting.

Resettable Operations Counter: A second software counter, similar to the operations counter, which may be reset by the user.

Harmonic Analysis: Provides the total harmonic distortion and the harmonic content of the load voltage and current up to the 31st harmonic (using TapTalk with BECO 2200 protocol).

Tap Position Record: Provides a record of the number of times each tap position has been passed through (using TapTalk with BECO 2200 protocol). The tap position record can be reset by the user.

AUTO/MANUAL Switch Status: Provides the user with the Auto/Manual switch position status through the Comm ports. When the M-2001C is configured for a switch status input, the switch status is read using the seal-in input on the control. When configured for Seal-in INPUT, the switch status is read using the counter INPUT.

M-2001C Digital Tapchanger Control

A or B Regulator Type: Allows the user to select the type of regulator being used to provide a more accurate source voltage calculation.

SCADA HeartBeat: The purpose of the SCADA HeartBeat feature is to have two sets of settings for the control and switch between these two setting sets based on the presence or absence of SCADA communications (utilizing the DNP protocol) to the control. The SCADA HeartBeat feature can be enabled from TapTalk Communications software. There are two different types of SCADA HeartBeat modes that can be selected:

- SCADA HeartBeat for transformer control applications (LTC)
- SCADA HeartBeat for regulator control applications (Regulator)

Manual HeartBeat Timer: The Manual HeartBeat Timer feature provides a method to place the control in HeartBeat Manual operation (implemented from Comms only) and automatically place the control back in Auto mode based on a Timer setting (settable only via Comms).

Inputs

Control Voltage Input: Nominal 120 V ac, 60 Hz (50 Hz optional); operates properly from 90 V ac to 140 V ac. If set at 60 Hz, the operating system frequency is from 55 to 65 Hz; if set at 50 Hz, the operating system frequency is from 45 to 55 Hz. The burden imposed on the input is 8 VA or less. The unit should be powered from a voltage transformer connected at the controlled voltage bus. The unit will withstand twice the voltage input for one second and four times the voltage input for one cycle.

Motor Power Input: Nominal 120 V ac to 240 V ac, at up to 6 A as required by the load, with no wiring changes required.

Line Current Input: Line drop compensation is provided by a current transformer input with a 0.2 A full scale rating. A Beckwith Electric model M-0121 (5 A to 0.2 A) or M-0169A (5 A or 8.66 A to 0.2 A) Auxiliary Current Transformer is available when required. The burden imposed on the current source is 0.03 VA or less at 200 mA. The input will withstand 300 mA continuously, 400 mA for two hours, and 4 A for 1 second.

Circulating Current Input: Parallel operation of regulators or transformers is accommodated by a current transformer input with a 0.2 A full scale rating. The burden imposed on the current source is 0.03 VA or less at 200 mA. The input will withstand 300 mA continuously, 400 mA for two hours, and 4 A for 1 second.

Control Power Backup Input (Two pin Molex connector on the top of control): The Control Power Backup Input feature when connected to either a M-2026 or M-2027 backup power supply sustains operation of the control in the event of a loss of AC input power to the control. Raise and Lower commands are possible if the control's motor power remains energized. See M-2026/M2027 Companion Control Power Backup Supplies (page 18).

Binary Inputs

Voltage Reduction 1 & 2 Inputs: These inputs provide three levels of programmable voltage reduction which can be manually invoked.

Neutral Position Detect: The Neutral Position Detect Input detects the neutral tap position, which assists the KeepTrack™ tap position function. This Neutral Position Detect Input also facilitates disabling the paralleling mode Δ VAR®2.

Counter Input/Switch Status Input: When Input Selection 1 configuration is set to Switch Status, the Counter Input detects tap position changes and updates two counters, one pre-settable and one re-settable. When Input Selection 1 configuration is set to Seal-In, the counter input is used as the Switch Status Input and the Seal-In input will cause the counter to increment.

Seal-in/Switch Status Input: When the Input Selection 1 configuration is set to "seal-in input", this input provides for detection of the seal-in state to operate the seal-in output and will also increment the counters. When "Input Selection 1" is set to Switch Status Input, this input provides the means to read the Auto/Manual switch position status using SCADA.

Non-Sequential/SCADA Cutout Input: When the Input Selection 2 configuration is set to "Nonseq Input", this input provides the means to perform non-sequential operations. When Input Selection 2 is set to "SCADA Cutout Input", this input provides a means to block all write operations to the control from SCADA.

Outputs

Raise Output: Capable of switching 6 A at 120 V ac to 240 V ac motor power.

Lower Output: Capable of switching 6 A at 120 V ac to 240 V ac motor power.

Seal-In Output: Connects to the B-0553 motor seal-in printed circuit board subassembly.

Deadman Alarm Output: Capable of switching 6 A at 120 V ac or 100 mA at 120 V dc.

Programmable Alarm Output: Capable of switching 3 A at 120 V ac or 100 mA at 120 V dc.

Front Panel Controls

Menu-driven access to all functions by way of four pushbuttons and a two-line alphanumeric display. There are two programmable passwords available to provide various levels of access to the control functions.

The M-2001C offers a 2-line by 20 character LCD display for enhanced viewing in direct sunlight. It also offers a low-level LED backlight for reading in darker environments. An optional 2-line by 20 character Vacuum Fluorescent Display (VFD) is available for industrial temperature range operations (-40°C to $+80^{\circ}\text{C}$).

LED Indicators

Front panel LED indicators show the following control conditions: Out-of-Band **RAISE**, Out-of-Band **LOWER**, Reverse Power Flow **REV PWR** detected, CPU **OK**, Line Drop Compensation **LDC IN EFFECT**, Voltage Reduction **V/RED IN EFFECT**, Communications or Front Panel Auto Operation Block **MANUAL**, **SCADA** control blocked **LOCAL** and **COM1 TX and RX**.

Output Contacts

Alarm Contact Outputs (2): One normally open programmable contact capable of switching 3 A at 120 V ac and one normally closed self-test alarm contact; capable of switching 6 A at 120 V ac.

Voltage Measurement Accuracy

Control accuracy is $\pm 0.3\%$ when tested in accordance with the ANSI/IEEE C57.15.9-1999 standard over a temperature range of -30°C to $+65^{\circ}\text{C}$. The control accuracy is $\pm 0.5\%$ when tested over the full operational temperature range of -40°C to $+85^{\circ}\text{C}$.

Communications

The communication ports provide access to all features, including metering, software updates, and programming of all functions. This is accomplished using a modem or direct serial connection from any Windows™ based computer running the M-2029A TapTalk® Communications Software package or SCADA communications software. COM1 (top) is available with RS-232, RS-485 or Fiber Optics. COM3 is an optional RJ45 Ethernet Port. COM2 is an RS-232 front port for local communications with TapTalk BECO 2200 and for software updates.

Protocols: The following standard protocols are included in COM1/COM3: BECO 2200, BECO 2179, Cooper 2179, Cooper 2179A, GP 2179, GP DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0, DNP3.0, MODBUS, and IEC 61850/UCA 2.0 (when used with the optional ethernet port). COM2 uses BECO 2200 for local communications.

Communications Via Direct Connection: TapTalk supports direct communication with a Beckwith Electric M-2001C Digital Tapchanger Control using a serial "null modem" cable with a 9-pin connector (DE9P) for the control, and the applicable connector (usually DE9S or DB25S) for the PC, or Fiber Optic communication using ST standard or two-wire RS-485.

Optional: An optional ethernet 10 Mbps port (COM 3) is available (Comprehensive Version only) through an RJ-45 jack on the top of the control. This port supports DNP over TCP/IP, BECO 2200 over TCP/IP, MODBUS over TCP/IP protocols and IEC 61850/UCA 2.0.

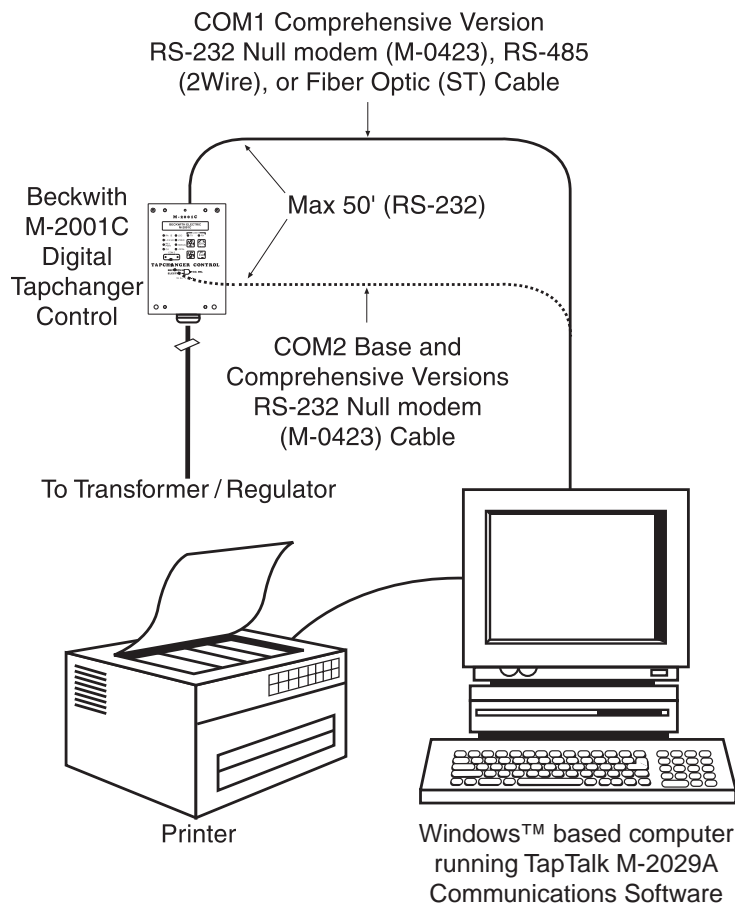


Figure 1 Direct Connection

Communications Via Modem: TapTalk® supports remote (modem) communications with a Beckwith Electric M-2001C Digital Tapchanger Control (COM1 or COM2, COM1 shown). A Hayes-compatible modem and proper cabling is required.

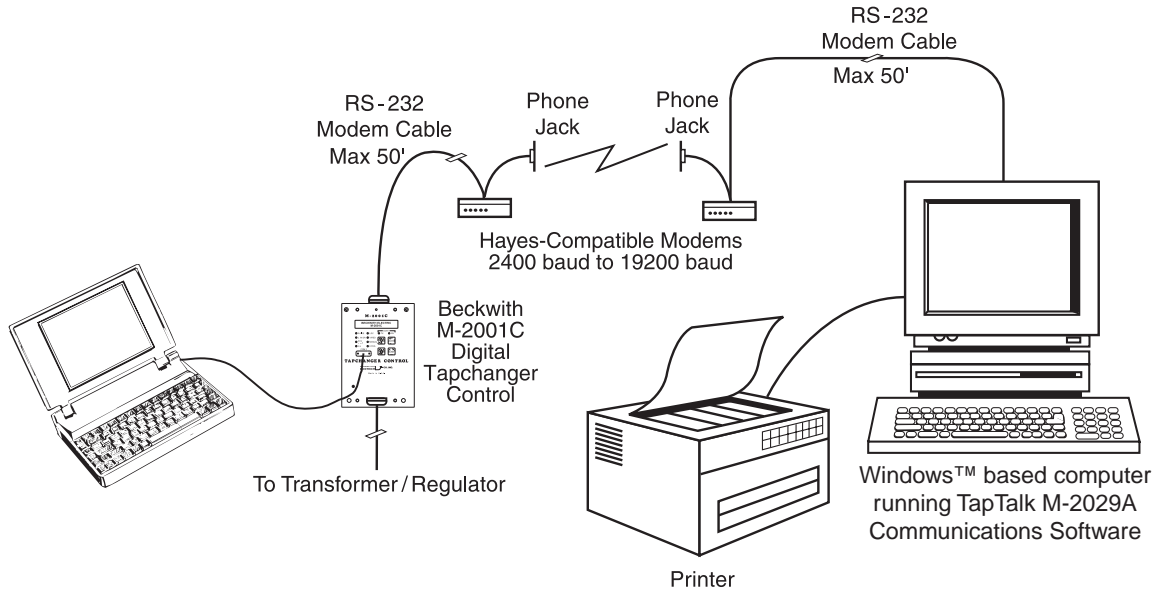


Figure 2 Modem Connection

Communications Using Networking: The addressing capability of TapTalk allows networking of multiple Beckwith Electric digital tapchanger controls (COM1 or COM2, COM1 shown). Each tapchanger control can be assigned an address ranging from 1 to 200. Selected commands may be broadcast to all controls on the network. Figures 3, 4, and 5 illustrate typical network configurations.

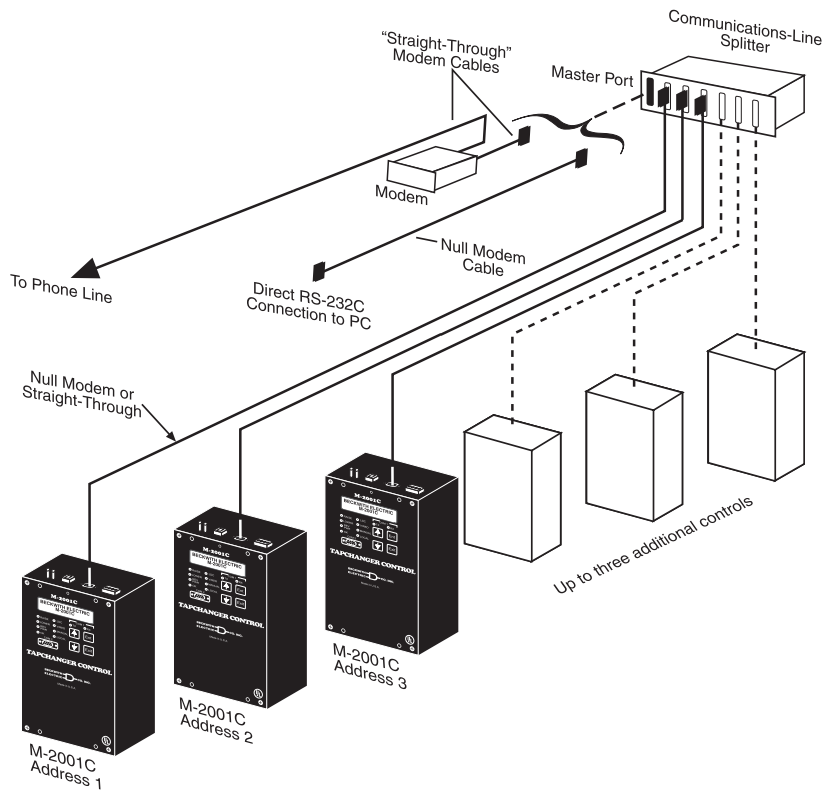


Figure 3 Network Connection

M-2001C Digital Tapchanger Control

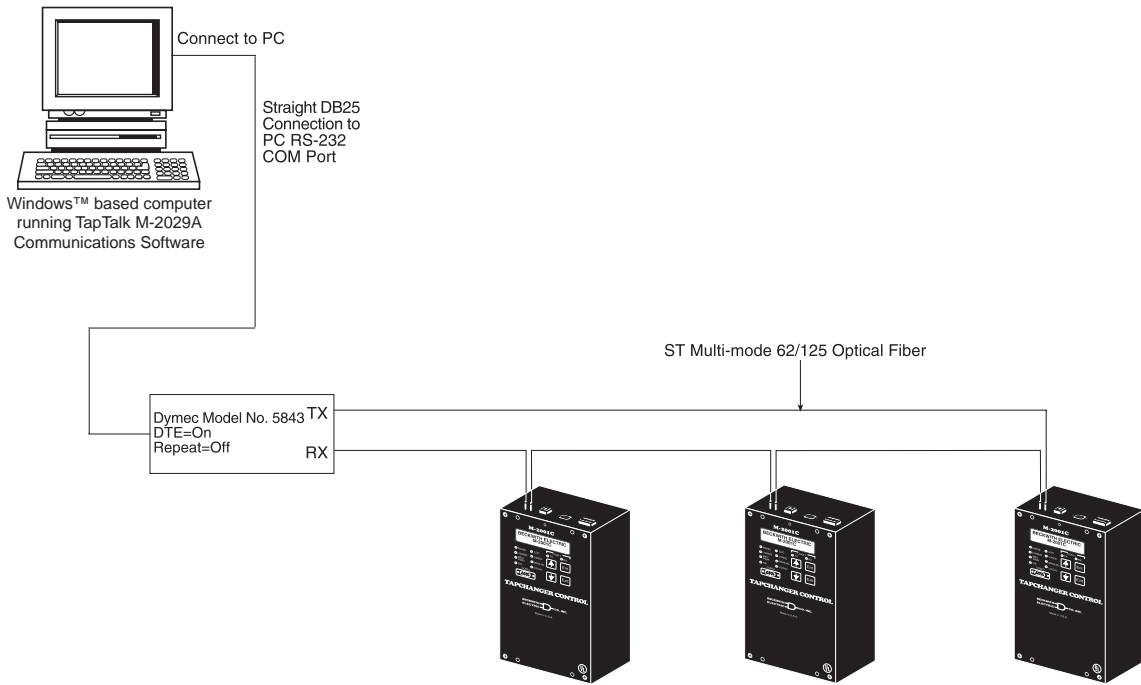


Figure 4 Fiber Optic Connection Loop

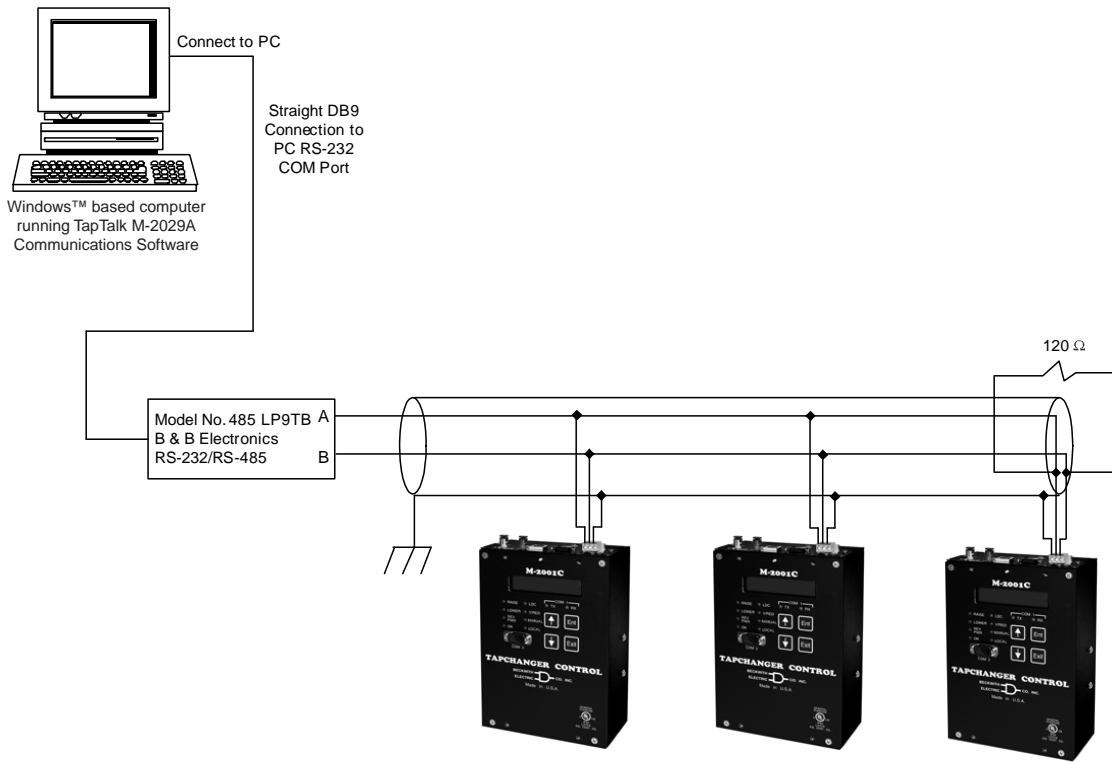


Figure 5 RS-485 Network Connection

Application: Using a PC, the operator has real-time, remote access to all functions of the M-2001C Digital Tapchanger Control. The control can act as the monitoring point for all voltage, current, and related power quantities, thereby simplifying operation while avoiding transducers and multiple Remote Terminal Unit (RTU) analog inputs. The protocols implement half-duplex, two-way communications. This allows all functions, which would otherwise require the presence of an operator at the control, to be performed remotely. Communication capabilities include:

- Interrogation and modification of setpoints
- Broadcast of commands, such as tap change inhibit and voltage reduction (up to three steps) to networked controls
- Recognition of alarm conditions, such as voltage extremes and excessive load
- Selective control of raise and lower tap change operations
- Re-configuration of the control, such as a change to the demand integration time period or a selection of different alarm parameters

Unit Identifier: A 2-row by 15-character alphanumeric sequence, set by the user, can be used for unit identification.

Tests and Standards

M-2001C Digital Tapchanger Control complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

IEC 60255-5 1,500 V ac for 1 minute applied to each independent circuit to earth
1,500 V ac for 1 minute applied between each independent circuit

Impulse Voltage

IEC 60255-5 5,000 V pk, +/- polarity applied to each independent circuit to earth
5,000 V pk, +/- polarity applied between each independent circuit
1.2 by 50 μ s, 500 ohms impedance, three surges at 1 every 5 seconds

IEC 60255-5 > 100 Megaohms

Electrical Environment

Electrostatic Discharge Test

IEC 60255-22-2 Class 4 (8 kV) – point contact discharge

IEC 60255-22-2 Class 4 (15 kV) – air discharge

Fast Transient Disturbance Test

IEC 60255-22-4 Class A (4 kV, 2.5 kHz)

Surge Withstand Capability

ANSI/IEEE 2,500 V pk-pk oscillatory applied to each independent circuit to earth
C37.90.1- 2,500 V pk-pk oscillatory applied between each independent circuit
1989 5,000 V pk Fast Transient applied to each independent circuit to earth
5,000 V pk Fast Transient applied between each independent circuit

ANSI/IEEE 2,500 V pk-pk oscillatory applied to each independent circuit to earth
C37.90.1- 2,500 V pk-pk oscillatory applied between each independent circuit
2002 4,000 V pk Fast Transient burst applied to each independent circuit to earth
4,000 V pk Fast Transient burst applied between each independent circuit

■ **NOTE:** The signal is applied to the digital data circuits (RS-232, RS-485, Ethernet communication port coupling port) through capacitive coupling clamp.

Surge Immunity

IEC 60255-22-5 2,000 V pk, \pm polarity applied, 1.2 μ s by 50 μ s, five surges, 1 every 5 seconds

Radiated Electromagnetic Withstand Capability

All units protected against electromagnetic radiated interference from portable communications transceivers

Atmospheric Environment

Temperature: Control operates from -40° C to $+85^{\circ}$ C with either the LCD or Vacuum Fluorescent Display

■ **NOTE:** The LCD display's functional temperature range is -20° C to $+70^{\circ}$ C. The optional vacuum fluorescent display's functional temperature range is -40° C to $+80^{\circ}$ C.

IEC 60068-2-1 Cold, -40° C

IEC 60068-2-2 Dry Heat, $+80^{\circ}$ C

IEC 60068-2-78 Damp Heat, $+40^{\circ}$ C @ 93% RH

IEC 60068-2-30 Damp Heat Condensation Cycle, 25° C, $+40^{\circ}$ C @ 95% RH

Mechanical Environment

Vibration

IEC 60255-21-1 Vibration response Class 1, 0.5 g
Vibration endurance Class 1, 1.0 g

Compliance

cULus-Listed per 508 – Industrial Control Equipment
– Industrial Control Equipment Certified for Canada CAN/CSA C22.2 No. 14-M91
cULus-Listed Component per 508A Table SA1.1 Industrial Control Panels

Recommended Storage Parameters

Temperature: 5° C to 40° C

Humidity: Maximum relative humidity 80% for temperatures up to 31° C, decreasing to 31° C linearly to 50% relative humidity at 40° C.

Environment: Storage area to be free of dust, corrosive gases, flammable materials, dew, percolating water, rain and solar radiation.

Periodic Surveillance During Storage: The M-2001C contains electrolytic capacitors. It is recommended that power be applied to the control every three to five years for a period not less than one hour to help prevent the electrolytic capacitors from drying out.

Physical

(M-2001C Comprehensive, BASE-T, BASE-RS, BASE-R)

Size: 5 13/16" wide x 8 1/2" high x 3" deep (10.81 cm x 21.6 cm x 7.62 cm)

Mounting: Unit mounts directly to adapter or conversion front panels sized to replace popular industry tapchanger controls.

Approximate Weight: 3 lbs, 11 oz (1.67 kg)

Approximate Shipping Weight: 6 lbs, 11 oz (3.03 kg)

Patent & Warranty

The M-2001C Tapchanger Control is covered by U.S. Patents 5,315,527 and 5,581,173.

The M-2001C Tapchanger Control, M-2026 AC-DC Control Power Backup Supply and M-2027 Control Power Backup Supply-AC Only, M-2948 Tap Position Sensor, and M-2025B(D) Current Loop Interface Modules are covered by a five-year warranty from date of shipment.

Specification subject to change without notice.

M-2025B (D) Current Loop Interface Modules and M-2948 Tap Position Sensor

The M-2025B(D) Current Loop Interface Modules are a current-to-voltage analog converters that can accept inputs from M-2948 Beckwith Electric Tap Position Sensors (Table 1) or Incon 1250B Rotary Position Sensor.

Sensor	Rotation Range	Degrees/Tap	Taps	Neutrals	Rotation/Slope
M-2948-91N	0 – 297°	9°	±16	1	Negative
M-2948-91P	0 – 297°	9°	±16	1	Positive
M-2948-92N	0 – 306°	9°	±16	2	Negative
M-2948-92P	0 – 306°	9°	±16	2	Positive
M-2948-93N	0 – 315°	9°	±16	3	Negative
M-2948-93P	0 – 315°	9°	±16	3	Positive
M-2948-11N	0 – 330°	10°	±16	1	Negative
M-2948-11P	0 – 330°	10°	±16	1	Positive
M-2948-12N	0 – 340°	10°	±16	2	Negative
M-2948-12P	0 – 340°	10°	±16	2	Positive
M-2948-13N	0 – 350°	10°	±16	3	Negative
M-2948-13P	0 – 350°	10°	±16	3	Positive

■ **NOTE:** Tap Position Sensors are available with either a positive "P" or negative "N" slope. Negative slope (clockwise rotation) causes a decrease in Tap Position. Positive slope (clockwise rotation) causes an increase in Tap Position.

Table 1 M-2948 Model Application Information

The tap position sensors are rotary shaft encoders with built-in microprocessors that provide stepped output signals in 9 or 10 degree increments. They have rotations of 297, 306, 315, 330, 340 and 350 degrees respectively for 32 taps and up to three neutral positions. The electrical output of these sensors is a 4-20 mA current loop that converts easily to a voltage signal at the input of the M-2025B(D) with the addition of a proper value shunt resistor. For a 4-20 MA Current Loop, 150 ohms is required on the input of the M-2025B(D).

Configurations

Most LTC tapchangers have an output shaft on the tapchanger mechanism whose angular position is a mechanical analog of the tapchanger tap position. In many cases, the total range of tap positions is represented by less than one complete rotation of this position output shaft. The typical values of shaft movement on 32 tap mechanisms are 9° or 10° of mechanical rotation per tap position.

Other angular rotation values are likely to be encountered. Contact Beckwith Electric for information on sensor availability for specific requirements.

Application Notes

- The M-2948 Tap Position Sensor directly mounts in place of the Incon Tap Sensor Model 1292.
- The M-2948 Tap Position Sensor directly mechanically replaces the Selsyn-Type Position Sensor.
- The M-2948-91N Tap Position Sensor is for use with a Qualitrol Position Indicator, Model 081-002-01 or equivalent.

Incon Tap Position Monitor connected to an Incon 1250 Series Rotary Position Sensor

Both types of devices provide a 4-20 mA dc current loop output. The current loop develops a voltage across a properly sized resistor on the input to the M-2025B(D). The resultant voltage signal is conditioned in the M-2025B(D) and routed to the M-2001 series Tapchanger Control where the voltage is converted to a corresponding tap position number.

The tap position sensors are rotary shaft encoders with built-in microprocessors that provide stepped output signals in 9 or 10 degree increments. They have rotations of 288 and 320 degrees respectively for 32 taps and one neutral position. The electrical output of these sensors is a 4-20 mA current loop that converts easily to a voltage signal at the input of the M-2025B(D) with the addition of a proper value shunt resistor. For a 4-20 MA Current Loop, 150 ohms is required on the input of the M-2025B(D).

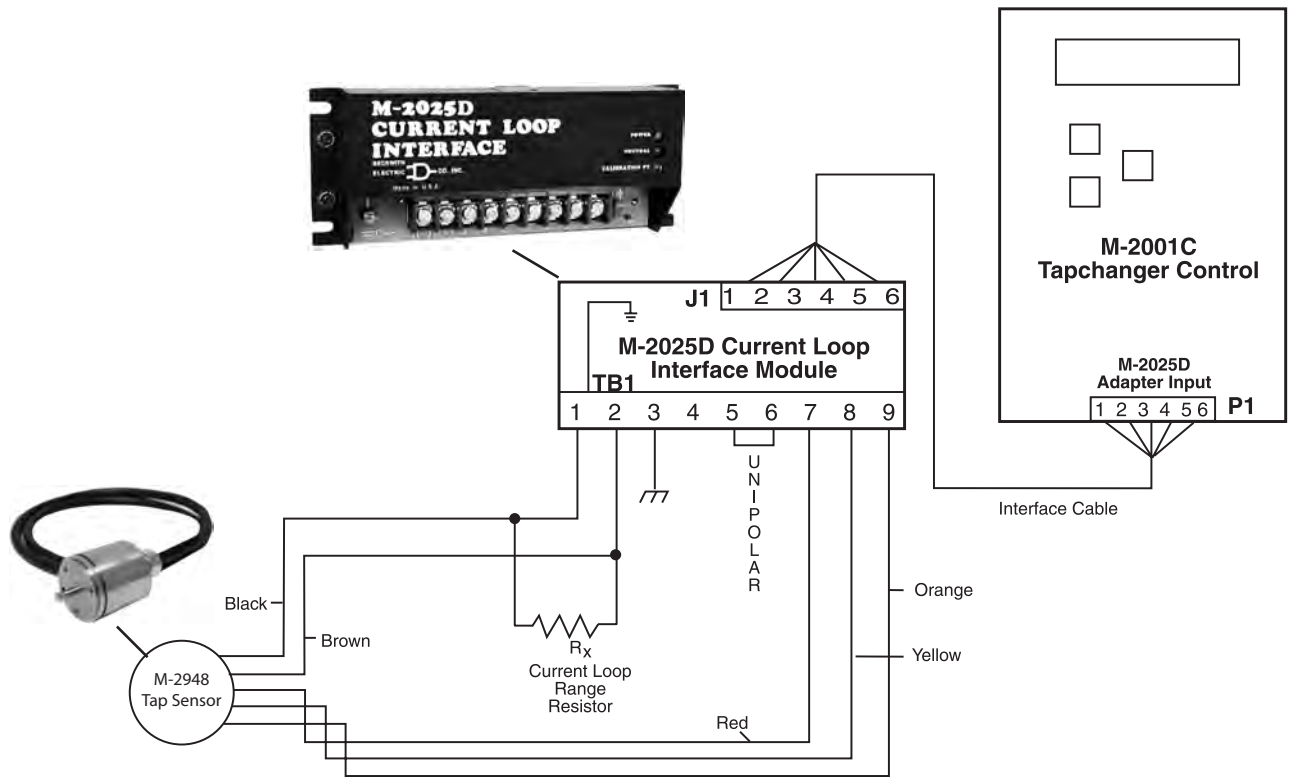


Figure 6 Typical M-2025B(D) External Tap Position Interface with M-2948 Tap Position Sensor

M-2001C Digital Tapchanger Control

M-2026/M-2027 Control Power Backup Supplies

If the optional Control Power Backup Input is purchased, the following accessories are available:

M-2026 AC-DC Control Power Backup Supply

The M-2026 Control Power Backup Supply will accept either an AC or DC input over the following ranges:

- 21 to 32 V
- 42 to 60 V
- 105 to 145 V

The M-2026 will output a regulated +12 V dc (± 0.5 V) output voltage. The unit incorporates a fused input, surge protection, and reverse polarity protection. The M-2026 is capable of up to a 1.5 Ampere output.

M-2027 Control Power Backup Supply-AC Only

The M-2027 will accept an AC (105 to 140 VAC, 50/60 Hz) input and output +12 V dc (Nominal). The M-2027 is capable of loads up to 1.0 Ampere. The unit incorporates a fused input and surge protection.

The M-2026 and M-2027 units are housed in a non-weathertight enclosure and equipped with screw terminal blocks for input and output connections.

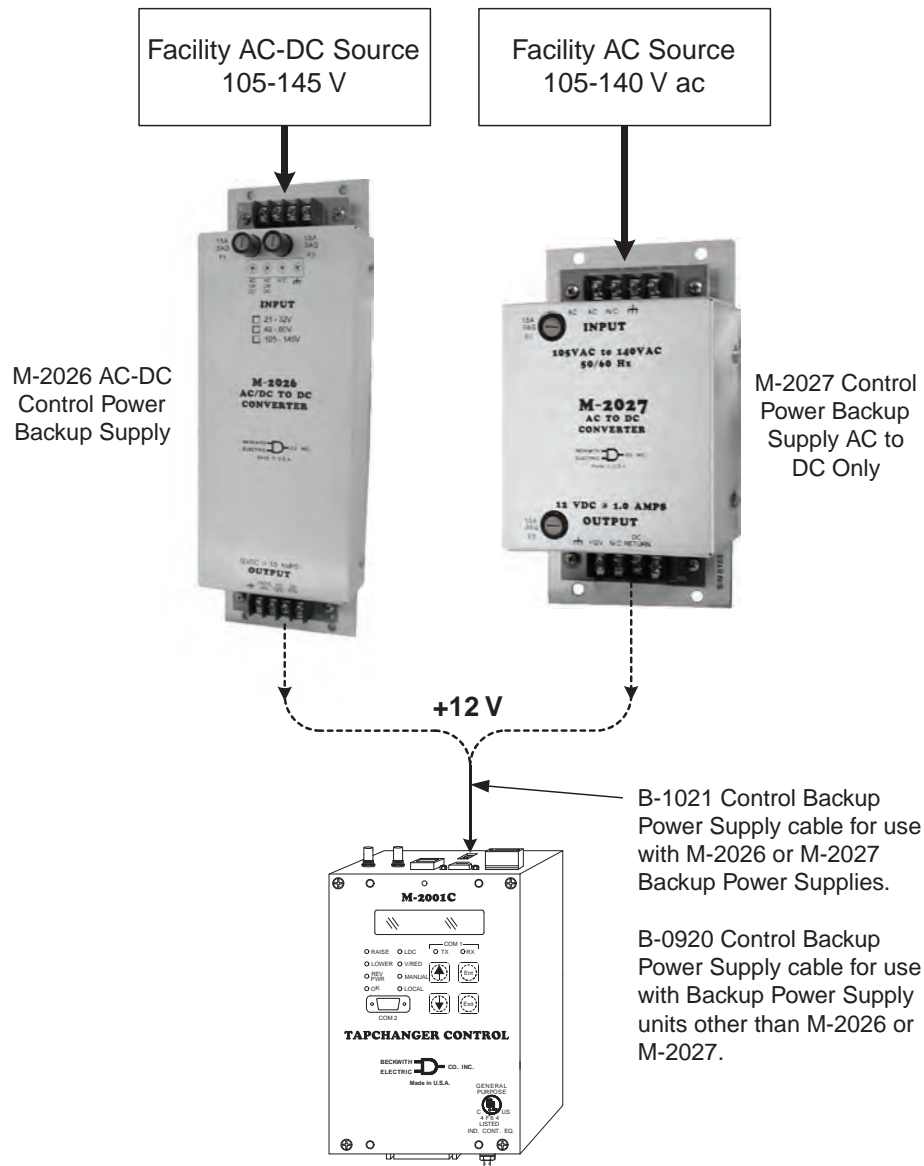


Figure 7 Typical M-2026/M-2027 Control Power Backup Supply Application

M-2001C Style Selection Chart

M-2001C 6 N L A A

<p>Frequency</p> <p>6 = 60 Hz operation 5 = 50 Hz operation</p> <p>Control Type</p> <p>N = Base R R = Base RS w/RS-485 F = Base RS w/Fiber T = Base T S = Comprehensive E = Comp. w/Ethernet U = Ethernet w/IEC 61850</p> <p>Display Type</p> <p>L = LCD V = Vacuum Fluorescent</p> <p>Additional Options</p> <p>A = No additional Option B = ΔVAR® Paralleling C = Backup DC power input D = Both B & C F = French G = French & ΔVar</p> <p>Customer MODs</p> <p>A = No MOD B = MOD 266 C = MOD 330 D = MOD 362 E = MOD 465 F = MOD 467 G = MOD 467R H = MOD 608 I = MOD 609 K = MOD 615 L = MOD 608 & 615</p>	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 20px;"> <p>6</p> <hr style="width: 100%;"/> </div> <div style="margin-bottom: 20px;"> <p>N</p> <hr style="width: 100%;"/> </div> <div style="margin-bottom: 20px;"> <p>L</p> <hr style="width: 100%;"/> </div> <div style="margin-bottom: 20px;"> <p>A</p> <hr style="width: 100%;"/> </div> <div> <p>A</p> <hr style="width: 100%;"/> </div> </div>
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Option Availability:	VFD	ΔVAR	Ethernet	DC pwr
M-2001C - Comp	Yes	Yes	Yes	Yes
M-2001C - Base-T	Yes	Yes	N/A	Yes
M-2001C - Base-R	Yes	N/A	N/A	Yes
M-2001C - Base-RS	Yes	N/A	N/A	Yes

Example Style Numbers:

M-2001C-6SV Comprehensive LTC Control (60Hz) with Vacuum Fluorescent Display (VFD). Inputs/Outputs: Non-sequential, Paralleling, Alarms, Tap Info (INCON), Voltage Reduction, LDC. Communication: RS232, RS485 & Fiber optic ports, 10 protocols including DNP3.0 & MODBUS.

M-2001C-5TLBA Base-T LTC Control (50Hz) With LCD. Inputs/Outputs: Non-sequential, Paralleling, Alarms, Tap Info (INCON), Voltage Reduction, LDC. Communication: RS232, BECO-2200 protocol only. Options: ΔVAR paralleling.

M-2001C-6NL Base-R Regulator Control (60Hz) With LCD. Inputs: Voltage Reduction, LDC. Communication: RS232, BECO-2200 protocol only.



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ISO 9001:2008

WARNING

DANGEROUS VOLTAGES, capable of causing death or serious injury, are present on the external terminals and inside the equipment. Use extreme caution and follow all safety rules when handling, testing or adjusting the equipment. However, these internal voltage levels are no greater than the voltages applied to the external terminals.

DANGER! HIGH VOLTAGE



- This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

PERSONNEL SAFETY PRECAUTIONS

The following general rules and other specific warnings throughout the manual must be followed during application, test or repair of this equipment. Failure to do so will violate standards for safety in the design, manufacture, and intended use of the product. Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric Co., Inc. assumes no liability for the customer's failure to comply with these requirements.



- This sign means that you should refer to the corresponding section of the operation manual for important information before proceeding.



Always Ground the Equipment

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test area, the Protective Earth Terminal must be attached to a separate ground securely by use of a tool, since it is not grounded by external connectors.

Do NOT operate in an explosive environment

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible fire or explosion.

Keep away from live circuits

Operating personnel must not remove the cover or expose the printed circuit board while power is applied. In no case may components be replaced with power applied. In some instances, dangerous voltages may exist even when power is disconnected. To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

Exercise care during installation, operation, & maintenance procedures

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified personnel should install, operate, test, and maintain this equipment. Be sure that all personnel safety procedures are carefully followed. Exercise due care when operating or servicing alone.

Do not modify equipment

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair facility is preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure that safety features are maintained.

PRODUCT CAUTIONS

Before attempting any test, calibration, or maintenance procedure, personnel must be completely familiar with the particular circuitry of this unit, and have an adequate understanding of field effect devices. If a component is found to be defective, always follow replacement procedures carefully to that assure safety features are maintained. Always replace components with those of equal or better quality as shown in the Parts List of the Instruction Book.

Avoid static charge

This unit contains MOS circuitry, which can be damaged by improper test or rework procedures. Care should be taken to avoid static charge on work surfaces and service personnel.

Use caution when measuring resistances

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instruction Book, is likely to cause damage to the unit.

M-2001C “SimpleStart” Initial Setup Instructions

Communicating with the M-2001C

Determine the method of communicating with the M-2001C:

Utilizing the front panel four pushbutton Human Machine Interface (HMI).

By connecting to the front panel RS-232 communications port with a laptop PC utilizing TapTalk for Windows Communications Software.

By connecting to the SCADA communications ports on the top of the unit.

Apply Power to the M-2001C

If the control is attached to an adapter panel, control power can be applied to the front “**External Power**” input or to the proper panel control input pins.

If the control is not attached to an adapter panel, or the “blue plug” is removed, the control may be energized utilizing a “**Blue Plug**” adapter cord (part number B-0849 available from Beckwith Electric) and a 120 V ac wall outlet.

M-2001C Setup Procedure using the Front Panel HMI

1. Press the **↑**, **↓** or **Ent** pushbutton, the screen will display **LOCAL VOLTAGE**.
2. Confirm input voltage.
3. Press and hold the **↑** pushbutton until **TIME OF DAY** is displayed, then press **Ent**, a flashing “**C**” will be displayed indicating that changes may be made.
4. Set the first digit of the time (indicated by an underline of the digit) with the **↑** or **↓** pushbutton, then press **Ent** to shift to the next digit. Repeat for each time digit.
5. When all time digits have been set, then press **↓** once, **DATE** will be displayed.
6. Press **Ent** to set the first digit of the date (indicated by an underline of the digit) with the **↑** or **↓** pushbutton, then press **Ent** to shift to the next digit. Repeat for each date digit.
7. When all date digits have been set, then press **↓** once, **VAR HRS R 1PH E** will be displayed.
8. Each demand quantity will display an “**E**” on the right side of the screen. Press **Ent** to reset the demand value to zero.
9. Press **↓** to display the next demand quantity, then press **Ent**.
10. Repeat Step 9 for each demand quantity, the last demand quantity is **OPER CNTR RSET**.
11. Press **Exit**, the screen will extinguish.
12. Review the default configuration settings in the M-2001C Instruction Book, Appendix A or B, and determine if any of the settings need to be changed for this application.
13. If no configuration settings need to be changed, then go to Step 15.

M-2001C “SimpleStart” Initial Setup Instructions Cont’d

14. If configuration settings need to be changed, then proceed as follows:

- a) Press the **↑**, **↓** or **Ent** pushbutton, the screen will display **LOCAL VOLTAGE**.
- b) Confirm input voltage.
- c) Press **↓** once, **TO CONFIGURE COMMUNICATION** will be displayed.
- d) Press **Ent**, **LEVEL 2 PASSWORD** will be displayed.

■ **NOTE:** The default Level 2 Password is 2222 on new controls.

- e) Set the first digit of the Level 2 Password (indicated by an underline of the first digit) with the **↑** or **↓** pushbutton, then press **Ent** to shift to the next digit. Repeat for each digit.

When the last digit has been entered, the control will briefly display **LEVEL 2 ACCESS GRANTED!**. The control will then display **COMM PASSWORD**.

- f) Press the **↑** or **↓** pushbutton as necessary to advance to the desired configuration parameter.
- g) Press **Ent**, a flashing “**C**” will be displayed indicating that changes may be made.
- h) Press the **↑** or **↓** as necessary to toggle between the available settings, then press **Ent** to save the setting.
- i) When the required changes have been completed, press **EXIT**, the screen will extinguish.

15. Review the default setpoints in the M-2001C Instruction Book, Appendix A or B, and determine if any of the settings need to be changed for this application.

16. If no setpoints need to be changed, then go to the Data Logging section.

17. Press the **↑**, **↓** or **Ent** pushbutton, the screen will display **LOCAL VOLTAGE**.

18. Confirm input voltage.

19. Press **↓** twice, **BANDCENTER F** will be displayed. This screen marks the beginning of the setpoints.

20. Press the **↑** or **↓** pushbutton as necessary to advance to the desired setpoint, then press **Ent**.

- a) If a flashing “**C**” is displayed on the right side of the screen, then go to Step 21.

■ **NOTE:** The default Level 1 Password is 0000 (password disabled) on new controls.

- b) If **LEVEL 1 PASSWORD** is displayed (indicating a user defined password has been entered), then set the first digit of the Level 1 Password (indicated by an underline of the digit) with the **↑** or **↓** pushbutton, then press **Ent** to shift to the next digit. Repeat for each digit.

When the last digit has been entered and the proper password has been entered, then a flashing “**C**” will be displayed indicating that changes may be made. Go to Step 21.

21. Press the **↑** or **↓** as necessary to toggle between the available settings, then press **Ent** to save the setting.

22. For additional setpoint changes press the **↑** or **↓** pushbutton as necessary to advance to the desired setpoint, then repeat Step 21 for each setpoint to be changed.

23. When the required setpoint changes have been completed press **EXIT**, the screen will extinguish.

M-2001C “SimpleStart” Initial Setup Instructions Cont’d

TapTalk Communications Software for Windows

PC hardware requirements, communications utilizing a modem, communicating with multiple units and an overview of TapTalk software operation can be found in the M-2001C Instruction Book, Chapter 9.

TapTalk Communications Software is provided on a CD-ROM with each unit. It is also available at <http://www.beckwithelectric.com/tapchangers/m2029/m2029a.htm> .

Install M-2029A TapTalk Communications Software (PC)

1. Insert the TapTalk software into your CD-ROM drive or download the M-2029A software.
2. Select **Run** from the **Start Menu**.
3. From the **Run** dialog box, initiate software installation by typing **D:\Setup.exe** (or other drive designator:\Setup.exe, depending on the letter designation for the CD-ROM drive or location of the downloaded file).

The Installation Wizard will prompt the user through the installation process. After installation, the TapTalk program icon (located in the Becoware folder) can be placed on the desktop.

M-2001C Setup Procedure using TapTalk

1. Connect a Null Modem Cable from the active PC COM Port to COMM 2 on the front of control.
2. Select the TapTalk program-item icon from the Becoware group in the Program Manager, or select TapTalk from the program list using the Start Menu.

The TapTalk toolbar is displayed along with the Access dialog screen.

3. The Access dialog screen contains the following new control default values:

Password – no changes needed

Comm Address – 1

Control Comm Protocol – BECO2200

PC Communication Device – Serial Comm Port

PC COM Port – COM1

PC Baud Rate – 9600

4. On the Access dialog screen verify the following:

PC COM Port is set to the active PC COM Port that the Null Modem Cable is connected to.

Active PC COM Port baud rate is set to 9600.

■ **NOTE:** The local display screen must be extinguished (press **EXIT**) in order to access the control through the communication ports.

5. From the Access dialog screen select **OPEN** to open communications. If the correct COM Port parameters have been entered TapTalk will respond with:

“Communication has been opened successfully”.

6. From the Access screen, select **OK** to close the Access screen.

7. From the drop down menu, select **Utilities/Set Control Date/Time**. The Set Control Date/Time dialog screen will be displayed.

M-2001C “SimpleStart” Initial Setup Instructions Cont’d

8. The Set Control Date/Time dialog screen **Set Control Time** section, default setting for Current Address or Broadcast is set to Current Address. If multiple controls are being set, then select Broadcast.
9. If the control is to be set to PC Time, then select **Set Control Time to PC Time**. TapTalk will respond with a confirmation screen that states:

“Control’s time has been successfully set to PC’s time.
Do you want to reset the following points:
Demand Metering, Energy Metering, Drag Hands and Resettable Op Count?
Click Yes to reset the values,
Click No to continue without resetting.”

Select **Yes**, Tap Talk will respond with the confirmation screen that states:

“Demand Metering, Energy Metering, Drag Hands and Resettable Op Count have been reset.”
10. If the control is to be set to a time that is manually input, then input the desired time and select **Set**. TapTalk will respond with a confirmation screen that states:

“Control’s time has been successfully set to PC’s time.
Do you want to reset the following points:
Demand Metering, Energy Metering, Drag Hands and Resettable Op Count?
Click Yes to reset the values,
Click No to continue without resetting.”

Select **Yes**, TapTalk will respond with the confirmation screen:

“Demand Metering, Energy Metering, Drag Hands and Resettable Op Count have been reset.”
11. From the Set Control Date/Time screen select **Exit**.
12. From the drop down menu, select **Control Setup/Configuration**. The Configuration dialog screen will be displayed.
13. Review the default configuration settings and determine if any of the settings need to be changed for this application.
14. If no configuration settings need to be changed, then go to Step 16.
15. If configuration settings need to be changed, then proceed as follows:
 - a) From the Configuration Dialog screen, select and edit the desired configuration setting(s).
 - b) Select **Write To Control**, TapTalk will respond with a confirmation screen that states:

“Configuration settings have been successfully written to the control.”
 - c) Select **Exit**.
16. From the drop down menu, select **Control Setup/Setpoints**. The Setpoints dialog screen will be displayed.
17. Review the default setpoints and determine if any of the setpoints need to be changed for this application.
18. If no setpoints need to be changed, then go to the Data Logging section.
19. If setpoints need to be changed, then proceed as follows:
 - a) From the Setpoint Dialog screen, select and edit the desired setpoint(s).

M-2001C “SimpleStart” Initial Setup Instructions Cont’d

- b) Select **Write To Control**, TapTalk will respond with a confirmation screen that states: “Setpoints have been successfully written to the control.”
- c) Select **Exit**.

Data Logging

The control data logger has been preset to automatically begin collecting partial data when power is applied to the control. If changes to the values to be logged or the logging interval are desired, then proceed as follows:

1. From the TapTalk drop down menu, select **Utilities/Data Logging/Control Setup and Download**. The Data Logging Control Setup and Download dialog screen will be displayed.
2. When all Data Logging and Download parameters have been set, then perform the following:
 - a) Select **Erase Existing Data and Start Logging data to Control**.
 - b) Select **Yes** to confirm.
 - c) Select **OK** to close the Data Logging Control Setup and Download dialog screen.

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1 Introduction

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1.0 Description

The M-2001C (Comprehensive) Digital Tapchanger Control is a microcontroller-based transformer and step-voltage regulator load tapchanger control.

The control is normally supplied with a separate adapter panel that is designed for initial OEM installation on new transformers or to replace a particular manufacturer's tapchanger control. The panel is designed to mechanically and electrically replace an old control, with matching mounting hardware to facilitate the replacement. See Figure 1-2, Typical Adapter Panel Mounting.

Interrogation of the control and setting changes are made via the user interface, or through the communications ports. User interface consists of a 20-character by 2-line display and four pushbuttons. Two passwords available to the user are accessed by the buttons and a third is accessed through the communications ports. All setpoints are stored in nonvolatile memory which is unaffected by control voltage disturbances.

Two operation counters are provided. One counter may be reset; the other may be preset by the user.

Nine LEDs are used to indicate Tapchanger Raise and Lower command status, Reverse Power detection, CPU OK, LDC In Effect, V/RED Voltage Reduction in Effect, MANUAL Control (Auto Operation Blocked Via Comm or Front Panel), LOCAL (SCADA control blocked locally) and COM1 TX and RX.

The control uses a Motorola microcontroller which has a self-testing watchdog system. Refer to Figure 1-1 for the functional diagram. The alphanumeric display and four-button interface provides complete front panel access to the scrolling menu program shown in the Appendix, Figure A-1. The control applies to tapchanger designs with many configurations of taps (e.g., ± 16 taps, 1 to 17 taps, 0 to 33 taps, etc.).

1.1 Adapter Panel/ Surface Mounting Kit

An adapter panel *or* an M-2050 or M-2054 Surface Mounting Kit *must* be used with the M-2001C Tapchanger Control. Each panel adapts the M-2001C as a transformer and regulator control replacement and provides the external connections necessary for operation via terminal blocks on the rear of the adapter panel. Contact Beckwith Electric for a list of adapter panels that are currently available. Refer to the Application Guides of the specific adapter panel for the mounting details. See Figure 1-2 for a typical adapter panel mounting.

The M-2050 is a mounting kit which permits surface mounting of the control using two right angle mounting brackets, four screws and a 24-pin connector with six-foot pigtailed on each pin. The M-2050 does *not* include features available on adapter panels. These features include mechanical configurations and wiring connections for direct replacement, CT shorting or front panel switches, fuses or test points. Refer to the Instruction Manual of the M-2050 for the mounting details.

The M-2054 is a mounting kit which permits surface mounting of the control using two right angle mounting brackets, four screws and a 24-pin connector with six-foot pigtailed on each pin. Refer to the Instruction Manual of the M-2054 for the mounting details and additional information.

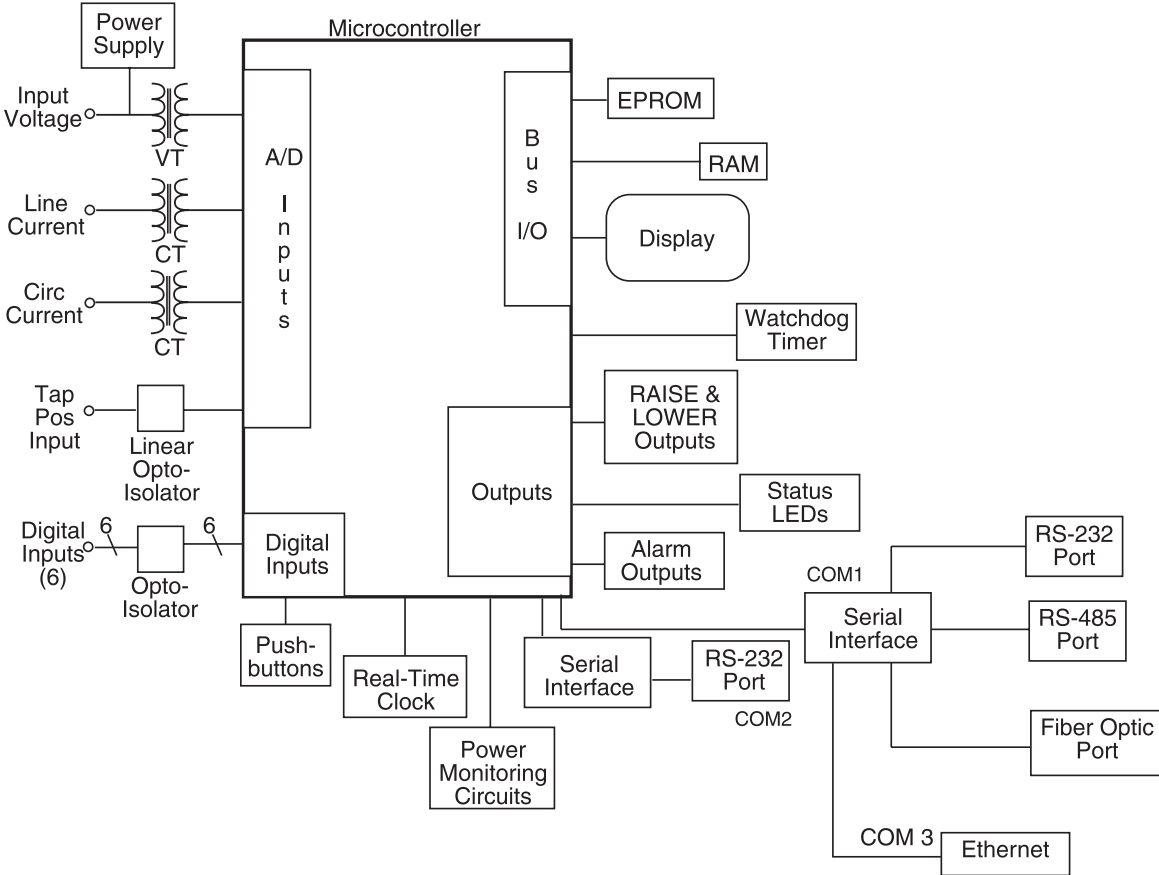


Figure 1-1 Functional Diagram

1.2 Accessories

M-2029A TapTalk® Communications Software

TapTalk is a Windows-based communications software program available for remote control and metering of the M-2001C Tapchanger Control. It is designed to interface with the microcontroller of the control through an RS-232, RS-485, Ethernet, or fiber optics port. The RS-232, RS-485, and Fiber Optics port support baud rates up to 19200 bps. The optional RJ-45 Ethernet port supports connection speeds up to 10 Mbps, but is limited by the capability of the Control's microcontroller. The TapTalk software displays all pertinent operating information. All operations that can be performed from the front panel user interface of the control can be duplicated remotely, through TapTalk. These operations include:

- Changing setpoint values. (This includes those values for normal tapchanger control operation, as well as custom configuration to the site.)

- Observing values. (This includes measured and calculated values of real-time operating parameters.)
- Data logging. The control can internally store various parameters at selected intervals. The TapTalk program can download this data into an Excel® spreadsheet and display. Alternatively, the PC can be programmed to poll the control and obtain a pre-selected list of parameters at selected intervals.

Additional Communications Ports

The Comprehensive M-2001C Digital Tapchanger Control comes with two RS-232 communication ports, COM1 and COM2. COM2 is located in the front of the unit. COM1 is located on the top of the unit. COM1 has up to four different interfaces: RS-232, RS-485, Ethernet, and fiber optic communication ports. When the Ethernet option is purchased, it is designated as COM3.

M-2025B and M-2025D Current Loop Interface Modules

The M-2025B and M-2025D are external self-contained interfaces designed to operate with the tapchanger control for tap position by positive knowledge, for LTC transformer applications. The modules connect to the current loop output of a tap position monitor such as the 1250-series INCON Programmable Position Monitors. The tap position monitor includes current loop outputs whose level corresponds linearly to any of a pre-programmed number of tap positions depending on the tapchanger mechanism being monitored. The modules accept current loop ranges of:

- 0 to 1 mA dc
- 0 to 2 mA dc
- -1 to +1 mA dc
- 4 to 20 mA dc

The **Tap Information** screen is provided in the tapchanger's Configuration Menu to select whether the control uses the current loop method or the Motor Direct Drive KeepTrack™ method for tap position knowledge. The M-2025B(D) Current Loop Interface module is not used with the "KeepTrack" method. The Motor Direct Drive KeepTrack method is used with single-phase line regulators having a counter contact and a neutral contact. The M-2025B(D) module easily connects to the Tapchanger control through a six-pin connector located on the bottom of the control. For more information, refer to the **Tap Position** section of the **Configuration** chapter.

For parallel operation using the circulating current method, the following accessories are needed: the M-0115A Parallel Balancing Module, the M-0127A AC Current Relay and the M-0169A Auxiliary Current Transformer. For more information, refer to the **Parallel Operation** section of the **Configuration** chapter.

The M-0329B Backup Relay or the M-5329 Multiphase Backup Relay are available to provide protection against failure of the primary control.

Control Power Backup Input

The Control Power Backup Input is designed to sustain communication port operation in the event of loss of AC power, maintaining Fiber Optic port operation, communication ports, data-logging, status monitoring, configuration and setpoint capability at full functionality.

M-2026 AC-DC Control Power Backup Supply

The M-2026 accepts either AC or DC input over a range from 21 to 32, 42 to 60 and 105 to 145 V. The unit will supply a regulated +12 V dc at up to a 1.5 A output. The unit includes a fused input, surge protection, and reverse polarity protection.

M-2027 Control Power Backup Supply - AC Only

The M-2027 will accept an AC input over a range of 105 to 140 V ac at 50/60 Hz. The unit will supply a +12 V dc at up to 1.0 A output.

M-2948 Tap Position Sensor

The M-2948 tap position sensor is a rotary shaft encoder that includes a built-in microprocessor that provides stepped output signals in 9 or 10 degree increments. The M-2948 is available with 0 to 297°, 306°, 315°, 330°, 340° and 350° rotation for ±16 taps and 1, 2 or 3 neutral positions. The electrical output of the sensor is a 4-20 mA current loop that converts easily to a voltage signal at the input of the M-2025B(D) with the addition of a proper value shunt resistor. For a 4-20 mA Current Loop, 150 ohms is required on the input of the M-2025B(D). The signal from the M-2025B(D) is then conditioned and sent to the M-2001C as an analog signal. The M-2948 Tap Position Sensor is available with either a positive or negative slope. Negative slope (clockwise rotation) causes a decrease in Tap Position. Positive slope (clockwise rotation) causes an increase in Tap Position. M-2948 Tap Position Sensor directly mechanically replaces the Selsyn-Type Tap Position Sensor.

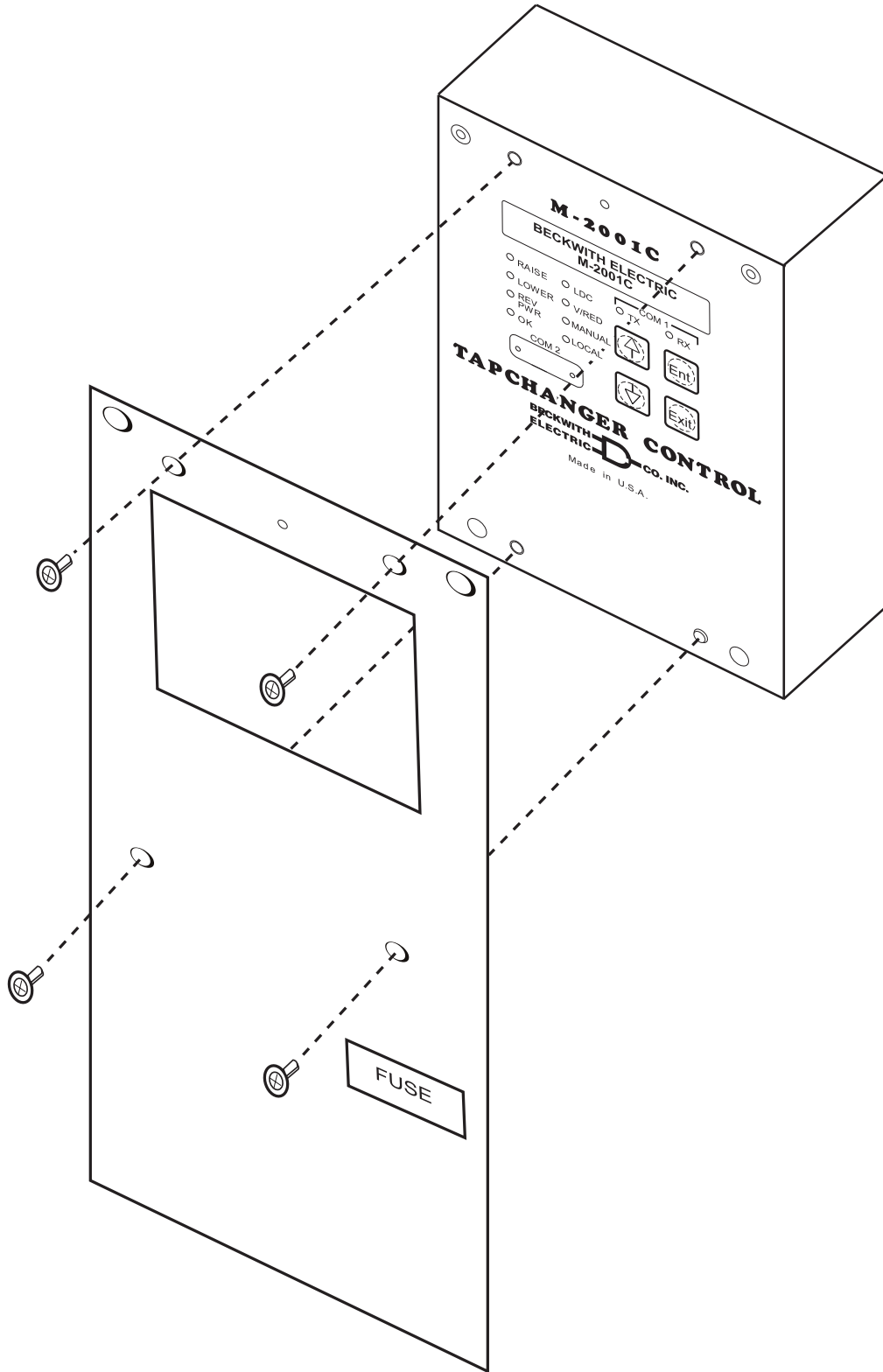


Figure 1-2 Typical Adapter Panel Mounting

2 Front Panel Controls

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2.0 Introduction

The front-panel user interface consists of a standard Liquid Crystal Display (LCD) or optional Vacuum Fluorescent Display (VFD), **▲**, **▼**, **EXIT**, and **ENT** pushbuttons, and the status indicators as shown in Figure 2-1, M-2001C (Comprehensive) Front Panel.

2.1 Display/Tapchanger Control

The display shows the desired function and its current status or setpoint value. The function is displayed on the top line, and the bottom line displays its current status. The display is normally blank and remains so until the **▲**, **▼**, or **ENT** pushbutton is depressed. Pressing any pushbutton will display the User Lines screen, and then the Local Voltage screen.

Power Up Screens

Each time the control is powered up, it will briefly display a series of screens that include:

- Beckwith Electric M-2001C
- Booting Ethernet (if purchased)
Configuring DHCP
Internet IP Address
Ethernet Board Version
- Serial Number
- Control Firmware Number
- Date
- Time of Day
- User Lines

Screen Blanking

The display automatically goes blank after exiting from any menu, or from any screen after 15 minutes of unattended operation. Manual screen blanking is accomplished by pressing the **EXIT** pushbutton.

Flashing C "CHANGE" Prompt

This prompt, in the bottom right corner of a screen, is enabled by initially pressing **ENT**. This prompt indicates that the user can change a setting using the **▲** or **▼** pushbuttons to increment or decrement the settings. Values have factory preset increments, such as 0.1 volt or 1 second. Press **ENT** the second time to execute the setting change.

"ENT" Prompt

When the "E" prompt appears in the top right corner of the drag-hand parameter screens, operation counter reset screen, and demand metering screen, it indicates that the value of display will reset if the **ENT** pushbutton is pressed.

2.2 User Interface Controls

↑ and ↓ Pushbuttons

The ↑ and ↓ pushbuttons have two functions. First, they are used to change screens and scroll through selections. Second, they are used to enter new values by incrementing or decrementing the displayed value. The new value is not stored until the **ENT** pushbutton is pressed a second time.

Pressing the ↑ or ↓ pushbutton for longer than one second will cause faster scrolling, either when selecting screens or when selecting setpoint values.

ENT Pushbutton

The **ENT** pushbutton is used to perform the following functions:

- Enter the change mode of a screen
- Store a setpoint or condition in memory
- Enter an access code
- Reset certain status screens

When entering an access code, the **ENT** pushbutton will move the cursor (an underline) to the selected digit location and the ↑ or ↓ pushbutton will change the value. When the final digit is selected, and "C" is flashing, the new access code is entered using the **ENT** pushbutton.

In some cases, it is desirable to leave a screen without making a change. In selecting setpoints or settings, wait 20 seconds without pressing the **ENT** pushbutton and the "C" will stop flashing. At that point, the ↑ and ↓ pushbuttons will again change screens rather than scroll the previous setpoint number or setting choice. The previous changes of that screen will not be recorded and the older setpoints or configuration choices will still be in effect.

When setting passwords, programmable alarm function or user lines in the Configuration Menu, the 20-second time-out is not functional and the user cannot cancel once a new entry has been started.

EXIT Pushbutton

The **EXIT** pushbutton is used to exit from any screen, causing the display to go blank. If **EXIT** is selected while the "C" is flashing, the control will exit without keeping the changed setting.

2.3 Status Indicators

RAISE LED

The red LED indicates when the voltage is below the lower band edge and the timer has started timing for a tapchanger raise operation.

LOWER LED

The red LED indicates that the voltage is above the upper band edge and the timer has started timing for a tapchanger lower operation.

REV PWR LED

The red LED will light to indicate when the unit detects reverse power flow.

OK LED

The green LED light will remain lit whenever power is applied to the unit and the watchdog circuit indicates the microcontroller is working properly.

LDC LED

The yellow LED will illuminate when any non-zero setting has been entered as LDC Fwd resistance or reactance, or LDC-Z. It will also illuminate when any non-zero setting has been entered as LDC Rev resistance or reactance with the "Rev Power Oper" configuration set to "regulate in Reverse" and the control in reverse power mode.

V/RED LED

The yellow LED will illuminate when any level of voltage reduction has been invoked. This is true for any voltage reduction process whether it came from an external contact or any COM input.

MANUAL LED

The yellow LED will illuminate when Auto operation of the control has been blocked from any COM port. It will also illuminate when Manual Mode has been selected using the Adapter Panel Auto/Manual Pushbutton or Toggle switch.

LOCAL LED

The yellow LED will illuminate when all write capability to the control is blocked from SCADA.

COM1 TX/RX LEDS

The red TX and green RX LEDs indicate that the control is transmitting and/or receiving through COM1.

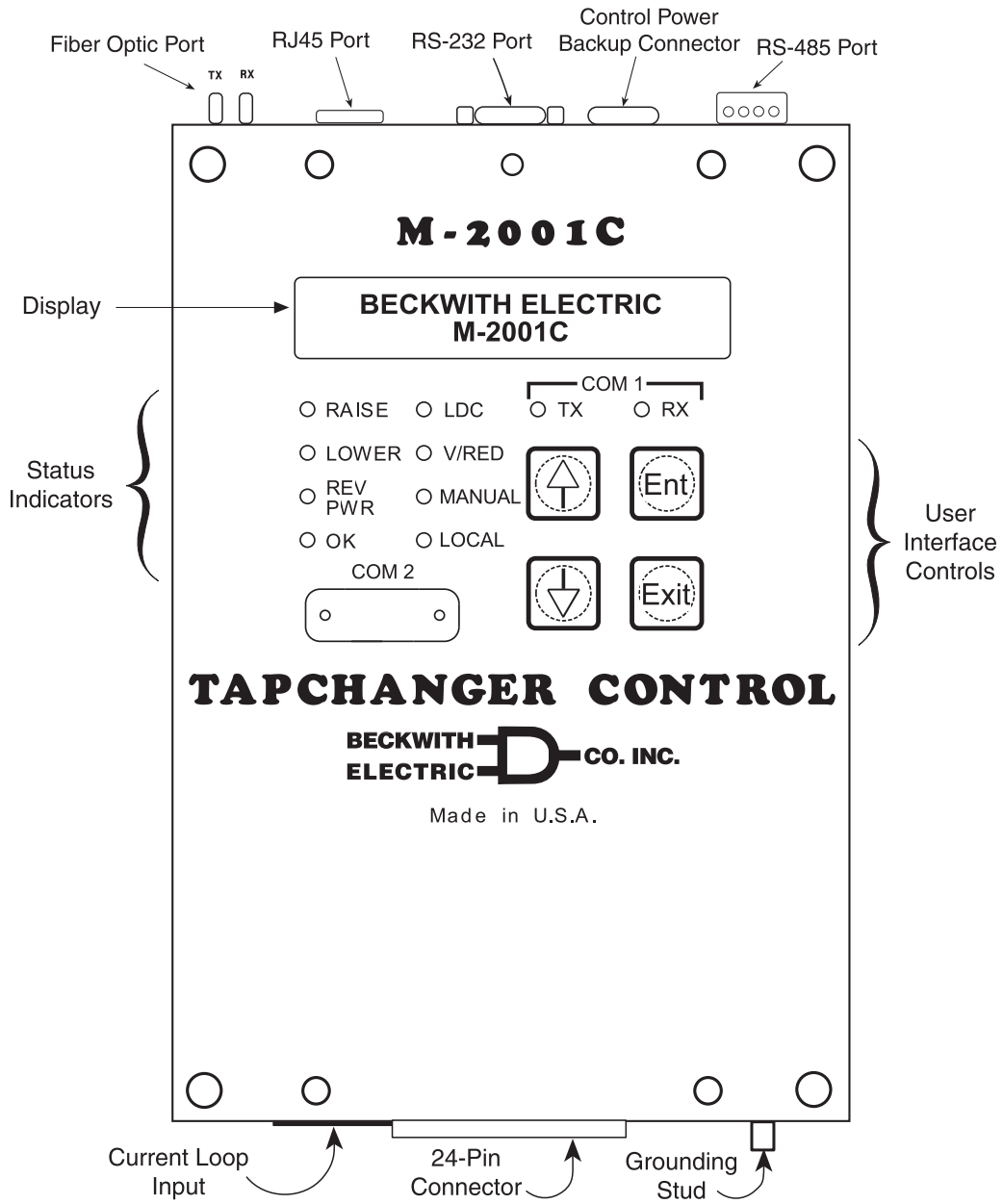


Figure 2-1 M-2001C Front Panel

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3 Setting The Control

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3.0 Introduction

If the control will not execute Raise or Lower operations due to remote blocking using TapTalk®, front panel operation can be restored by using TapTalk's Remote Control screen to remove the block, or momentarily removing power from the control. In order to restore front panel operation, the Save Comm Block at Power Off configuration setting must be set to Disable.

Local and remote control may be used at the same time by designating "Local Mode" disabled in the Configuration menu.

Settings Entry

Use the **↑** and **↓** pushbuttons to scroll to the desired setpoint entry screen and press **ENT** to enter the change mode. A password is required for entry into change mode, unless the Level 1 password has been disabled. Use the **↑**, **↓** and **ENT** pushbuttons to change the setting.

When the control is first energized, the quickest way to properly initialize the control prior to entering the setpoints is to set the real-time clock. This action will initiate a prompt from the control to perform a reset operation for the following items:

- Demand Metering
- Energy Metering
- Drag Hands Reset Registers
- Resettable Operations Counter

It is then easy to proceed with the remainder of the control setup.

3.1 Passwords

Password Access Screens

To prevent unauthorized access to the control functions, there are provisions in the software for assigning up to three passwords. Two are for use with the front panel controls and one is for use with the communication interface. The passwords can be set in the Configuration Menu. For more information, refer to the **Passwords** section of the **Configuration** chapter.

Access Levels

General access to read setpoints, to monitor status, to reset drag-hand parameters and the resettable operations counter do not require a password.

The **Level 1** password, if set, is required to make local setting changes including the date and time of day. If the Level 1 password is set to all zeros, this request for a password will not be seen and changes can be made without a password.

The **Level 2** password, if set, is required to make changes to the configuration, passwords, and user identification. If the Level 2 password is set to all zeros, this request for a password will not be seen and changes can be made without a password.

The **COMM** password is for use with the TapTalk® Communications Software. This password provides secure remote operation. If the communications password is set to all zeros in the M-2001C Digital Tapchanger Control, the communications program will not ask for a password.

■ **NOTE:** Please record all passwords in a secure location. If the password is lost or forgotten, please contact the factory.

3.2 Voltage Regulation

Standard Control Settings

Refer to the Appendix, Figure A-4. With the Level 1 password, six forward and six reverse setpoints are available (see Table 3-1) from the Setpoint Menu. They are: bandcenter, bandwidth, time delay, inverse time, and line drop compensation resistance and reactance for each direction and Z-compensation.

The control will send commands to the tapchanger to change taps as needed to hold the voltage within the bandwidth setting as modified by the line drop compensation settings and by paralleling.

The control will only respond to an out-of-band voltage excursion after the timer has reached the time delay setting. The timer can be set as an integrating timer or an instantaneous reset timer upon the voltage return to an in-band condition. As an integrating timer, it increments during time out-of-band and decrements during time in-band, but not below zero.

Voltage Regulation Without LDC

When the control is just used to regulate the voltage on the transformer or regulator low-side bus, the only input required is voltage from a line-to-line or line-to-ground VT with a nominal 120 V ac secondary.

Bandcenter (BC)

The center of the voltage band is adjustable from 100 to 135 V ac in 0.1 volt increments (for example, 120 V ac).

Bandwidth (BW)

The LTC uses discrete steps and the Bandwidth must have a width that allows at least one tapchange position where the control remains satisfied. To minimize excessive operations on the tapchanger, this bandwidth is usually set to include two or three in-band tap operation positions.

The range is settable from 1 to 10 volts in 0.1 volt increments, and 2 volts minimum is recommended. This setting is the total bandwidth.

Time Delay (TD)

The time delay setting is needed to inhibit the tapchanger from unnecessary operations on temporary voltage excursions and is commonly set at 30 to 60 seconds.

The control has two types of timers for time delay: definite time and inverse time. The kind of time delay the control will use depends on the setting found in the configuration menu called **TIMER SELECTION**. Both types of delay will work in forward or reverse power flow. The inverse time delay will follow the curve in Figure 3-1, Inverse Time Delay Curve.

Inverse Time Example

Bandcenter 120 V

Bandwidth 3 V

Inverse Time Delay Setting 120 s

$$\Delta V = (\text{Bandwidth}/2) = 1.5 \text{ V}$$

$$V_{in} = 123 \text{ V}$$

Voltage deviation in multiples of ΔV

$$= [V_{in} - \text{Bandcenter}]/\Delta V$$

$$= (123 - 120)/1.5$$

$$= 2$$

Time delay from Figure 3-1

$$= 50\% \text{ of Inverse Time Delay setting}$$

$$= 60 \text{ sec.}$$

Function	Setpoint Range	Increment	Default Setting
Bandcenter	100.0 V to 135.0 V	0.1 V	120.0 V
Bandwidth	1.0 V to 10.0 V	0.1 V	2.0 V
Time Delay	1 second to 120 seconds	1 second	30 seconds
Inverse Time Delay	1 second to 120 seconds	1 second	30 seconds
LDC Resistance	-24 V to +24 V	1 V	0 V
LDC Reactance	-24 V to + 24 V	1 V	0 V
LDC-Z	0 V to 24 V	1 V	0 V

Table 3-1 Bandcenter, Bandwidth, Time Delay & Line Drop Compensation Setpoint Ranges

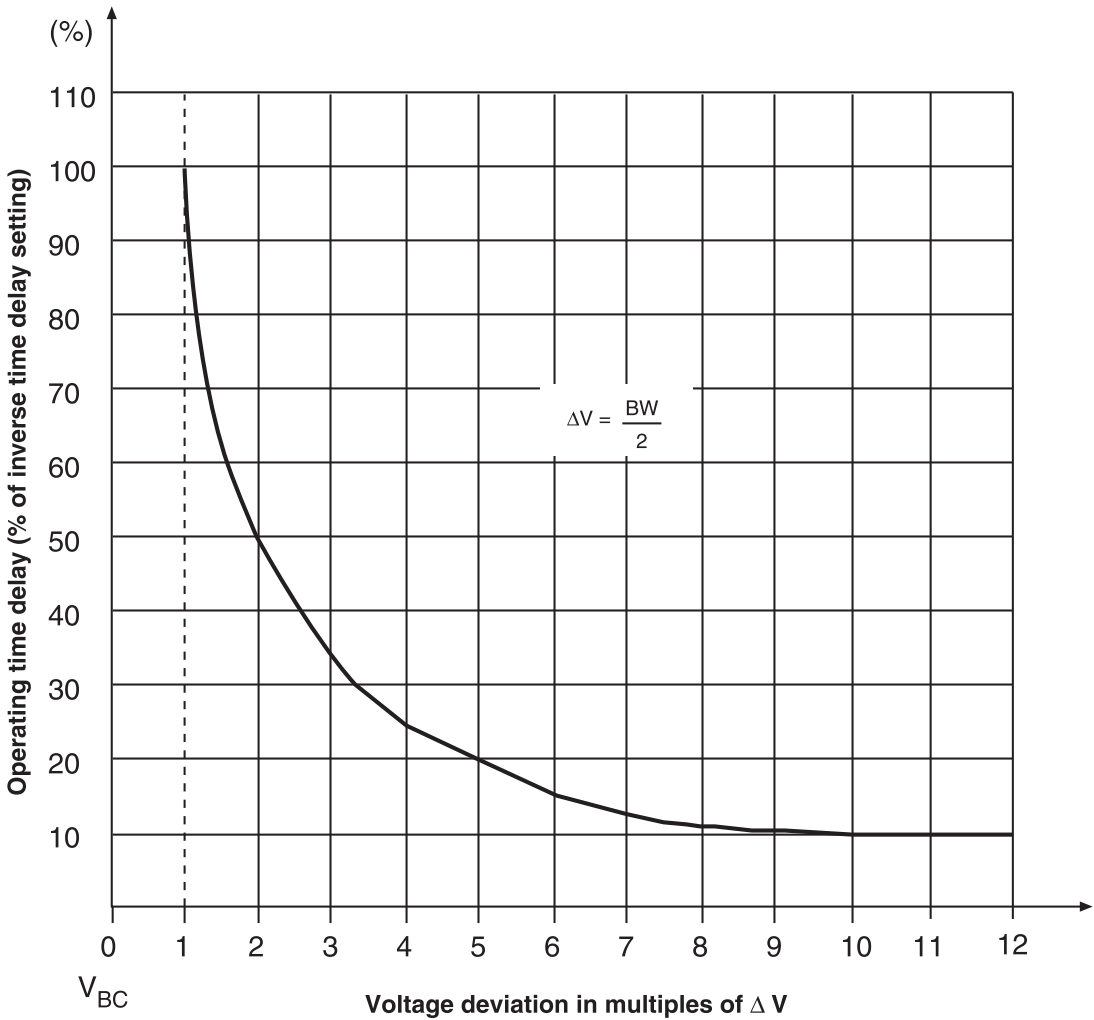


Figure 3-1 Inverse Time Delay Curve

Voltage Regulation with LDC

When it is desirable to regulate the voltage at some distance from the transformer or voltage regulator, or in general to raise the voltage during high load conditions, the Line Drop Compensation (LDC) feature is used.

Two different LDC methods are available in the M-2001C Digital Tapchanger Control. A configuration setpoint called LDC Selection allows the user to select from either of these methods.

The Bandcenter, Bandwidth, and Time Delay functions are set the same as if LDC were not used.

LDC X/R

A classical approach can be used to determine the X/R settings for the LDC, however this assumes a load center point and is usually not applicable to the typical distribution feeder. For more information, contact Beckwith Electric for **Application Note #17**.

A simpler method, which will work for most applications, is recommended. This involves looking at the lines leaving the station and determining the reactance/resistance (X/R) ratio for the main line. The reactive and resistive line drop compensation setpoints should then be entered in this same X/R ratio.

If the CT and VT phasing corrections have been made to remove any phase angles between measured voltage and line current, only positive values of R and X compensation need to be used.

Table 3-2 gives the X/R ratio for various wire sizes and typical conductor spacings.

By knowing the ratio of the maximum expected load to the present load, the amount of voltage compensation needed is found as shown in the following example.

Example

Desired

- local voltage @ min load = 120 volts
- local voltage @ max load = 124 volts

Using the following assumptions:

- Desired Bandcenter = 120 volts
- Desired Bandwidth = 2 volts
- The device being controlled is 50% loaded

Setting

Start with R=0 and X=0 and increase both values using the ratio shown in the table for the feeder conductor. Keeping the X/R ratio, increase R_{set} and X_{set} until the difference between the compensated voltage and the local voltage is 2.0 volts.

This example would let the voltage vary from 119 V at no load to 125 V at maximum load taking into account the bandwidth.

With this simplified method of LDC setting, the first customer's voltage will be limited by the upper voltage limit at the highest daily load, depending on the accuracy of the daily load projection. At the same time, the furthest customer will receive the highest voltage possible under the line and loading conditions. The first customer protection can be set on the control. Refer to the **Regulation Limits** section of this chapter.

Since the daily load projections will likely have a seasonal variation, the best balance of first customer to furthest customer voltage may require seasonal adjustment of the LDC settings. Note that the settings of R and X compensation are proportional to the peak load projection and that new settings can be scaled from the first setting obtained by the experimental process just described.

ACSR		COPPER	
MCM	X/R	MCM	X/R
795	4.0	750	6.0
477	2.5	500	4.5
336	2.0	350	3.3
266	1.5	250	2.4
AWG	X/R	AWG	X/R
4/0	1.2	4/0	2.0
2/0	1.2	2/0	1.5
2	0.5	2	0.7
6	0.2	6	0.3

Table 3-2 Approximate Ratio of Line Reactance to Resistance (X/R) of Typical Distribution Circuits

LDC-Z

The second available compensation method is called Z-compensation (LDC-Z). LDC-Z must be selected in the control configuration portion of the menu or software and the **VOLTAGE RAISE** (V_R) setpoint must be set in order for this feature to be implemented. The LDC-Z application is

especially useful on systems where several lines exist with different load centers where the proper compensation is not related to any single R & X values as set in R & X compensation.

Basically, LDC-Z compensation consists of designating a target bus voltage increase (line drop compensation) that correlates to the **magnitude** of the control current rather than to the calculation of input R & X line drop at control current magnitude and angle values.

The setting, (V_R), is the calculated line voltage drop (at maximum load) in the circuit or line that has the highest voltage drop at maximum load condition - ratio'd to the rated CT output (200 ma).

$V_R = 0$ to 24 volts in increments of 1 volt.

Example:

- Calculated voltage drop = 5 volts at load level of 150 ma control current.
- V_R setting = $200/150 \times 5 = 6.7$ volts (rounded) = 7 volts

To calculate the line drop compensation at any given control current level (I):

- $V = I/200 \times 7$ (setting):
If $I = 50$ ma; $V = 50/200 \times 7 = 1.75$ volts

As with R & X compensation applications, the "Block Raise" and "Dead Band" settings are used for first house protection on all circuits or lines.

■ **NOTE:** For additional information about LDC-Z applications, contact Beckwith Electric to obtain Distributech Paper 1/27/05, "*Maximizing Automatic Reverse Power Operations with LTC Transformers and Regulators.*"

3.3 Voltage Reduction

Refer to the Appendix, Figure A-4. The control allows three steps of voltage reduction via external dry contacts or by serial port connection. The percentage voltage reduction at each step is adjustable from 0 to 10% in 0.1% increments. When one or more contacts are closed, the effect is to shift the bandcenter setpoint lower thus causing the LTC to lower the voltage.

Recognize that the "effective" bandcenter may have been raised by line drop compensator action when the voltage reduction is initiated and that the resultant voltage setting will be the combination of the two effects. Note also that the undervoltage block setting may limit the lowering of voltage, especially if there is little raising of the local voltage due to LDC action.

When first initiated, or when a subsequent step of voltage reduction is needed, the control will respond immediately to the voltage reduction command without regard to either the intertap time delay setting or the control time delay setting. After the desired voltage reduction, operation will revert back to normal operation with the time delay. Refer to the Application Guide of the appropriate adapter panel for contact connections.

Wired SCADA dry contacts or serial port connection can be used to provide stepped voltage reduction as described earlier. However, these should *not* be used together, since the resulting reduction would be the combination of the inputs.

3.4 Regulation Limits

Overvoltage Limit & Voltage Runback

Refer to the Appendix, Figure A-4. Setpoints are available to establish a block raise limit and voltage runback. The overvoltage limit is adjustable from 95.0 V to 135.0 V in 0.1 V increments. The overvoltage limit must be set above the upper control band limit. This limit is one portion of the First Customer Protector to limit overvoltage from line drop compensation action during heavy loading.

The voltage runback level is the Block Raise setting plus the Dead Band setting (this establishes the First Customer Protection Level.) This deadband should not be confused with the control deadband above and below the center voltage setpoint, which is generally called the control "bandwidth".

The voltage runback deadband is used to assure that the runback setting is sufficiently above the upper voltage limit setting to limit hunting. It is adjustable from 1.0 to 4.0 V in 0.1V increments, and must be set greater than the voltage change of one single tapchange, or hunting will occur. It is suggested it be set for approximately twice the voltage change of one tap.

If the voltage exceeds the runback limit, as might be caused by combinations of LDC action and load shifts or by a system disturbance without LDC action, the control will immediately call for an "automatic" lower without any time delay. The lower command will continue until the voltage is reduced below the runback voltage limit. After this occurs, the timer will reset. If the voltage is still high, normal control action will bring the voltage down to within the normal control band.

Overvoltage block can be effectively disabled by setting it to 135 V. By setting the runback deadband to 4 V, the runback voltage becomes 139 V which effectively disables the feature. All automatic raise/lower operations are blocked when the DC Power

Backup option is enabled and the input voltage decreases to less than 85.0 V. Manual tap changes can be initiated if Motor Power is available.

Undervoltage Block

Refer to the Appendix, Figure A-4. This limit is adjustable from 95.0 V–135.0 V in 0.1 V increments. This limit can be set to limit low customer voltage to safe limits and will block voltage reduction action that could cause motor stalling and other undesirable low voltage effects. Undervoltage block can be effectively disabled by setting it to 95 volts. If the voltage is below the Block Lower setpoint, the control will not respond to further lower commands. Raise commands are not affected. Operation of the overvoltage limit, voltage runback and undervoltage block is illustrated in Figure 3-2.

All automatic raise/lower operations are blocked when the Control Power Backup Input option is enabled and the input voltage decreases to less than 85.0 V. Manual tap changes can be initiated if Motor Power is available.

Coordination with Backup Relay

The M-2001C Digital Tapchanger Control provides the first customer protection functions. Use of a backup relay, such as the M-0329B, is recommended since the M-2001C (or any independent control) cannot be expected to be its own backup. The backup relay Bandcenter setting is usually set the same as the primary control, with the Bandwidth setting 1 or 2 volts greater than the primary control bandwidth, the Block Raise setting 1 volt greater than the primary control, and the Dead Band setting 1 or 2 volts. These settings create a runback level 1 or 2 volts above the runback level of the primary control.

If primary control operation is desired first, the Block Raise setting and the resulting runback level of the backup relay must be higher than those of the primary control and the block lower setpoint must be lower than the primary control setting.

Tap Position Block

The Tap Position Block is disabled by setting the Tap Information screen to the Disable condition. Refer to the Appendix, Figure A-5. If the Tap Information screen is not disabled, the Tap Position block can be disabled by setting the Tap Limits screen to Disable.

When using the M-2025B(D) Current Loop Interface Module, a one-second intertap time delay should be used, due to the time setting of the module.

Overcurrent Block Operation

▲ **CAUTION:** The current input to the control is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

Refer to the Appendix, Figure A-4 for the Line Limit I screen of the Setpoint Menu. The Line Limit Current setpoint is available to block operation whenever the current exceeds the setting. Depending on the current scaling choice made in the **Configure** menu, the setting is adjustable from 0.2 to 0.64 amps in 0.01 amp increments, when using a 200 mA CT scale. If "Curr Transformer" is set for 1 A, the setting is adjustable from 1.0 to 3.2 Amps, and if the "Curr Transformer" is set for 5 A, the setting is adjustable from 5.0 to 16.0 Amps.

This feature can be used to protect the tapchanger switch during periods of excessive current. This feature can be effectively disabled by setting the blocking current to 0.64 amps, 3.2 Amps or 16-0 amps, depending on scaling CT choice.

3.5 Pulsed Output

▲ **CAUTION:** If an appropriate pulse width setting is not input, then a misoperation of the tapchanger may occur when a SCADA Manual Raise or Lower is initiated.

When the output selection is "Pulsed", the pulse width can be programmed from 0.2 to 12 seconds, in increments of 0.1 seconds.

Under normal conditions, when the output is set to "Pulsed" and the control is calling for Raise/Lower, an output will turn on for the preprogrammed time, or until a counter contact operates, and then turn off the output for a time period of 0.5 seconds plus the intertap time delay setting value. When the control is calling for a Raise/Lower and no non-sequential or counter input is applied, the output will activate for the full preprogrammed time and deactivate for 0.5 seconds, plus the intertap time delay.

SCADA INITIATED Manual Raise/Lower

When the control is placed in Manual via SCADA, to perform a Manual Raise/Lower, the control will switch to the "Pulsed" output mode until the control is returned to "Auto". This will allow only a single Raise/Lower operation to take place each time a SCADA Raise/Lower command is sent. When the control is returned to "Auto", the control will revert back to the output selection setting. Therefore, an appropriate "Pulsed" output time setting should be set if SCADA initiated Manual Raise/Lower operations are performed.

When enabling the pulse feature on an LTC without a counter contact, to prevent hunting, care must be taken to set the ON pulse width less than the time it takes for a complete tap change to occur, but long enough for the seal-in circuit to be activated. The Intertap Time Delay should be longer than the time it takes for a complete tapchange to occur.

When a counter input is applied, and there is an intertap delay, the pulse will cease immediately (triac is turned off) with counter contact closure for the intertap time delay. After the counter contact opens, the intertap timer will start at the end of the time delay. If there is still a Raise/Lower condition, another pulse will start.

When the non-sequential input is applied, the Raise/Lower timers will reset with the contact closure, and a timer count will start again, if a Raise/Lower condition is still present, the pulse will start once more.

3.6 Application Considerations

Sequential/Non-Sequential/Blocking

The control normally operates in Sequential Mode. In this mode, the tap change output is initiated after the time delay timer has timed out. The tap change output will remain "on" until the control senses that the voltage has returned in-band. This permits successive tap changes to be made in a "sequential" mode with no delay between tap changes.

If a delay between successive tap changes is desired, an intertap time delay may be used. This value is set at the Intertap Delay screen in the Configuration Menu. The value is set from 0 to 60 seconds and will interrupt tap change outputs for the preset time after a counter-contact closure is detected by the control's operations counter input#1.

If the full initial time delay is desired, the control may be used in the "non-sequential" mode. This mode is selected by applying a momentary contact closure to the control's non-sequential operation/ auto tapchanger inhibit input from the counter-contact circuit or an auxiliary relay contact. Refer to the Application Guide of the appropriate adapter panel for details on implementation of non-sequential contacts.

If the closed contact supplied to the non-sequential input is maintained, instead of momentary, the initial timer will not time out for the duration of the maintained contact, and the outputs of the control will be effectively blocked.

Intertap Time Delay

The intertap time delay may be used in conjunction with sequential operation or pulsed output. The normal operation of this delay timer is as follows: once a tapchange command is initiated, when there would normally be a continuous command (raise or lower) to run the tapchanger until the voltage has returned to within the band setting, there is now an intertap time delay initiated between tapchanges. When the intertap time delay is set to zero, it is disabled.

When invoked by a user who possesses Level 2 security access (or above), the intertap time delay will:

1. Recognize that a tapchange has occurred, indicated by the counter contact input.
2. Remove the output signal and wait for the intertap time delay, even though the voltage remains outside the designated voltage band.
3. Command another tapchange after the intertap time delay has expired, without regard to the basic time delay setting, if the voltage remains out of band in the same direction as the previous tapchange.

If the intertap time delay is enabled on a control where non-sequential operation is enabled, the intertap time delay setpoint is disregarded. The basic time delay setting prevails for subsequent tapchange commands in the non-sequential mode.

■ **NOTE:** The intertap time delay is similar in operation to non-sequential operation, but the two should not be confused. The intertap time delay applies a short delay after every tapchange, for the user-selected time delay (0 to 60 seconds). It is enabled via a menu screen. The non-sequential operation time delay will be the same as that of the basic user-selected Time Delay as described at the beginning of this chapter. For application with pulsed output, see Section 3.5, **Pulsed Output**.

Test Mode/Status Screen

This convenient screen permits entering a bias voltage for simulating the raising or lowering of the sensed input voltage. This exercises the control as if the input voltage were being changed. The contacts actually operate.

This screen is valuable in the rapid determination of operating quantities present to influence the normal operation of the control. Items that will block operations or change setpoints are described here and illustrated by LEDs on the face of the control.

The Test Mode/Status screen displays control status information that includes:

- Output Status
- Compensated Voltage
- Band Status
- Runback/Blocking Status
- Voltage Reduction Status

This screen automatically resets on exit or in 15 minutes if not exited. Refer to Appendix A, Figures A-2 and A-3.

Function	Setpoint Range	Increment	Initial Setting
Intertap Time Delay	0 to 60 seconds	1 second	0 seconds

Table 3-3 Intertap Time Delay Setpoint Range

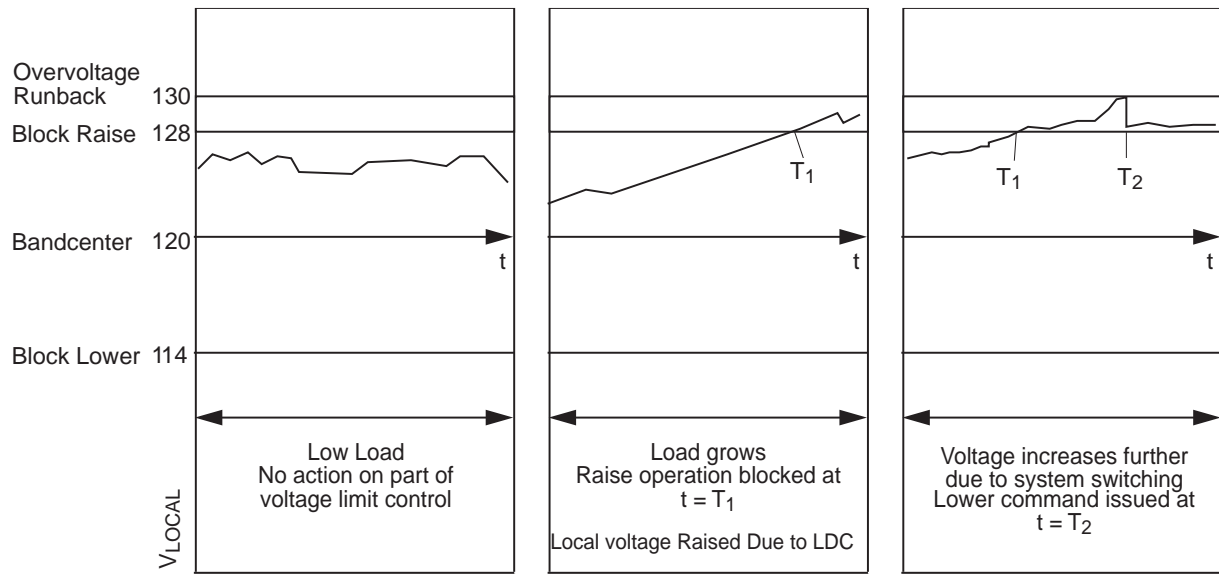


Figure 3-2 Local Voltage as Function of Load Current When Using Line Drop Compensation/ Action of Overvoltage and Overvoltage Runback Control

3.7 SCADA HeartBeat

The purpose of the SCADA HeartBeat feature is to have two sets of settings for the control and switch between these two setting sets based on the presence or absence of SCADA communications to the control.

In order to determine if the SCADA communications is present a HeartBeat detection algorithm is implemented. There are two types of SCADA HeartBeat modes; Confirmed HeartBeat (previously known as MOD 467/MOD 467R with M-2001C/B controls) and Direct HeartBeat.

The SCADA HeartBeat feature can be enabled from TapTalk Communications software. There are two different types of SCADA HeartBeat modes that can be selected:

- SCADA HeartBeat for transformer control applications (LTC)
- SCADA HeartBeat for regulator control applications (Regulator)

SCADA HeartBeat, when enabled, provides an additional set of control settings that are only accessible through communications utilizing the DNP protocol.

The second set of settings (applicable only for forward power settings) include:

- Bandcenter
- Bandwidth
- Time Delay
- LDC R
- LDC X
- Block Lower Voltage
- Block Raise Voltage
- Intertap Time Delay
- Sequential or Non-Sequential
- HeartBeat Timer Period

In addition, direct and confirmed HeartBeat modes will also include Voltage Reduction settings.

- Voltage Reduction 1
- Voltage Reduction 2
- Voltage Reduction 3

The SCADA HeartBeat DNP 3.0 Protocol sequence is provided in Figure 3-3.

The SCADA HeartBeat feature is enabled for LTC or Regulator applications from the TapTalk Control Settings dialog screen (Figure 9-17). The selections that are available are; Regulator, LTC or Disable.

DNP Protocols for SCADA HeartBeat Feature

The SCADA HeartBeat feature is available in specific firmware versions (D-0146 V08.08.05 or later). When the SCADA HeartBeat feature is enabled, Beckwith Electric Protocol document "DNP 3.0 Communication Database With HeartBeat (Failsafe) Feature Rev. 00 M-2001C Firmware Version D-0146V08.08.05" is required to be used. This Protocol Document is available for download from Beckwith Electric website.

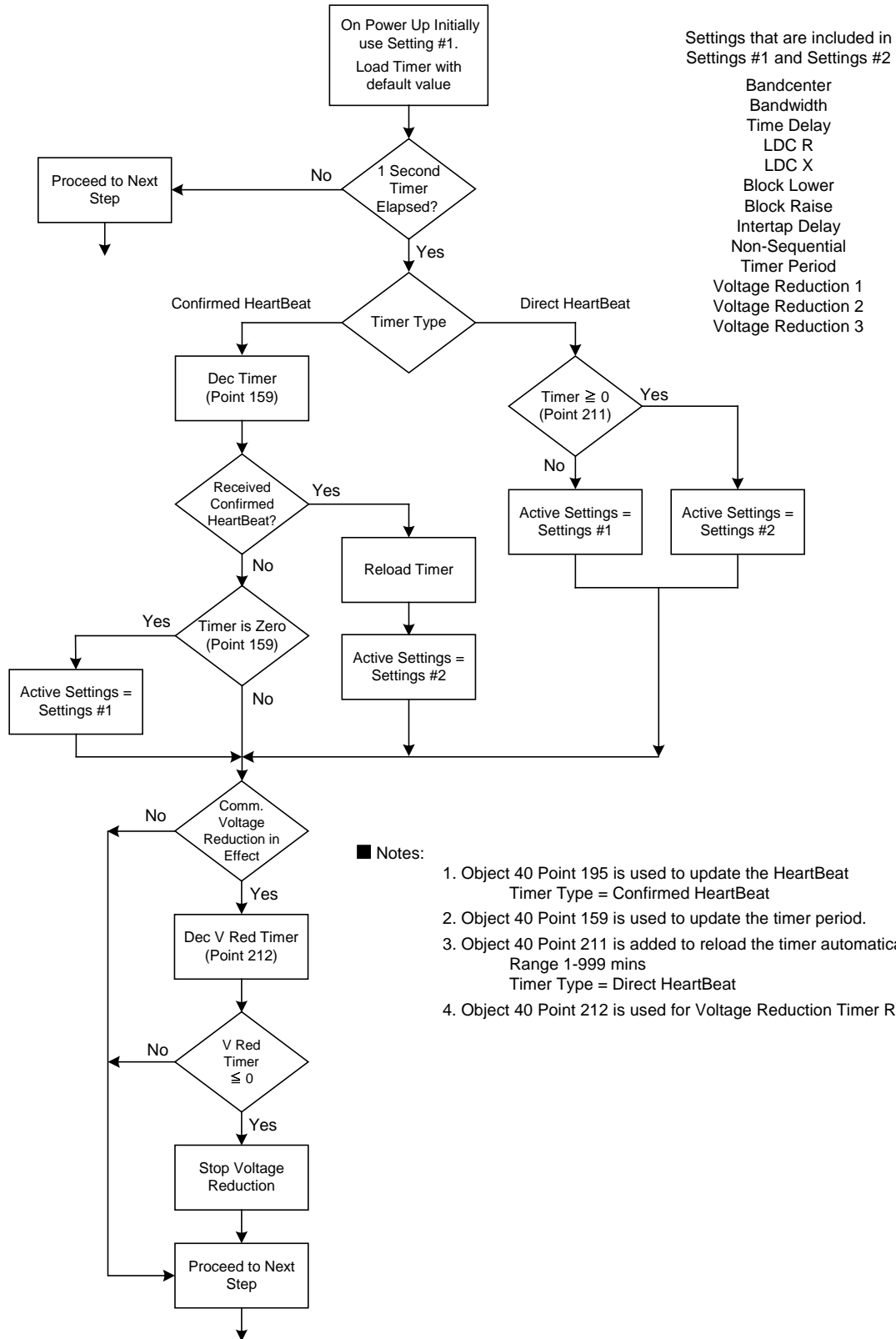


Figure 3-3 SCADA HeartBeat DNP 3.0 Protocol Sequence

3.8 Manual HeartBeat Timer

The purpose of the Manual Heartbeat Timer feature is to provide a method to place the control in Heartbeat Manual operation (implemented from Comms only) and automatically place the control back in Auto mode based on a Timer setting (settable only via Comms).

The Manual Heartbeat Timer is settable to 0 to 999 minutes via Comms Only and will start timing down to 0 once it is set > 0. The DNP comm point for the timer is Scan tag 216 in the DNP protocol and Register 4839 in MODBUS®. When the timer is set to a non 0 value it will place the control in Heartbeat Manual Mode (Auto operation blocked, same as comm block via comms). If the timer is written as > 0 again before it times down 0, then the control will stay in manual. When the timer is set to 0 or times down to 0, it will place the control back in Auto Mode. The status point that shows if the control is in the Heartbeat Manual Mode is: Scan tag 54 in the DNP protocol and Register 1840 in MODBUS. This point will be set to 1 only when in HeartBeat mode and Comm Blk is in Auto.

Heartbeat Manual Mode

The Heartbeat Manual Mode is separate and in addition to the original comm block manual mode. They both perform the same function, but use a different method and comm point to activate auto or Manual mode. When the control is in Comm Blk Manual, the Manual LED will turn on steady as before, but when in the new HeartBeat Manual mode it will flash.

The HeartBeat Manual method can only be activated via the new comm timer point while the old comm blk method can be activated via comms or the toggle/scamp switch as before. The Comm Blk mode has priority over the HeartBeat Manual mode regardless of how it is enabled (comms or switch input). When in HeartBeat Manual mode the tap/voltage limit blocks are active just as before with Comm Blk mode, but in HeartBeat Manual the runback due to high Voltage will also be enabled. If the control is in HeartBeat Manual mode and the Comm Blk manual is also turned on (via comms or switch input), then the Heartbeat timer will continue to count down. If Comm Blk is turned off, then it will go back to HeartBeat Manual mode unless the HeartBeat Manual timer has reached 0.

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4 Configuration

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4.0 Introduction

This section describes the Configuration Menu of the software flow. Refer to Appendix A, Figures A-5 and A-8.

- **NOTE:** Panel display for configured items do not refresh. In order to reflect the change, user must scroll past the screens and then return.

4.1 Passwords

Initializing Passwords (Control)

Refer to the Appendix, Figure A-5. The Level 1 and the communications passwords are set to all 0000 at the factory. The Level 2 password is set to 2222 at the factory and that password must initially be used to access the Configuration Menu. See Chapter 9, **M-2029A TapTalk®**, Utilities/Set New Passwords section, for TapTalk passwords.

New passwords may be entered from the screen within the Configuration Menu as described below. As soon as new passwords are entered, they will be required. Changing any setpoint or configuration will require the password, if enabled. *Enter passwords with care and record them for future use!*

- **NOTE:** Please record all passwords in a secure location. If the password is lost or forgotten, please contact the factory.

Configuring Passwords

The user who possesses the current Level 2 password may change any password using four new numbers. *A password is not required if the Level 2 password has been set to 0000.*

When **ENT** is pressed while viewing the password at its screen within the **Configuration** menu, an underline cursor is displayed under the digit furthest to the right of the password.

Each digit is changed by using the **↑** and **↓** pushbuttons to select the number. Use the **ENT** pushbutton to move the underline to the left. When the underline is on the far left digit, press **ENT** and the new password is stored into nonvolatile memory. If a wrong number has been entered, press **ENT** as many times as necessary and the underline will move to the digit furthest to the right for entry of the correct password. This should be done immediately to ensure that an incorrect password is not stored in memory.

If no key entry is made for approximately 15 minutes and the screen goes blank and the digit furthest to the left has not been entered, the password will revert to the previous one regardless of digits that have been changed. After a new Level 2 password has been entered, the new password must be used to reenter the **Configuration** menu. *Be sure to record the new password for future use.*

When a communication password has been configured at the control, the communication password allows the user to bypass both the configuration and setpoint passwords otherwise required by a control.

■ **NOTE:** The communication password is identified as a string #. Therefore, the passwords "0001" and "1" are not interchangeable.

Each control can be given a unique, 4-digit password ranging from 0 to 9999. If the password has been configured at the control as 0000, communication is not restricted a password does not need to be identified by TapTalk®. The control is shipped with communication password disabled (set to 0000).

Disabling Passwords

Any one of the three passwords can be disabled within the screens of the Configuration Menu by changing the password to zero (0000). When a password is disabled, its access screens will not be seen and the password will not be required.

Configuration Changes

Use the **↑** and **↓** pushbuttons to display the To Configuration Menu prompt and press **ENT**. The Level 2 password is required for entry, unless disabled. Use the **↑**, **↓** and **ENT** pushbuttons to change the configuration.

4.2 User Identification

Changing User Lines

Refer to the Appendix, Figure A-8. The user station identification lines allow the user to uniquely identify the unit. In normal operation, after 15 minutes without pressing a pushbutton on the display, the screen will be blank. If the screen is blank, any pushbutton press will reactivate it and display the User Lines screen. Each line of this display can have up to fifteen ASCII characters. Both of the lines are factory preset with asterisks.

When **ENT** is pressed at the User Line screen in the **Configuration** menu, an underline cursor is displayed under the left-most digit. Each digit is changed by using the **↑** and **↓** pushbuttons to select the ASCII character (the ASCII character list begins with "!"). The **ENT** pushbutton is used to move the underline to the next digit. When the **ENT** pushbutton is pressed for the right-hand digit, the new user line is stored into nonvolatile memory.

4.3 Alarm Relays

Two alarm relays are provided in the control to indicate status.

■ **NOTE:** If the M-2001C is configured for the SCAMP pushbutton Auto/Manual Switch type, then the Self Test Alarm Relay is not available. However, the Programmable Alarm output can be configured to act as the Self Test Alarm on the Programmable Alarm configuration screen.

Configuring The Programmable Alarm Output as a Self Test Alarm Output

To configure the Programmable Alarm Output as a Self Test Alarm Output proceed as follows:

1. Determine that control firmware is revision D-0146V08.06.05 or later
2. Confirm that the control "Auto/Manual Switch Type" configuration is set to "SCAMP"
3. Set Programmable Alarm Relay Mode to "As Deadman Out".

After completing this procedure, the Programmable Alarm function is no longer available.

Since the physical wiring of the original Self-test Alarm output is form B, (normally closed), and the physical wiring of the Programmable Alarm output is form A (normally open), it is necessary for the user to connect the Programmable Alarm Output terminals (#’s depend on Adapter panel used), to an external relay to change the form of the contact. A typical connection for the M-2067B Adapter Panel is shown in Figure 4-1.

Malfunction or Loss-of-Power Alarm Relay

If the control experiences either a malfunction or Loss-of-Power condition, then a dry contact will close indicating that the control is out of service. This contact will switch up to 6 A at 120 V ac.

User Programmable Alarm Relay

Refer to the Appendix, Figure A-6. The User Programmable Alarm Relay is non-latching and is capable of switching 3 A at 120 V ac and is user-programmable to indicate one or more of the following conditions:

- Block-Raise Voltage Limit exceeded
- Block-Lower Voltage Limit exceeded
- Voltage Reduction of any step is invoked
- Reverse Power Flow condition is detected
- Line Current Limit/Delta VAr Reactive Current exceeded
- Tap Block Raise/Lower is in effect
- Communication Block is in effect

If none of the conditions are programmed, then the alarm output is disabled (factory default).

4.4 Counters

▲ CAUTION: When "Input Selection 1" configuration is set to "Seal-In," the Counter Input is used as the Switch Status Input and the Seal-In Input will cause the counter to increment.

The M-2001C includes three configuration setpoints for the proper operation of the counter functions. These are necessary due to the different types of counter contacts on various equipment using these Digital Tapchanger (DTC) controls and the effect of wear on older counter operating mechanisms.

Operations Counter

The user must select the method of counting tapchanger operations consistent with the tapchanger.

X1 – Operation count will increment by one with an open-close-open state change on the tapchanger counter switch. The closed state may be present for as little as 20 ms. The open state may be present indefinitely.

X2 – Operation count will increment by one with either an open-close or a close-open state change of the tapchanger operation counter switch. Both the closed and open states may exist indefinitely.

Count Window – Operation count will increment by only one count during a set time period or "Count Window". This is true no matter how many counter inputs occur during the count window time. After a counter input is accepted, the count window timer begins and another count won't be accepted until the count window time expires. The count window time can be set from 0.5 to 10.0 seconds, under the **Configuration** menu.

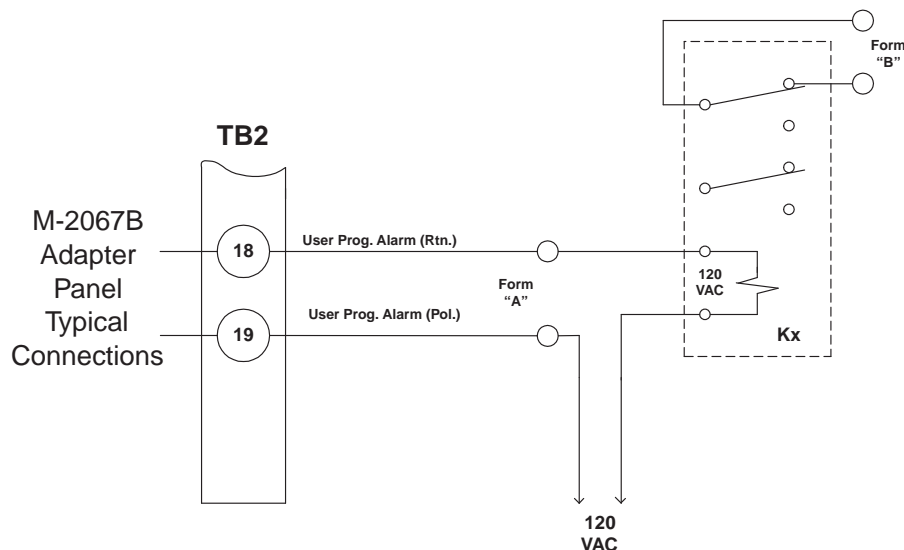


Figure 4-1 Programmable Alarm Output as a Self Test Alarm Output Typical Connections

The counter accommodates 999,999 operation counts and the number of counts stored in memory is not affected by a loss of supply power. Total operation count is displayed in the Status Menu. This counter cannot be reset, but can be preset to any value up to 999,999 in the Configuration menu.

Resettable Operations Counter

A second, resettable, operations counter operates with the method selected by X1/X2/Count Window. The user resets this counter to zero by pressing **ENT** while viewing the resettable operation counter screen within the Status Menu. No password is required to reset the resettable operations counter.

■ **NOTE:** The counter will only increment with a connection to the counter input.

4.5 Correction Factors

VT Ratio Correction

Refer to the Appendix, Figure A-5. The operation of some regulators is such that the internal VT does not provide the desired voltage ratio. In these cases, it is desirable to correct the VT secondary voltage to a 120 V ac reference base. This change is easily made in software, eliminating the need for a multi-tap sensing transformer.

▲ **CAUTION:** The use of a voltage correction factor is incorporated in the calculation of primary quantities in the control, and erroneous values will be displayed and recorded if the VT correction factor is not included in the PT multiplier.

The correction is derived from information provided by the regulator original equipment manufacturer (OEM). The numerical value of the correction is the value, in volts, required to adjust the VT nominal secondary voltage to 120.0 volts. The correction range is ±15 volts in 0.1 volt increments.

■ **NOTE:** The maximum allowable continuous VT secondary voltage is 140 volts. The correction is made only in software. As a result, the value of V_{LOCAL} read on the control display will differ from that measured at the voltmeter test terminals by the percent of the correction voltage.

CT/VT Phase Shift

Refer to the Appendix, Figure A-5. The control will recognize forward and reverse power flow to the load. With the CT and VT (reference) signals in-phase for unity power flow to the load, it will properly calculate line drop compensation. Depending on the connection of the CT and VT, the phasors may not

be in-phase. If this is the case, the phase shift can be corrected in software. The usual characteristics of three phase systems only allow multiples of 30° phase shifts. The control, therefore, has a range of 0° to 330° in 30° increments.

By comparing system operating conditions with power flow direction and power factor as shown on the M-2001C Tapchanger Control, improper phase shift can be determined. An incorrect connection may be resolved using well-known phasor methods. The following procedure may be useful to check the choice of correction or even to determine the correction by trial and error:

1. Put the transformer or regulator on manual control.
2. Determine the Watts and VArS load on the transformer or regulator from other metering.
3. Read the Watts and VArS indicated by the control, and make certain that they are of the same sign and ratio of magnitudes as obtained from the external readings.
4. If not, change the correction in 30° increments until the control and external readings are in best agreement.

When two single-phase regulators are connected in open delta, the current signals will be out-of-phase with the voltage signals. For one regulator, the current will lead the voltage by 30° and is called the "leading" regulator. For the "lagging" regulator, the current will lag the voltage by 30°.

Contact Beckwith Electric for **Application Note #17** for more information on VT and CT connections.

4.6 Ratio Multipliers

Voltage & Current Multipliers

▲ **CAUTION:** The use of a voltage correction factor is incorporated in the calculation of primary quantities in the control. Although the control operation is not affected, erroneous values will be displayed and recorded if the VT correction factor is not included in the PT multiplier.

Refer to the Appendix, Figure A-5. Primary quantities are displayed when voltage and current multipliers are set into the control. The voltage multiplier is:

$$V_{mult} = V_{pri} / (V_{sec} + V_{corr})$$

For a VT ratio of 7620/117 V and a voltage correction of 3 V, the multiplier is:

$$V_{mult} = 7620 / (117 + 3) = 63.5$$

The voltage multiplier setting range is from 0.1 to 3260 in 0.1 steps.

The current multiplier is the value of the line CT primary rating divided by 0.2 A. For a CT primary rating of 1000 A, the multiplier is:

$$CT_{mult} = 1000 / 0.2 = 5000$$

The current multiplier setting range is from 1 to 32600 in 1.0 steps.

Both multipliers are entered in the **Configuration** menu.

▲ CAUTION: The current input to the control is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

■ NOTE: The current transformer selection in the Configure menu only changes the scaling factor for current reading and setting.

4.7 Tap Information

The M-2001C Digital Tapchanger Control tap position information applies to many different configurations of tapchangers, e.g., ± 16 taps, 1 to 17 taps, ± 10 taps, 1 to 33 taps, etc. Two configuration points, Tap Min and Tap Max, are assigned to allow the user to select the range of a specific tap changer. The Tap Max range is 0 to 33 taps, and the Tap Min range is –33 to +29 taps. The user is able to program the control to select the method of tap position knowledge or to disable this feature. Table 4-1, outlines the ten selections available for the Tap Information screen.

Load Tapchanger (LTC) Positive Tap Position Knowledge

With the advent of Smart Grid initiatives, Utility SCADA systems require positive tap position information for Real Time Power Flow Calculations that are required for proper implementation of their Integrated Volt VAr Management (IVVM) programs. This section reviews several different methods that can be used to provide positive tap position knowledge in LTC transformer applications. The following positive tap position knowledge methods will be reviewed that can be applied in new and retrofit applications depending on installed equipment.

- Contact KeepTrack™
- Shaft Coupled KeepTrack™
- Resistor Divider KeepTrack™
- Motor Direct Drive KeepTrack™

Screen Selections	Tap Position Knowledge Method	Current Range	Screens Disabled
XFMR EXTERNAL #3	Current Loop	0 to 1 mA	Source Voltage
XFMR EXTERNAL #2	Current Loop	4 to 20 mA	Source Voltage
XFMR EXTERNAL #1	Current Loop	0 to 1; 0 to 2; or ± 1 mA	Source Voltage
REG EXTERNAL #3	Resistor Divider	Not Applicable	None
REG EXTERNAL #2	Current Loop	4 to 20 mA	None
REG EXTERNAL #1	Current Loop	0 to 1; 0 to 2; or ± 1 mA	None
REG INTERNAL	Motor Direct Drive KeepTrack	Not Applicable	None
CONTACT KT 1R1L	Direct Contact KeepTrack	Not Applicable	None
CONTACT KT 1N	Direct Contact KeepTrack	Not Applicable	None
DISABLE	None	None	Source Voltage, Tap Position

Table 4-1 Tap Information Screen Selections

Contact KeepTrack™

M-2001C Tapchanger Control Firmware Version D-0146V08.11.01 and above include the 1R/1L and 1N Contact KeepTrack methods. No cost firmware upgrades are available for M-2001C Tapchanger Controls with earlier firmware versions.

There are two basic methods of Contact KeepTrack. The applicable method used depends on whether a neutral contact is available that will **always stay closed while the LTC is on neutral, including multiple neutrals**. Both methods require that up to four contacts be available and accessible in the LTC to operate correctly.

The original M-2001C Voltage Reduction inputs are now used for the Aux Raise and Aux Lower Inputs required by the Contact KeepTrack methods. Thus, the voltage reduction function via physical contacts will not be available when Contact KeepTrack is implemented, but voltage reduction via communications is not affected.

The Raise and Lower Outputs from the control must agree with the operation of the external Aux Raise and Aux Lower status contacts, and this must be maintained whether the tapchanger is on the low or the high side of the transformer.

The Neutral input on the M-2001C is used for Tap Calibration in the Contact KeepTrack method.

Contact KeepTrack Method I – Using 1R/1L Contact Input

If the neutral contact can't be used, the following four Cam switch based dry contacts are required.

- Aux Raise contact – This contact must close and open once between taps each time the LTC takes a tap in only the Raise direction.
- Aux Lower contact – This contact must close and open once between taps each time the LTC takes a tap in only the Lower direction.
- 1R contact – This contact must close when the tapchanger moves onto the 1 Raise tap position and open when leaving it.
- 1L Contact – This contact must close when the tapchanger moves onto the 1 Lower tap position and open when leaving it.

All four contacts must be either dry contacts or run through auxiliary relay contacts if wet. The M-2001C control Voltage Reduction, Neutral, and Counter inputs require dry inputs wetted internally

with 12 V dc. The conceptual diagram illustrated in Figure 4-2 assumes dry contacts are available. The conceptual diagram illustrated in Figure 4-3 assumes the contacts are wetted with 120 VAC.

Example of Contact KeepTrack Method I – Using 1R/1L Contact Input

In this example, an out-of-band condition occurs which causes the raise output from the M-2001C to turn on. This will cause current to flow to the motor causing it to start a raise operation. The Aux Raise contact will close which will send directional feedback to the VR1 Input of the M-2001C. This will tell the control to increment the Contact KeepTrack tap position by 1 tap.

Once the raise operation is completed, the Aux Raise contact will open removing the input to VR1. When the unit no longer requires a raise output the raise output from the control will be turned off. If a lower operation is required then the same steps will occur except that Aux Lower contact will close and VR2 will be used.

Activation of the 1R contact in conjunction with the Aux Raise contact closing, then opening will cause the Contact KeepTrack tap position to be set to 1R. If the next operation results in the 1R contact opening in conjunction with the Aux Lower contact closing then opening, then Contact KeepTrack will increment to Neutral. Once in Neutral, the control will continue to display Neutral until either the 1R or 1L contact operate in conjunction with the appropriate Aux Raise or Lower contact. That allows the control to compensate for multiple neutrals.

Contact KeepTrack Method II – Using Neutral Contact Input

This method provides Contact KeepTrack for LTC transformers that have dedicated Raise, Lower, and a Neutral contact that stays closed while the LTC is on neutral, including multiple neutrals. A Counter contact may also be required.

This Contact KeepTrack method requires a pulsed input for each tap operation either raise or lower. The raise contact input to the M-2001C must close and open each time the tap position raises by one tap as is the case when the contacts are derived from Cam switches. Likewise the lower contact input to the M-2001C must close and open each time the tap position lowers by one tap.

M-2001C With Raise/Lower Contact KeepTrack™ Feedback Inputs

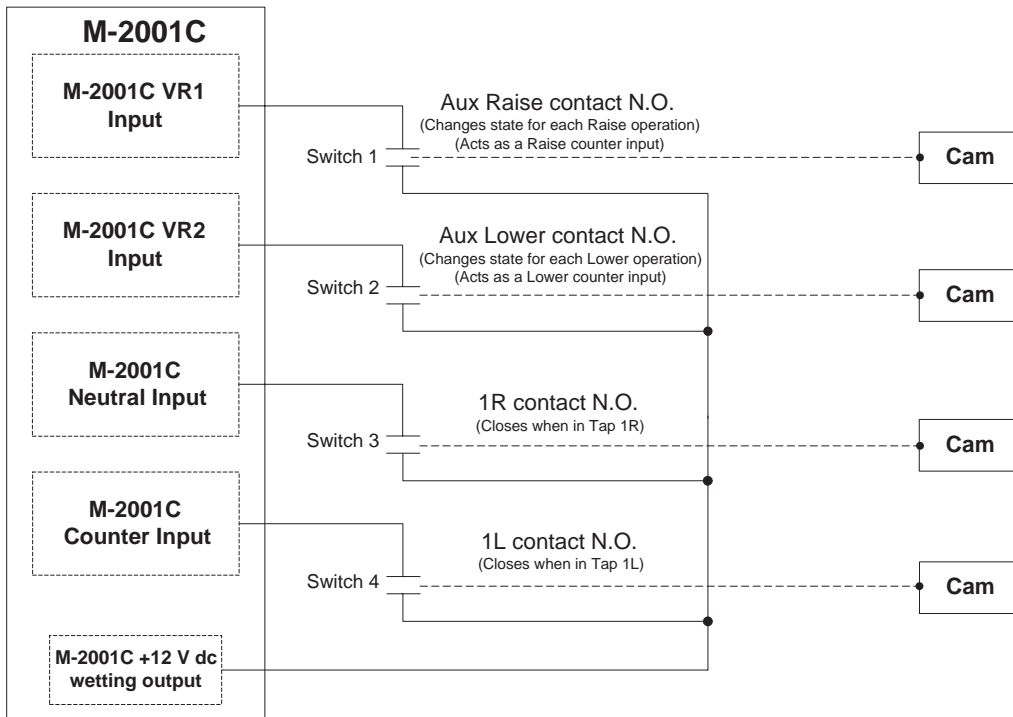


Figure 4-2 Cam Switches Available With Dry Contacts

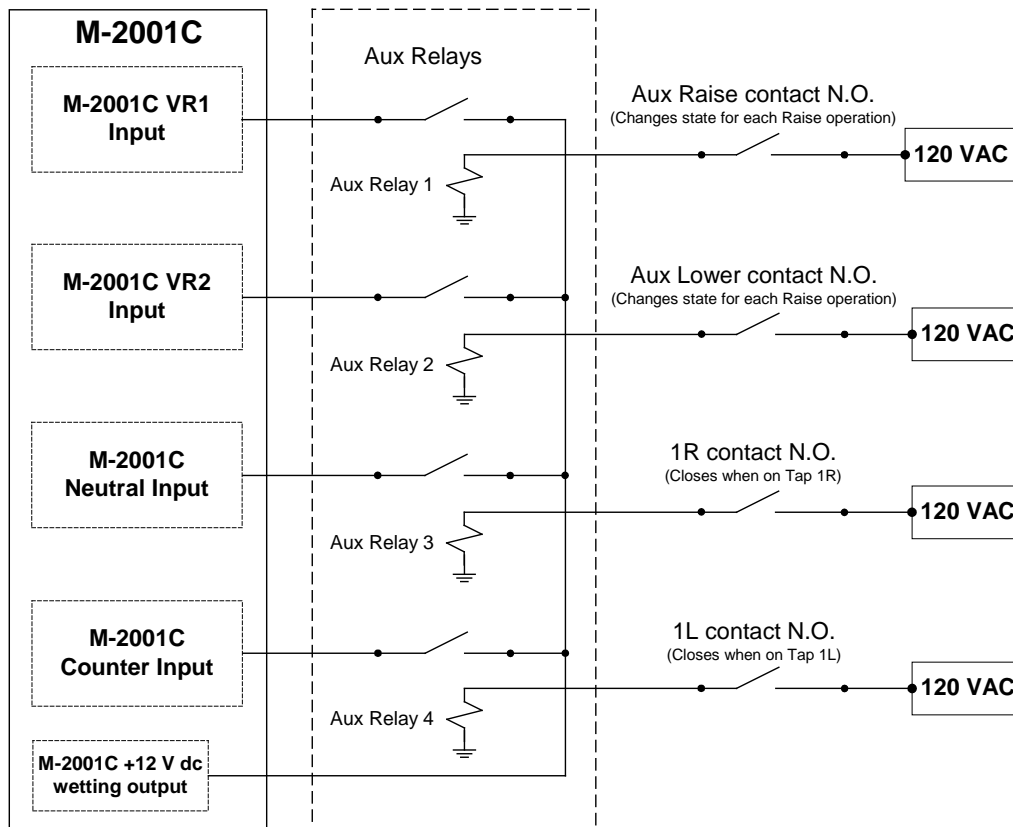


Figure 4-3 Cam Switches Available With Wetted 120 VAC

If the contacts are derived from 84R and 84L relays, an additional contact derived from the operations counter must be placed in series with them to provide the required pulsed input. With these inputs the M-2001C Control can "keep track" of the tap position since it will always receive either a raise or lower pulse as an indication of which direction the tapchanger is moving.

The neutral contact input recalibrates the control tap position to neutral if needed. This provides an extremely positive indication that the tapchanger is performing either a raise or lower operation.

To implement the Contact KeepTrack™ Method II scheme with contacts derived from Cam switches, the Contact KeepTrack method requires that three contacts be available and accessible in the LTC to operate correctly.

- Aux Raise contact – This contact closes when the LTC takes a tap in the Raise direction.
- Aux Lower contact – This contact closes when the LTC takes a tap in the Lower direction.
- Neutral contact – This contact must close when the unit moves onto the Neutral tap position and open when leaving it.

All three contacts must be either dry contacts or run through auxiliary relay contacts if wet. The M-2001C Voltage Reduction inputs, now used for the Aux Raise and Aux Lower contact inputs, and the Neutral input require dry contacts wetted internally with 12 V dc. The conceptual diagram illustrated in Figure 4-4 assumes dry contacts are available.

To implement the Contact KeepTrack Method II scheme with 84R and 84L derived contacts, the KeepTrack method requires that four contacts be available and accessible in the LTC to operate correctly.

- Aux Raise contact – This contact closes when the LTC takes a tap in the Raise direction.
- Aux Lower contact – This contact closes when the LTC takes a tap in the Lower direction.
- Counter contact – This contact is only required when using Aux Relays and must close and open when the unit moves in either the Raise or Lower tap position.
- Neutral contact – This contact must close when the unit moves onto the Neutral tap position and open when leaving it.

Auxiliary relays must be connected to the 84R and 84L contacts to provide dry contacts for the Aux Raise and Aux Lower inputs. The Neutral and Counter contacts must be either dry contacts or run through auxiliary relay contacts if wet. The Aux Raise and Aux Lower contacts are connected in series with a dry Operations Counter contact. They are then wetted with the M-2001C's internal 12 V dc wetting voltage thereby providing the required pulsed signals to properly increment tap position. The conceptual diagram illustrated in Figure 4-5 assumes wet contacts are available.

Example of Contact KeepTrack Method II – Using Neutral Contact Input (with 84R/84L derived contacts)

In this example, an out-of-band condition occurs which causes the raise output from the M-2001C to turn on or a manual operation is initiated. This will cause current to flow to the motor and it will start a raise operation. The Aux Raise contact will close and then the counter contact will close once the tap change is in process. When both of these contacts close they will send directional feedback to the VR1 Input of the M-2001C. This will tell the control to increment the KeepTrack tap position by 1 tap.

If more than one tap raise is needed, the raise contact will stay closed and the Counter contact is used to open the Aux Raise contact circuit removing the input to VR1 resulting in the correct tap position being kept. When the unit no longer requires a raise output, the raise output from the control will be turned off. If a lower operation is required, then the same steps will occur except that Aux Lower contact will close and VR2 will be used.

As a verification scheme, a contact that closes when the tapchanger is on the neutral position is also used as an input to the M-2001C control. When this Cam operated contact closes, the control recalibrates the tap position to neutral if needed. As an example, if the tap position is on 1R and a lower command is issued, the tapchanger moves to the neutral position, and when the neutral contact closes, the control would recalibrate the tap position if it was not already indicating neutral. If there are multiple neutral positions the neutral contact would need to be closed on all the neutral positions.

M-2001C With Raise/Lower Contact KeepTrack™ Feedback Inputs

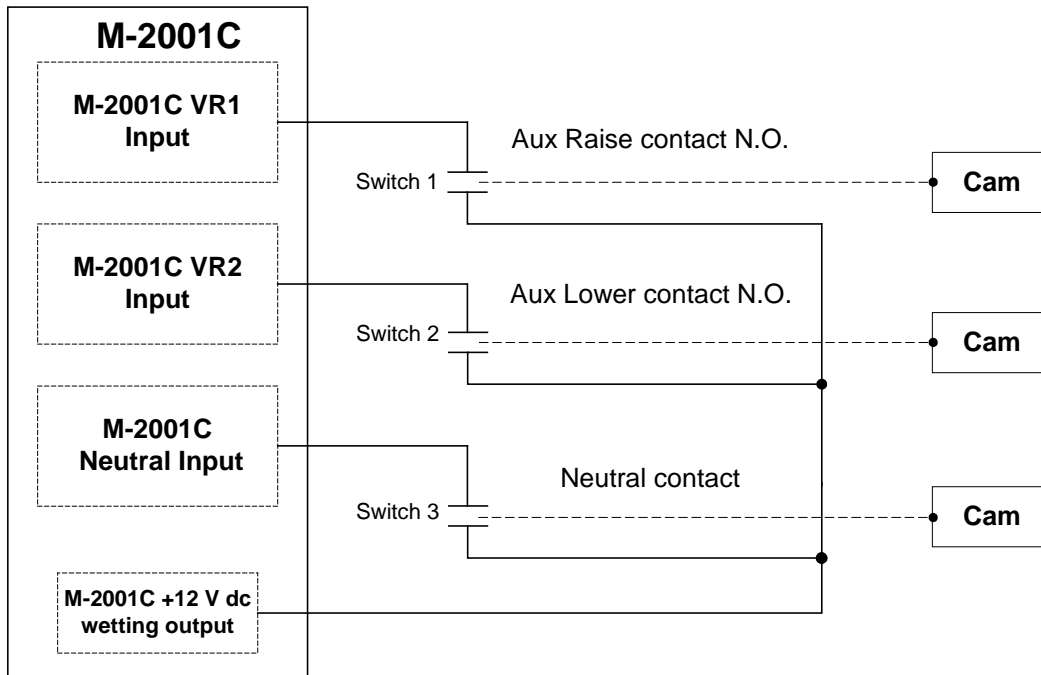


Figure 4-4 Cam Switches Available

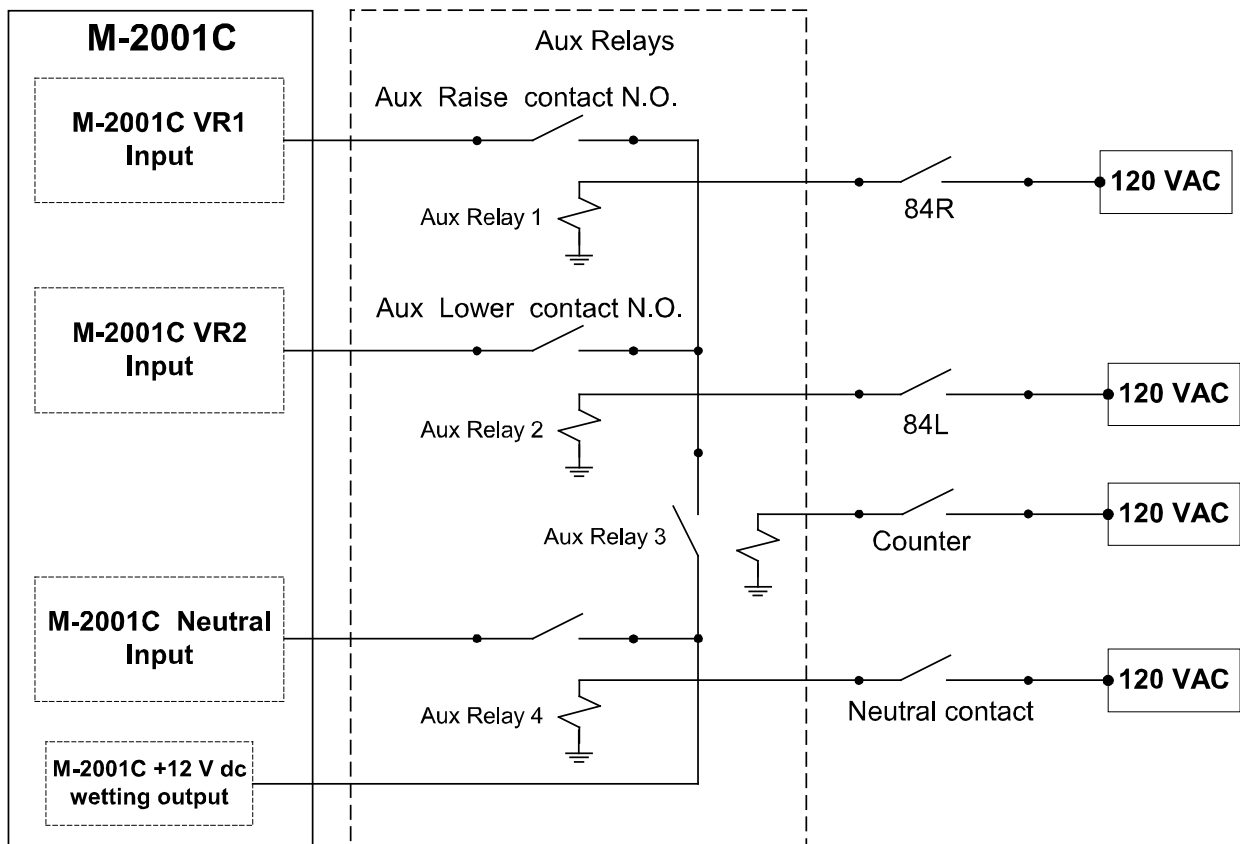


Figure 4-5 84R and 84L Aux Relays Available With Wetted 120 VAC

Shaft Coupled KeepTrack™ Tap Position Knowledge

Applicable controls and accessories for both Shaft Coupled KeepTrack Methods include:

- M-2001C Tapchanger Controls
 - Beckwith Electric M-2025B(D) Current Loop Interface
 - Beckwith Electric M-2948 Tap Position Sensor
- OR
- INCON 1292 Synchro Transmitter and 1250 Tap Position Monitor

Beckwith Electric Shaft Coupled KeepTrack Method

If Cam positions are not available and switches can not be retrofitted, a Shaft Coupled KeepTrack method can be used. Most LTC tapchangers have an output shaft on the tapchanger mechanism whose angular position is a mechanical analog of the tapchanger tap position. For these applications, the following methods can be used to provide positive tap position knowledge.

Figure 4-6 represents a typical application of the Beckwith Electric Model M-2948 Tap Position Sensor. The tap position sensor is a rotary shaft encoder with a built-in microprocessor that provides stepped output signals in 9 or 10 degree increments. The tap position sensor is available in both clockwise and counter-clockwise rotation configurations for increasing tap position. It has rotations of 0° to 297°, 306°, 315°, 330°, 340° and 350° degrees to accommodate tapchangers with 32 taps, 9 or 10 degrees per tap, and one to three neutral positions.

Thus, the information needed from an individual transformer is: the number of degrees per tap (always 9 or 10), rotation of the Tap Position Sensor, and the number of neutral tap positions. The sensor requires a +12 V dc power input that is supplied from the M-2001 control via the M-2025D. The electrical output of the M-2948 Tap Position Sensor is a 4-20 mA current loop that is converted to a voltage signal at the input of the M-2025D Current Loop Interface with the addition of a shunt resistor. The resultant voltage signal is conditioned in the M-2025D Current Loop Interface and routed to the M-2001C Tapchanger Control where the voltage is converted to a corresponding tap position number. The scheme can be used with all M-2001C Tapchanger Controls.

If replacing an INCON Tap Position Monitoring device, the INCON 1292 Synchro Transmitter is removed and the Beckwith Electric M-2948 Tap Position Sensor mounts in the existing bracket and uses the existing flexible coupling shaft.

Beckwith Electric-INCON Shaft Coupled KeepTrack Method

If tap position sensors already exist such as the INCON 1292 Synchro Transmitter, the shaft coupled KeepTrack method is still applicable. The INCON 1292 Synchro Transmitter is an electromagnetic device that resembles a small electric motor. Although various configurations of internal windings are used, they typically excite rotor winding(s), and induce AC signal voltages in the stator windings which can be compared in amplitude and polarity to determine the angular position of the rotor shaft.

This application is traditionally used with the INCON 1250 Tap Position Monitoring device (Figure 4-7). The INCON 1250 supplies the 120 VAC to the INCON 1292 rotor winding(s). It then measures the resulting signals from the stator winding to determine the shaft's rotational position. This information is converted to a tap number and displayed on the front panel numeric readout. An analog current signal is also generated which corresponds to tap position. The M-2025B(D) Current Loop Interface module accepts this current analog. The scheme can be used with all M-2001C Load Tap Changer models.

Connection of the optional M-2025B(D) will require either a B-0752 (5 pin to 6 pin) or B-0753 (6 pin to 6 pin) interface cable. See M-2025B(D) Specification for details.

The transformer (XFMR) and regulator (REG) external setting is for use with the Positive Knowledge (current loop) system, except REG #3, which is designed to be used with a Toshiba resistive voltage divider. Selecting either **XFMR** or **REG** will determine which screens are disabled, and then selecting either #1, #2, or #3 will depend on the output current or voltage signal from the Tap Position monitor. Table 4-1 outlines the options available for the Tap Information screen.

The user initializes the control at a given, known, tap position upon installation, by performing the following steps:

1. In the Tap Information screen in the Configuration Menu, select any External selection.
2. Determine the actual tap position from the external tap position indicator.
3. Scroll through the display to the Tap Calibrate screen in the **Configuration** menu. Press **ENT**. A flashing "C" indicates that the control is ready to accept data. Press the **▲** or **▼** pushbuttons until the correct tap position is displayed. Press **ENT** again. The tap position is now calibrated to recognize all subsequent operations of the tap position of the tapchanger.
4. The present tap position at which the tapchanger is operating is indicated in the **Status** menu at the Tap Position screen.

■ **NOTE:** To obtain accurate calibration, it is suggested that the calibration should be performed near the neutral tap for 0 to 1, 0 to 2 and 4 to 20 mA, and at tap position 8 R or 8 L in the case of –1 to +1 mA range.

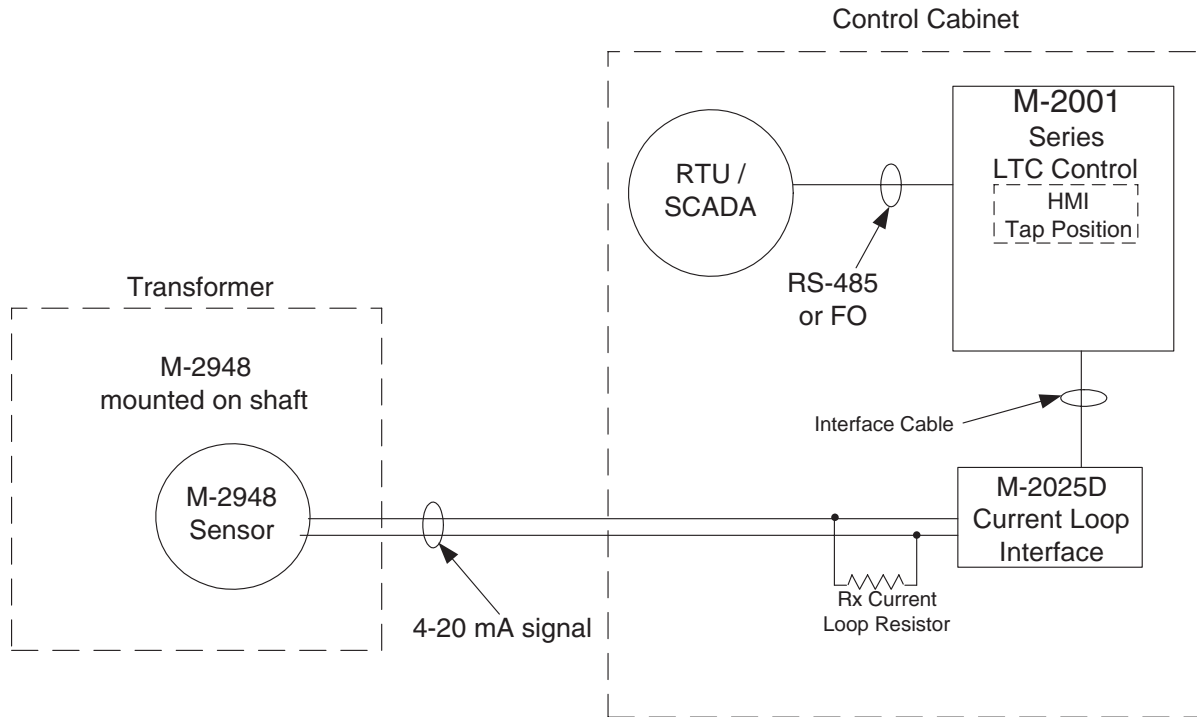


Figure 4-6 Tap Position Scheme Using Shaft Coupled KeepTrack

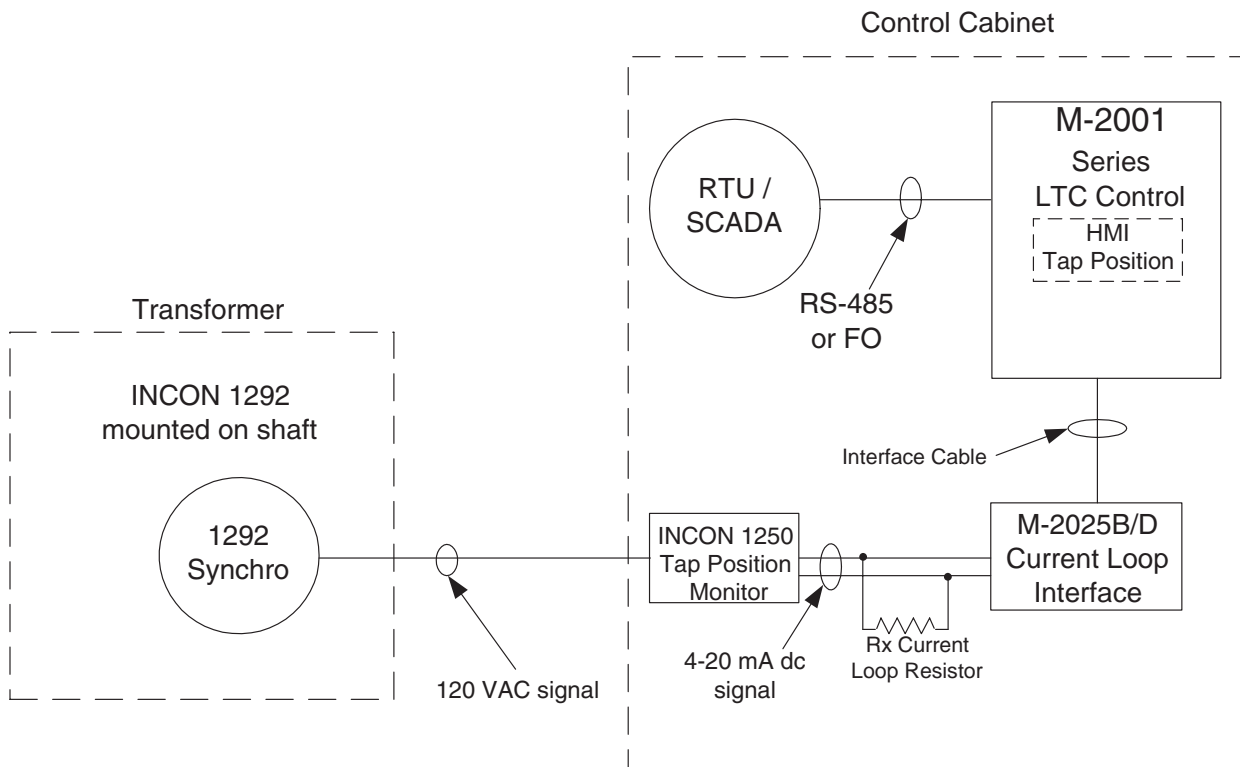


Figure 4-7 Tap Position Scheme Using INCON Devices

Resistor Divider KeepTrack™ Tap Position Knowledge For LTCs

Applicable controls and accessories for Resistor Divider KeepTrack Method include:

- M-2001C Tapchanger Controls
- Beckwith Electric M-2025B(D) Current Loop Interface
- Existing installations may use the Crompton Model 253-TRTU transducer or the Rochester Instrument Systems Model PR-2050 transducer (both now obsolete).
- New installations or existing installations with failed transducers use the Carrel Precision Model T-R Series transducer (or equivalent).

The typical application (Figure 4-8) uses a resistor string mounted on a separate insulating deck within the tap-changing mechanism. The resistor string is comprised of equal value and wattage resistors. Depending on manufacture and age the resistance varies from 10 to 400 ohms between each tap and can have either the same valued resistors between multiple neutral positions or direct wire connections.

The application uses a tap position transducer driven from a customer selectable AC or DC voltage source. The transducer provides a low DC voltage of 1 to 10 volts to the resistor string of the tap changer mechanism. The transducer measures the DC voltage from the wiper on the currently active tap, comparing it to the voltage applied to the string. The transducer then converts that voltage to a current loop value of 0-1 mA or 4-20 mA for transmission of an analog signal. The M-2025B(D) Current Loop Interface module accepts this current analog signal. The scaling to the correct number of taps is achieved by sizing the scaling resistor to obtain a 3.0 V signal at the maximum tap position.

Older installations may use the Crompton Model 253-TRTU transducer or the Rochester Instrument Systems Model PR-2050 transducer, both of which are now obsolete. The Carrel Precision Model T-R Series transducer (or equivalent) can be used in new installations or to replace failed obsolete transducers. The scheme can be used with all M-2001 Series Load Tap Changer models, M-2001 through M-2001C. This output can then be provided to a M-2025B(D) Current Loop Interface Module and then input to a M-2001C using the XFMR EXT #3 configuration setting.

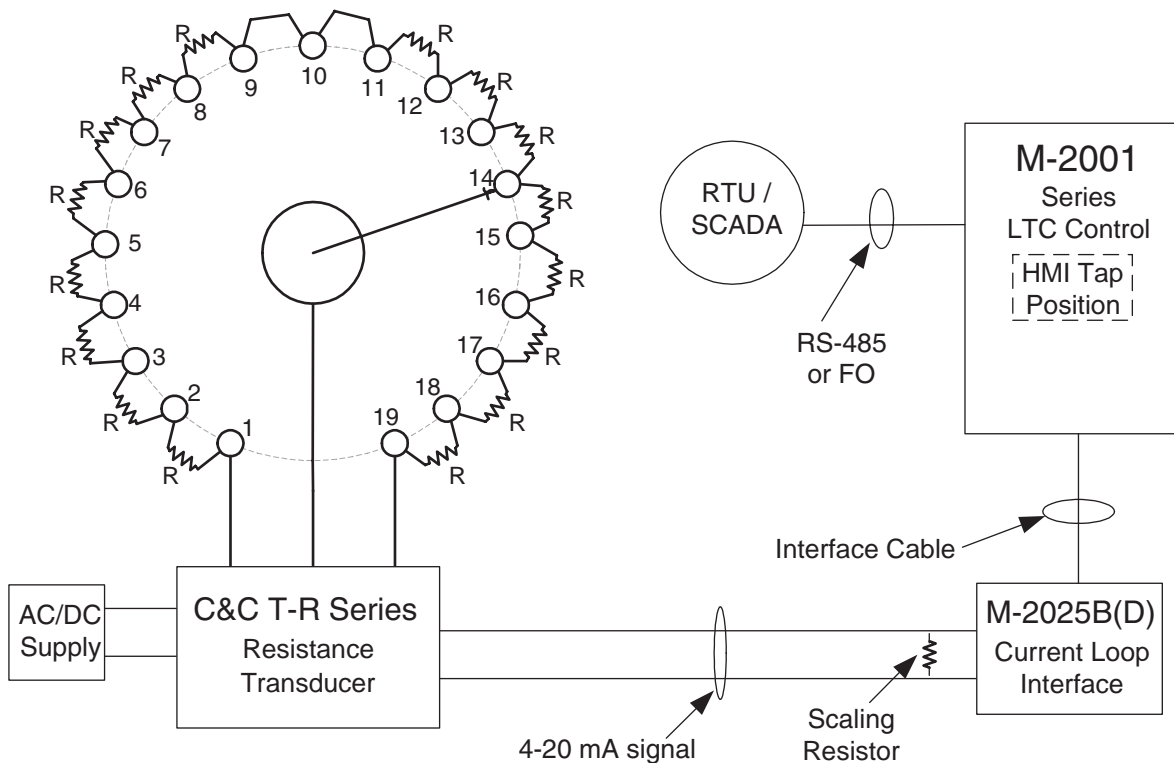


Figure 4-8 Tap Position Scheme Using Resistor Divider KeepTrack

The regulator (REG #3) setting is designed to be used with a Toshiba resistive voltage divider.

The positive knowledge by voltage divider method (REG External #3) is used on regulators that have +/- 16 taps, a voltage divider tap position sensor, and a separate raise/lower output. The Tap Max and Tap Min can only be set to 16 raise and 16 lower, respectively, while in the REG External #3 tap mode. The voltage divider method is designed to read a tap position sensor that contains 18 resistors in a voltage divider network. Each tap position will give a specific output voltage from the tap position sensor. The voltage from the sensor will only be read into the M-2001C control once one (1) second has elapsed after the counter input has toggled. The tap position sensor will not be read again until another tap change occurs, causing the counter input to toggle once more. Also, an external input to the control will be read to determine if a raise or lower condition exists. The raise/lower input and the voltage from the divider network will be used to determine what position the tap is on.

■ **NOTE:** The tap position calibration must be performed at or above the 4 raise tap, but to obtain the best accuracy, it should be calibrated at or above the 8 raise tap.

Motor Direct Drive KeepTrack™ Tap Position Knowledge For LTCs

In most Load Tap Changer (LTC) applications, the M-2001C control does not directly energize the LTC motor. Instead it energizes interposing relays which energize the motor in the raise or lower direction.

Some LTC Transformers however, have been designed such that the control does directly energize the motor similar to a Line or Feeder Voltage Regulator. M-2001A and later Beckwith controls contain a Motor Direct Drive KeepTrack method for Line and Feeder Regulators which may be applicable to these LTC Transformers.

▲ **CAUTION:** Reverse Power Operation must NOT be programmed for "Regulate in Reverse" if the "Reg Internal" method is used. Incorrect operation will occur.

This can be easily verified on the LTC transformer by setting the Tap Information setting on the M-2001C Control to Motor Direct Drive KeepTrack "REG INTERNAL" in the control and observing the tap position displayed in the control during both automatic and manual tap operation in both the Raise and Lower directions. It is very important that Reverse Power Operation NOT be programmed for "Regulate in Reverse" if this method is used. "Regulate in Reverse" was designed for Line and Feeder Regulators which have fixed impedances. Since LTC Transformer impedances are not predictable, incorrect operation will occur if Reverse Power Operation is set to "Regulate in Reverse".

Motor Direct Drive KeepTrack™ Tap Position Knowledge For Regulators

▲ **CAUTION:** This feature is applicable to single-phase regulators only.

▲ **CAUTION:** This feature is only applicable for ± 16 tap ranges with neutral tap and neutral indicator. The source voltage will only be applicable with a tap range of ± 16 taps.

This feature allows the control to keep track of the present tap position. The "Reg Internal" setting is selected for this method.

● **WARNING:** Do not rely on the tap position indication on the M-2001C Tapchanger Control display for neutral position when bypassing voltage regulators.

The motor power source for the manual, automatic, or external (SCADA) initiated tap changes must be the same as the motor power input to the control. The operations counter and neutral light circuit should be operational. The counter input and power source is required for detecting tap changes and determining direction of the tap change. Connecting a regulator neutral tap position indicating contact to the control will reset the tap position to neutral each time the tap goes through the neutral position. It is recommended that the indicated tap position be compared to the mechanical tap position indicator at regular intervals, and that the indicated value be corrected, if necessary.

The tap position stored in memory is not affected by a loss of power. The tap position record is checked and corrected to neutral, if necessary, with the closure of a neutral contact (when the neutral tap position contact is connected to the controls).

▲ **CAUTION:** When the Motor Direct Drive KeepTrack "Regulate Internal" tap position method is used, it must be calibrated for proper voltage control with reverse power operation.

If desired, the Motor Direct Drive KeepTrack "Regulate Internal" feature can be disabled in which case the screen will indicate "**Disabled**".

The user initializes the control at a given, known, tap position upon installation, by selecting "Reg Internal" in the Tap Information screen in the Configuration Menu and performing the following steps:

1. Determine the actual tap position from the external tap position indicator on the regulator.

2. Scroll through the display to the Tap Calibrate screen in the **Configuration** menu. Press **ENT**. A flashing "C" indicates that the control is ready to accept data. Press the **▲** or **▼** pushbutton until the correct tap position is displayed. Press **ENT** again. The tap position is now calibrated to recognize all subsequent operations so as to "Keep Track" of the present tap position.
3. The present tap position is indicated in the Status Menu at the Tap Position screen.

Or, if the neutral tap position contact is connected to the control, run the regulator to neutral as shown by the tap position indicator on the regulator. The control will recognize the neutral light signal and set the tap position accordingly.

The Motor Direct Drive KeepTrack "Regulate Internal" procedure recognizes tapchanges commanded via **manual, automatic or external (SCADA)** contacts. The power source for the manual- or SCADA-initiated tapchanges must be the same as the motor power source used for the automatic tapchangers.

The Motor Direct Drive KeepTrack "Regulate Internal" position knowledge is based on the detection of a closed switch (manual or automatic), and feedback from the operation counter input.

The method by which Motor Direct Drive KeepTrack "Regulate Internal" is achieved is as follows:

The control includes two Zero Voltage Detection (ZVD) circuits. These circuits individually monitor the AC voltage across the internal raise and lower triacs. This is done since any external raise or lower contacts or manual switches have to be placed in parallel with the triacs to run the tapchanger motor. When the triacs (or any contact paralleled across the triacs) closes, the voltage measure decreases to almost zero. When a counter input event is received while the raise circuit is activated, the Motor Direct Drive KeepTrack "Regulate Internal" will increment the tap count by one. When a counter input event is received while the lower circuit is activated, the Motor Direct Drive KeepTrack "Regulate Internal" will decrement the tap count by one.

If the tapchanger reaches the mechanical tap limits of operation, (± 16), limit switches open up the appropriate circuit so the control cannot force a raise above +16, or force a lower below -16. This is potentially confusing to the ZVD circuits, since they can see zero voltage on the output with a closed triac and also see zero voltage on the other output due to an open limit switch. When this condition is encountered, the control can only make a best guess of which operation really occurs and moves one step in the direction of neutral, which should be away from the side with the open limit switch.

An additional feature is the neutral zero feature. When a regulator passes through the neutral position, a neutral contact closes. This is most often used to drive a neutral light that is an indicator that the mechanism is in the neutral position, and it is safe to bridge the input and output of the regulator because they are at the same voltage. Upon detection of a neutral circuit closure, Motor Direct Drive KeepTrack "Regulate Internal" resets the tap position to neutral to resynchronize the circuit.

4.8 Reverse Power Operation

Detecting Reverse Power

Reverse power flow exists whenever the real component of the line current changes direction from forward and remains until another reversal to forward power flow occurs. The control reliably determines power direction with as little as 2% of the real component of the nominal 200 mA line current (4.0 mA).

Power Direction Bias Configuration

The Power Direction Bias Configuration screen contains three settings to determine how the control will switch between forward and reverse power operation. The three settings are **No Bias**, **Forward Bias**, and **Reverse Bias**.

"No Bias" Setting

When the Power Direction Bias function is set to "No Bias", the control applies an 8 mA hysteresis band with a bandcenter of 0 load current (+4 mA to -4 mA) to switch between forward and reverse power. The control will switch from forward power to reverse power when the load current exceeds -4 mA (reverse direction). The control will switch from reverse power to forward power when the load current exceeds +4 mA (forward direction).

"Forward Bias" Setting

When the Power Direction Bias function is set to "Forward Bias", the control applies a 0 mA to -4 mA hysteresis band to switch between forward and reverse power. The control will switch from reverse power to forward power when load current is ≥ 0 mA (forward direction). The control will switch from forward power to reverse power when the load current exceeds -4 mA (reverse direction).

"Reverse Bias" Setting

When the Power Direction Bias function is set to "Reverse Bias", the control applies a 0 mA to +4 mA hysteresis band to switch between forward and reverse power. The control will switch from forward power to reverse power when load current is ≤ 0 mA (reverse direction). The control will switch from reverse power to forward power when the load current exceeds +4 mA (forward direction).

Upon detection of power reversal, after a 5 second delay, the control will operate in the selected mode. The operating mode is selected from the following options:

Ignore – The control will take no different action than in the forward direction. It essentially does not use the power direction in the control decisions. This is the same as a control which does not have power direction knowledge.

Can be used on distribution systems which have the possibility of power reversal because of distributed generation (DG) on the feeders. In these applications, the DG usually does not have the capacity to control the voltage with the more powerful system intact.

The condition required for DG to control the voltage is the generation and transmission of large amounts of VARs through the line impedance back towards the system source. Usually two items prohibit this action:

- The ability of the DG to generate those amounts of VARs.
- The contractual obligations enforced by many utilities that the DG only affect KWs on the system.

Block – Inhibits automatic tapchange operation. This locks the tapchanger on the tap position in use at the time reverse power flow is detected. It is the recommended setting for independent power producers or in situations when reverse power flow is not expected. The control will revert to normal operation when forward power flow resumes.

Regulate REV (single-phase regulators only) – The control will detect reverse power flow and regulate according to reverse power settings as selected in the Setpoint Menu. With tap position knowledge, the control calculates the source-side potential without the use of a source side VT. This feature is designed for use with feeder voltage regulators which continue to operate in a radial mode after system switching causes the power flow reversal.

The source voltage is calculated by knowing the local voltage, the load current, and the tap position using a presumed regulator impedance. That impedance is a function of the tap position. The calculated source voltage is only valid with a 5/8% step-voltage regulator.

With the control recognizing reverse power flow, the following occurs:

- The **REV PWR** LED is illuminated.
- Reverse power setpoints are used.
- Source voltage is calculated and motor output commands are reversed. For example, when the voltage is high, the control raises the tap thereby lowering the voltage and a lower is indicated on the front panel LEDs.

Return to Neutral – To use this feature, a counter input must be provided, and one of the tap information modes must be enabled.

The Return to Neutral feature will cause the tap position to be driven to neutral when reverse power is detected. Tap position will be driven to neutral regardless of the voltage or currents present at the control. Once neutral is reached, the tap position will remain unchanged as long as reverse power is present. Normal operation will resume when forward power is detected.

This mode is intended as a safe response to a power reversal on a system which can have conflicting situations. As described earlier, a radially operating system with reverse power should be set to "Regulate Rev." However, if a DG causes a power reversal, the proper setting is usually "Ignore". In an application where both conditions are possible and it is not possible for the control to determine the cause of power reversal, the proper setting of "Return to Neutral" is advised.

Distributed Generation – Distributed Generation allows alternate LDC R and X values to be applied to the control when reverse power is detected. The factory setting is **BLOCK**. This mode is intended for use on distribution systems which have the possibility of power reversal because of distributed generation (DG) on the feeders. In these applications, the DG usually does not have the capacity to control the voltage with the more powerful system intact.

The condition required for DG to control the voltage is the generation and transmission of large amounts of VARs through the line impedance back towards the system source. Usually two items prohibit this action:

- The ability of the DG to generate those amounts of VARs.
- The contractual obligations enforced by many utilities that the DG only affect KWs on the system.

4.9 Parallel Operation

Refer to Figures 4-9, 4-10, 4-11, 4-12 and to Appendix A, Figure A-8. The user with access to the Configuration Menu may select the circulating current method of paralleling LTC transformers, or disable the feature. If the optional Δ VAR[®]1/ Δ VAR2 methods were purchased, they may also be selected. Paralleling by the circulating current method or the Δ VAR1 method involves a configuration in which each M-2001C Tapchanger Control is used with a Beckwith Electric M-0115A Parallel Balancing Module. The control is provided with a current input which is representative of the circulating current between two or more LTC transformers operating in parallel.

Circulating Current/ Δ VAR1

The general paralleling schemes for two and three transformer paralleling using the circulating current method are shown in Figures 4-9 through 4-12.

Figure 4-9 is a schematic of the current circuit only; redrawn from the Paralleling Scheme figures to allow easier tracing of the load current (I_L) and circulating current (I_p) paths.

A current, proportional to the transformer secondary current, is fed to the M-0115A unit. Because of the secondary parallel connection, however, this is actually the vector sum of the desired load current and any undesired circulating current. The M-0115A separates these currents, and sends them to the proper load (LDC) and circulating current inputs of the associated control.

Two current loops are formed. One involves the K3 auxiliary transformers in each of the M-0115A units. This loop forms a measure of the transformer bank circulating current, subtracted from the LDC control input and forced to flow into the control circulating current input.

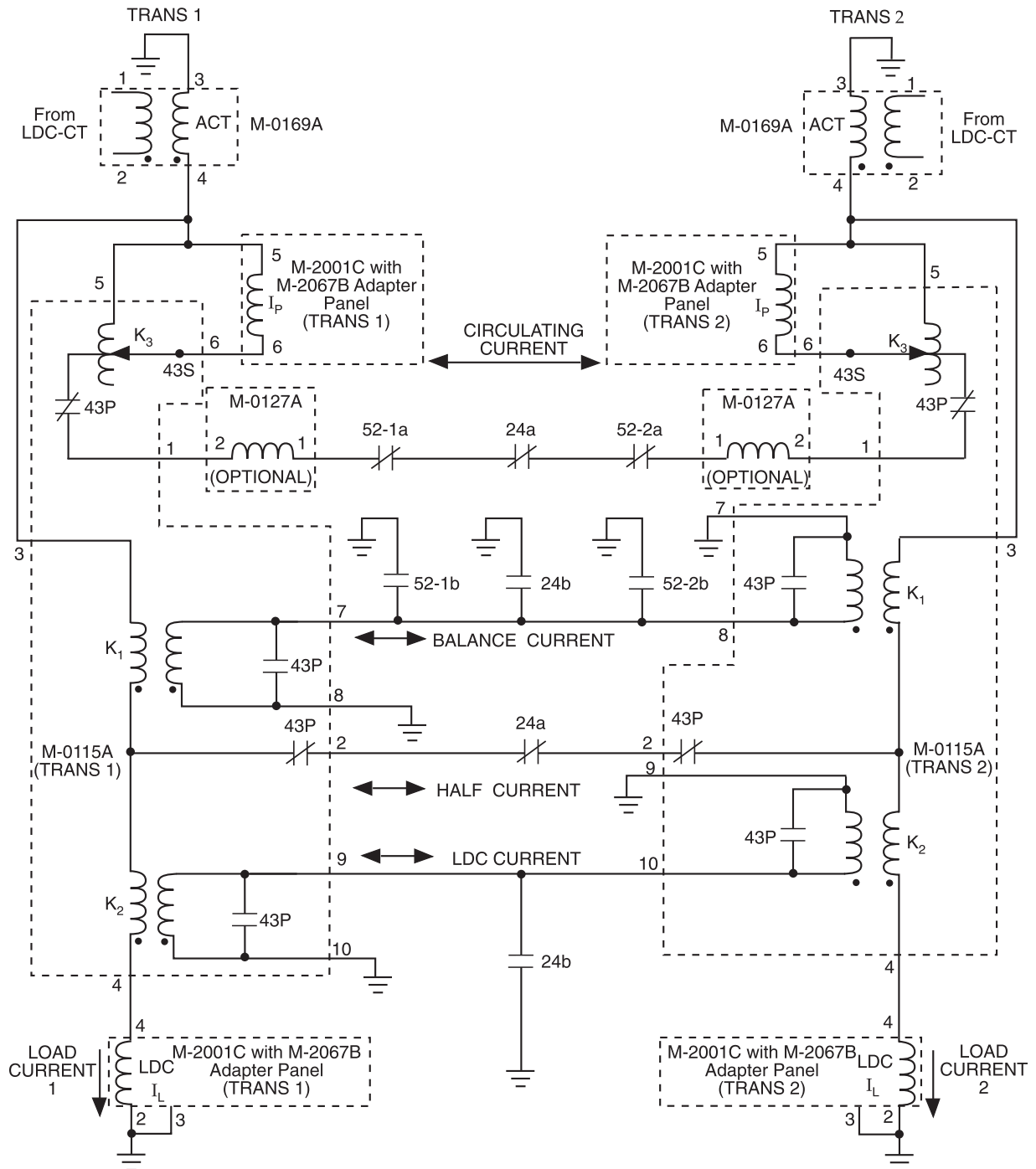
The second loop involves the K1 and K2 auxiliary transformers. They force the load current to divide properly between the various controls so that each senses its proper portion of the total bank load. Thus, the LDC setting for each control may properly be the same, regardless of whether or not the associated transformer is being used in parallel.

The first current path shown (Circulating Current) has a current analogous in angle and magnitude to the reactive current circulating through the paralleled transformers. It also includes the M-0127A

Overcurrent Relay, which is used to detect excessive circulating current and block the tapchanger movement, if this occurs. Also, a lamp will alert the operator when excessive circulating current is detected.

The second path shown (Balance Current), connecting the K1 auxiliary CT of the M-0115A modules together, has a balance current which forces the two load currents of transformers #1 and #2 to be identical. This means that any difference in currents must flow in the circulating current path.

The third and fourth path shown (Half Current and LDC Current), connecting the K2 auxiliary CT of the M-0115A modules together, ensures proper operation of the Load Drop Compensator circuit if one of the transformers is taken out of service by opening its breaker. For instance, if transformer #2 is taken out of service by opening breaker 52-2, then half of transformer #1's load current is forced to flow through the half current loop. In this way, transformer #1's voltage regulating control sees the same load current as it did before, and the proper amount of line drop compensation in the transformer #1 control is maintained. This circuit configuration and grounding points must be maintained, if transformers are to be successfully paralleled.



■ NOTES:

1. 52 contacts are shown in the breaker closed position; 43P in parallel position.
2. K3 is a circulating current sensitivity control.
3. M-0127A is a current relay to detect excessive circulating current.

Figure 4-9 Simplified Schematic of Current Circuit for M-2001C Paralleling Two Transformers using the Circulating Current or Δ VAR[®] Method

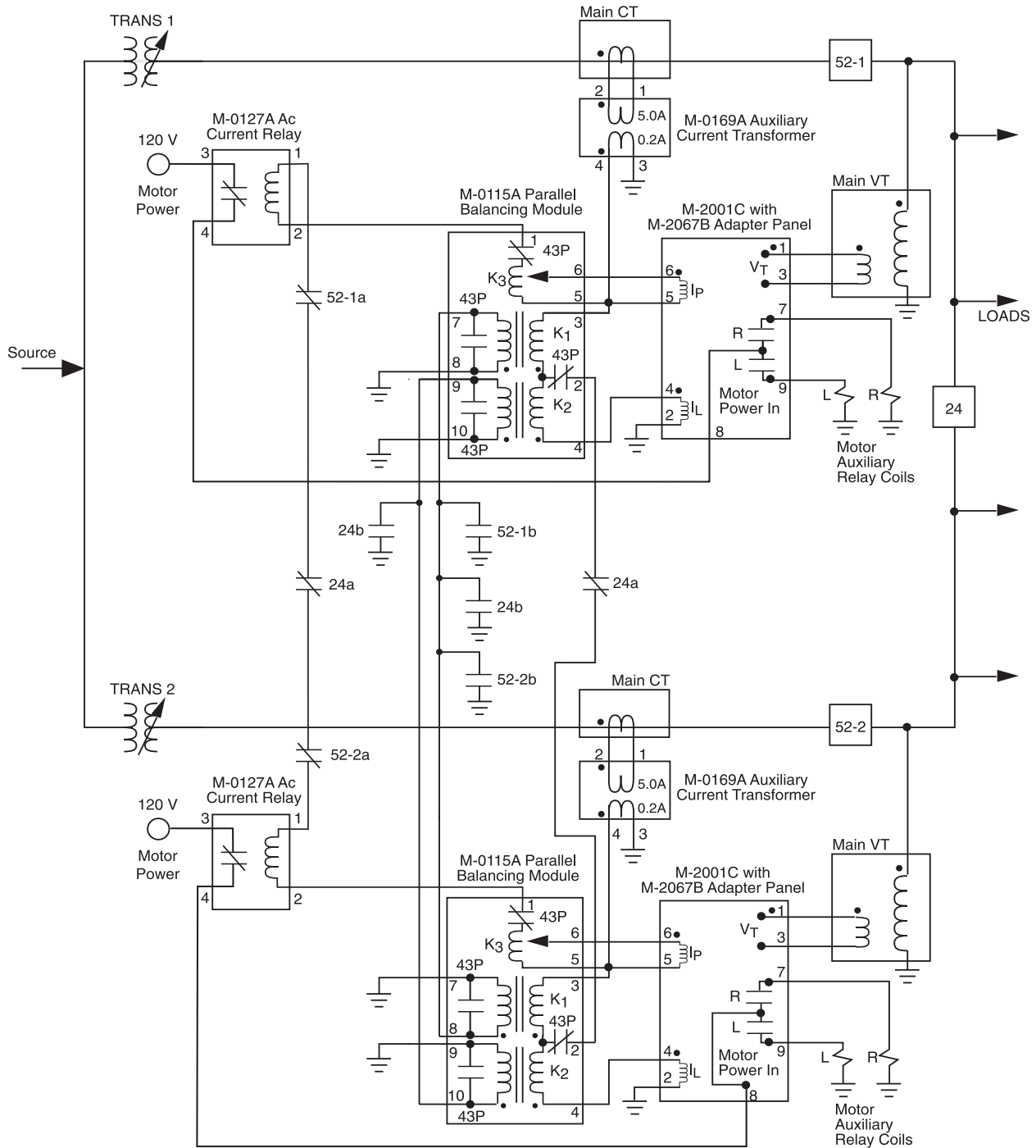


Figure 4-10 M-2001C and M-2067B Paralleling Scheme for Two Transformers using the Circulating Current or Δ VAR[®] Method

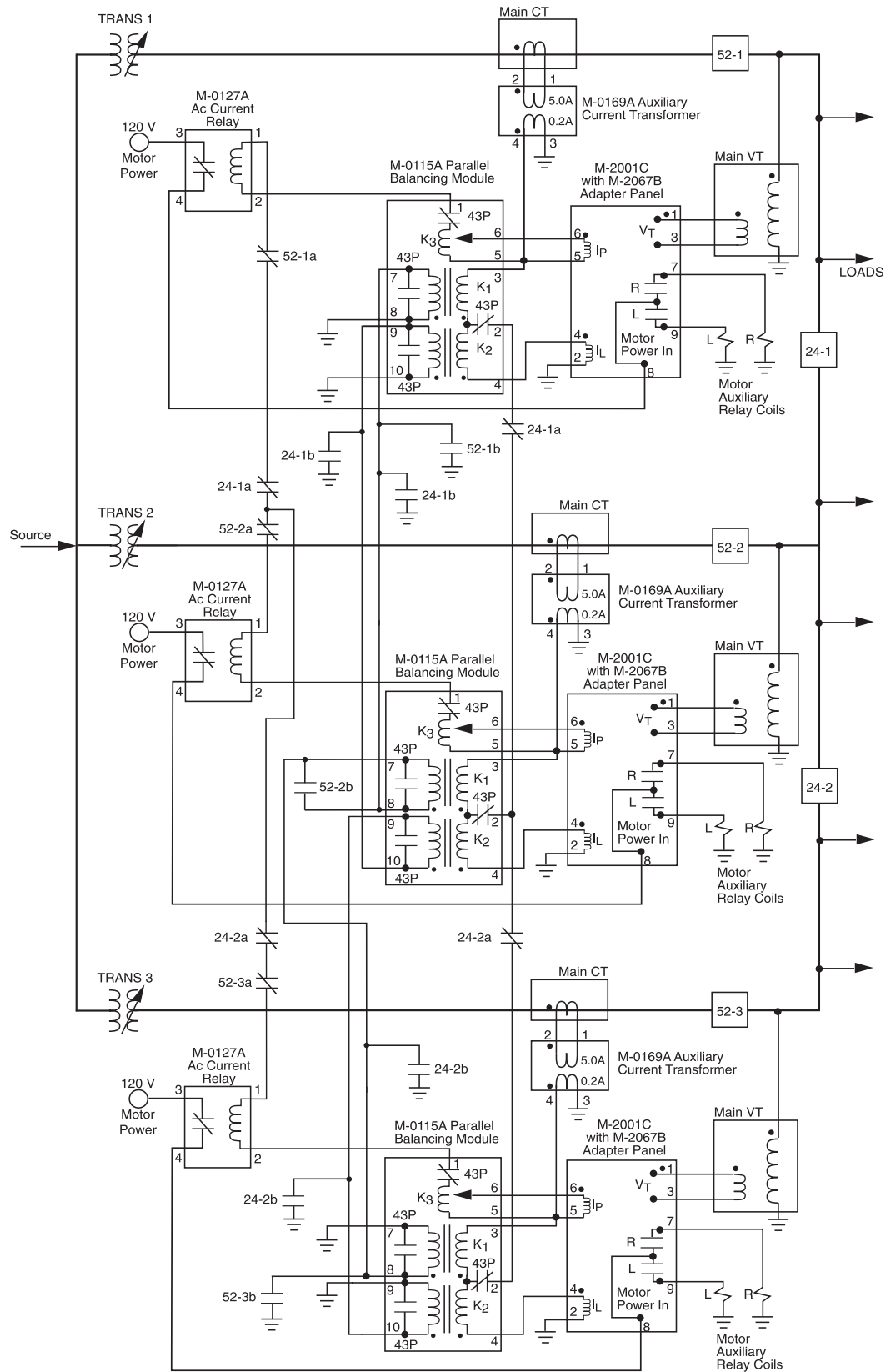


Figure 4-11 M-2001C and M-2067B Paralleling Scheme for Three Transformers using the Circulating Current or Δ VAR[®] Method

A more detailed description of the theory of operation is available from Beckwith Electric upon request. Application Note #11, "*Introduction to Paralleling of LTC Transformers by the Circulating Current Method*" and Application Note #13, "*Advanced Paralleling of LTC Transformers by the Circulating Current Method*" provide a thorough analysis of parallel LTC transformers operating by the circulating current method.

It is suggested that either the non-sequential or Intertap time delay be used when paralleling.

The sensitivity of the control or the amount of control setpoint bias for a 200 mA circulating current is 24 V. For circulating current applications, that is a 24 V setpoint shift for 200mA of total circulating current input. For Δ VAR1 applications, that is a 24 V setpoint shift for 200 mA of reactive circulating current.

For applications with low transformer impedances, the circulating current or VARs per tap difference is greater than in applications with high transformer impedances. This creates a need for a method to adjust the sensitivity of the control according to the system application.

On the circulating current application method and the Δ VAR1 application method, this is accomplished with a sensitivity adjustment on the M-0115A Parallel Balancing Module (see the M-0115A Instruction Book.)

■ **NOTE:** In all M-0115A applications, the M-0115A sensitivity settings should be equal on all paralleled transformers.

Δ VAR[®]2 Paralleling and Δ VAR2 Paralleling + Motor Direct Drive KeepTrack™

The theoretical basis for the Δ VAR2 Method of paralleling is that paralleled transformers are meant to SHARE the VAR load (as well as the KW load) of the load bus. Since the KW sharing of the parallel transformers is determined by the relative transformer impedances and NOT the tap position, KW flow should not effect tap position choice. Further, that the best choice of loading parallel transformers is to maintain the VAR sharing regardless of KW loading which can be accomplished with relative tap positioning.

The Δ VAR Method will result in the VAR flow to the substation load to be shared in the appropriate ratio of the paralleled transformers' ratings. It should be noted that auxiliary CT's are required in circulating current schemes to balance the currents when transformers with different impedances are paralleled. Those auxiliary CT's are not necessary when the Δ VAR Method is used.

The Δ VAR2 implementation is limited to use with no more than two transformers and each transformer current is input to each control. This eliminates the need for the parallel balancing module and removes the path for the installation of the overcurrent relay. For this implementation, the sensitivity setting is added to the M-2001C Tapchanger Control along with a circulating current overcurrent inhibit function. The Δ VAR2 implementation also contains a CT ratio-matching setting making it unnecessary to match CT ratios exactly to transformer MVA ratings for proper operation.

The Δ VAR2 Method is incorporated in the Beckwith Electric M-2001C Tapchanger Control, as an option. This option internally calculates and compares the individual transformer VAR flows. Decisions for voltage setpoint biasing are then made and implemented to change tap positions in such a manner that the difference in VAR flow is minimized.

Action is taken continuously as the MVAR load is changing such that the magnitude of difference in VAR loading is minimized (depending on the VAR difference of one, off-optimum, tap position).

The use of LDC (line drop compensation) is precluded when Δ VAR2 is used since no provision is made for the increase in load currents in one transformer when the other is out of service. The result would be doubling the LDC effect when in independent operation.

ΔVAR2 Connection

As shown in Figure 4-12, the current input is connected to the load current terminals of the control and then into the circulating current terminals (Ip) of the paralleled transformer control. Each control now sees the same voltage and each transformer current separately. This allows each control to calculate the VAR flows in both transformers for comparison, without externally sorting out the load and circulating current values. Breaker contact 52-3b is used to signal the M-2001 Control to disable paralleling using the neutral light input (Redefined when ΔVAR2 selected). An external independent/parallel switch (43P) is suggested to provide manual control for testing and maintenance. The effectiveness of this grounding is important for the recognition of this condition.

Paralleling by the ΔVAR2 method does not use the M-0115A Parallel Balancing Module. This method of paralleling can only be used for two transformers. Refer to Figure 4-12 for the ΔVAR2 connections. Instead, the two load currents are brought into the control, and the actual ΔVAR's which exist between the paralleled transformers is calculated internally. When using the ΔVAR2 method, the control's load current input is to be connected to the load current CT of the transformer which is controlling the tap position. The control's circulating current is to be connected to the load current CT for the opposite paralleled transformer.

The measured voltage the M-2001C controls on each of the transformers will be biased in such a way as to attempt to minimize the circulating current between the two. In the case of ΔVAR, the tap positions will minimize the difference in VARs from each transformer.

For ΔVAR2 applications, there is a 24 V setpoint shift for 200 mA of calculated reactive current difference between transformers. (ΔVAR2 is only applicable for two parallel transformer applications.)

For applications with low transformer impedances, the circulating current or VARs per tap difference is greater than in applications with high transformer impedances. This creates a need for a method to adjust the sensitivity of the control according to the system application.

On the ΔVAR2 application method, which uses no M-0115A module, a control setting is provided to accomplish the sensitivity adjustment.

NOTE: In all ΔVAR2 applications, the sensitivity settings should be equal on all paralleled transformer controls.

Exclusively for the ΔVAR[®]2 method, there are three functions activated and set in the Configuration menu for proper operation: **ΔVAR2 Sensitivity**, **ΔVAR2 Reac Limit**, and **ΔVAR2 I Ratio**. When the ΔVAR option has not been purchased, these input screens will be disabled.

The **ΔVAR2 Sensitivity** ranges from -4.0 to +4.0, as did the M-0115A adjustment. At a ΔVAR2 Sensitivity setting of 0.0, 100% of calculated reactive current difference will be used to bias the setpoint. At a setting of -4.0, only 50% of the calculated reactive current difference will be used to bias the setpoint, making the control less sensitive to the circulating current. At a setpoint of +4.0, the bias will be adjusted by a value of 200% of the calculated reactive current difference, making the control more sensitive to the system current.

The **ΔVAR2 Circ Limit I** setpoint establishes a limit on the calculated reactive current difference between transformers. The settings range from 5 mA to 200 mA in 1 mA increments. If the calculated reactive current difference reaches this setpoint, the operation of the control will be blocked and the alarm output function will be activated, if enabled. The purpose of this limit is to stop any runaway condition. This feature is required to replace the M-0127A overcurrent relay used in the circulating current and ΔVAR1 applications.

NOTE: Care must be taken in setting the **ΔVAR2 Circ Limit I**, to ensure it is high enough to allow a two or three tap difference from optimum in transformers before operating. Some knowledge of system impedances are useful in determining this setting, but the current difference may also be tested for immediate system conditions by reading the current change when one tap is changed on either transformer.

The **ΔVAR2 I Ratio** is used to adjust the sensitivity to the line current input versus the circulating current input (opposite transformer load current) to compensate for unequal CT ratios between transformers. For proper operation with a ratio setting of 1, the ratio of the CT ratios must be equal to the ratio of the transformer ratings (CT1/CT2=MVA1/MVA2).

$$\left(\frac{\text{TX1 Rating}}{\text{TX2 Rating}} \right) \left(\frac{\text{TX2 CT Ratio}}{\text{TX1 CT Ratio}} \right) = \pm \text{Ratio TX 1}$$

$$\left(\frac{\text{TX2 Rating}}{\text{TX1 Rating}} \right) \left(\frac{\text{TX1 CT Ratio}}{\text{TX2 CT Ratio}} \right) = \pm \text{Ratio TX 2}$$

Example: A 20 MVA transformer is being paralleled with a 15 MVA transformer. If the CT ratios are 2000 A and 1500 A to 0.2 A, no compensation would be required (both transformers are fully loaded when the CT outputs are 200 mA.) However, if they each had 2000 A to 0.2 A CTs, the $\Delta\text{VAR2 I Ratio}$ on the 20 MVA transformer control should be 1.34, and the $\Delta\text{VAR2 I Ratio}$ on the 15 MVA transformer control should be 0.75.

The settings for this ratio are 0.50 to 2.00, in 0.01 increments. When the setting is 0.50, the control will be 0.50 times as sensitive to the VARs from the circulating current input versus the load input current. The default setting for the sensitivity is 1.00, indicating the ratio of the CT ratios are equal to the ratio of the transformer ratings.

This feature can also be used to replace the need for auxiliary transformer for matching transformer CT ratios. No correction is necessary to compensate for impedance differences in the transformers with ΔVAR operation.

For ΔVAR2 applications (without Motor Direct Drive KeepTrack™), paralleling will be disabled if either current input drops to less than approximately 10 mA or if a neutral input is present. When ΔVAR2 operation is configured, the normal neutral input is directed to this duty rather than the normal neutral light operation. It is highly recommended that this input be connected to operate whenever any breaker opens which isolates the transformer from parallel operation.

For ΔVAR2 Paralleling + Motor Direct Drive KeepTrack mode the Voltage Reduction Step 2 Input will be the Neutral Input. This is needed since the Neutral Position Input is used for KeepTrack.

4.10 Output Selection

Output Selection

There are two setup screens associated with this feature. This screen is located in the **Configuration** menu. A selection of continuous or pulse may be chosen.

Output Pulse

▲ CAUTION: If an appropriate pulse width setting is not input, then a misoperation of the tapchanger may occur when a SCADA Manual Raise or Lower is initiated.

Located in the Setpoint menu. The output pulse can be programmed from 0.2 to 12 seconds, in increments of 0.1 seconds. An initiated pulse will continue until the pulse time has been reached or a counter contact operates.

■ NOTE: When enabling the pulse feature on an LTC without a counter contact, care must be taken to make the ON pulse width less than the time it takes for a complete tap change to occur, but long enough for the seal-in circuit to be activated. The Intertap Time Delay should be longer than the time it takes for a complete tapchange to occur.

Continuous

The output is continuous until the voltage returns into the bandwidth.

4.11 Protocols/Communication

Refer to the Appendix, Figures A-5 and A-8. The user must select the protocol that is to be used with the M-2001C Tapchanger Control's COM1 port and optional COM 3 port. The following standard protocols are included in the control: BECO 2200 (factory setting), BECO 2179, Cooper 2179 (screen displays "2179" only), Cooper 2179A, GP 2179, MODBUS, GP DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0 and DNP3.0. COM2 port (front) uses BECO 2200 exclusively.

■ NOTE: When selecting or deselecting DNP points, power to the unit must be removed and then reapplied in order for the changes to take place.

■ NOTE: The following features are not able to be set using optional IEC 61850/UCA 2.0 protocol: Pulsed Output, Data Logging, Inverse Time Selection, LDC-Z, Configurable Tap Position, and Current Display/Scaling.

When DNP All Points is enabled, baud rates greater than 4800 are recommended. Baud rates less than 4800 will delay the response of the front panel display.

Detailed descriptions of the data points used for any of the four standard protocols are available from Beckwith Electric upon request, and are available for download from our website, www.beckwithelectric.com. For further information on communication ports, please see Section 6.5, Communication.

4.12 Basic Timer Types

The time delay of the control may be selected from two different types. Selection of an *Integrating* timer type increments the timer when the voltage is outside the band, and decrements the timer towards zero when the voltage is within the band. Selection of *Instantaneous* timer type increments the timer when the voltage is outside the band, and resets to zero instantly when the voltage returns within the band.

4.13 Data Logging

This feature allows you to configure the parameters that the control will use to log data (with TapTalk®) to a compatible spreadsheet file. Once the log parameters are uploaded through TapTalk, the control will log data to on-board memory. Logging will continue indefinitely until a new set of log parameters are uploaded, at which point all previously logged data will be lost. It is necessary that the log parameters are set up, and logging be initiated, through the TapTalk Data Logger for this feature to work as expected.

There are 19 communication points associated with the data logging on the control. Data logging may be set/read from BECO 2200 or BECO 2179 protocols.

There are four command points:

Log Sample Period – This is a read/write point. Data range is 1–9,999 minutes in increments of one minute.

Full Record Flag – This is a read only point. It reads zero if the memory has not yet been written over. Reads one if the data has wrapped around, and overwritten previous data.

Log Point Select – This is a read/write point. Data is set in binary format.

Log Status – This point is a command/status/read/write point. Command/status is as follows:

- 0 Not logging (command)
When a zero is written to this point, logging will stop.
- 1 Logging (status)
If log status reads 1, logging is in progress.
- 3 Start Logging (command)
When a three is written to log status, logging will start. Points 9-00 and 9-02 must be set up prior to issuance of a logging command. Logging will continue indefinitely, or until a stop logging command (0) is issued, in a circular buffer manner. The absolute size of the data logging array is 311,040 bytes. The start address of this buffer is 90000 hex. Data will always be logged in records. If the last record exceeds this number (311,040), then the first record at address 90000 hex will be overwritten.
- 4 Download (command)
When a four is written to log status:
 - *The oldest record time stamp can be read in BECO 2200 9-04, 9-05, 0-06.*
 - *The newest record time stamp can be read in BECO 2200 9-07, 9-08, 9-09.*
 - *The current logged data pointer can be read from BECO 2200 9-10, 9-11.*
 - *The ready to download logged data pointer can be written in 9-12, 9-13.*
 - *The first parameter of a record (a 16 bit word of information pointed by 9-12 and 9-13), along with the next 14 words will be ready for query with BECO 2200 protocol. You must issue a read of 15 points (only), starting with point number 9-14. Be aware that this scheme will not read records. It will read 15 words at a time, crossing record boundaries. It will start by reading the 1st parameter in a record, then it will read the next 15 words. As this happens, the control will set up the next 15 words to be read, starting with point 9-14, by incrementing the ready-to-download logged data pointer accordingly.*

4.14 Current Display/Scaling

The current input rating of the M-2001C Tapchanger Control is 200 mA, continuous. Auxiliary CT's are necessary if primary currents exceed this value.

The Current Transformer scaling selection is set in the Configure menu to be 200 mA, 1 A or 5 A. This choice fixes the scale of both the metering readout quantities and the settings of current values.

The status screens showing this information, **CONTROL LOAD I** and **CONTROL CIRC I** will be updated accordingly

▲ **CAUTION:** This selection is for scaling purposes only, and neither 1 A nor 5 A should be input to the control.

The values of the current displayed in the control load I, and on circulating current screens can be displayed in either 200 mA, 1 A or 5 A scale.

▲ **CAUTION:** The current input to the control is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

The Line Limit Current setpoint screen is also affected by this selection.

4.15 Regulator Type

Regulator Type A or B can be selected in the **Configuration** menu. This will allow the source voltage to be calculated correctly for either type of regulator (see Figure 4-13). It will also allow the control to operate more accurately when in the "regulate in reverse power" mode.

General Electric VR-1 voltage regulators are available in two winding configurations; Type "A" non-inverted configuration and type "B" inverted configuration. These types refer to the internal power component connections. See figure 4-13.

The Type "A" non-inverted configuration regulator includes a wire jumper on the NN terminal block for Potential Transformer tap selection.

On the older regulator controls (those not having power disconnect and CT shorting knife switches), the PT tap selection jumper is usually connected between terminals NN-9 and NN-20, NN-21 or NN-22. On newer regulator controls, (those with power disconnect and CT shorting knife switches), the PT tap selection jumper is usually connected between terminals NN-8 and NN-20, NN-21 or NN-22. There are special cases when a PT ratio correcting transformer is supplied and the jumper position is different. **In all cases please consult the regulator tank nameplate for the proper jumper connections.**

The Type "B" inverted configuration regulator is supplied from the factory with a standard 0.75 ohm resistor installed on the NN terminal block in addition to the PT tap selection jumper. This series resistor limits short circuit currents in the event of an external fault.

On the older regulator controls (those not having a power disconnect and CT shorting knife switches), the resistor is usually connected between terminals NN-9 and NN-22. The PT tap selection jumper is usually connected between terminals NN-22 and NN-20 or NN-21. On newer regulator controls, (those with power disconnect and CT shorting knife switches) the resistor is usually connected between terminals NN-8 and NN-22. The PT tap selection jumper is usually connected between terminals NN-22 and NN-20 or NN-21. **In all cases please consult the regulator tank nameplate for the proper jumper connections.**

▲ **CAUTION:** The control can be damaged if the PT tap selection jumper is not connected properly when the regulator is energized.

The control is not powered if either the PT tap selection jumper or resistor is missing or open.

The user should always verify proper connections by **consulting the nameplate on the regulator tank**. The user is cautioned that the nameplate on the control cabinet could possibly be incorrect if the control has ever been replaced. If the serial number on the control cabinet matches the serial number on the regulator tank or nameplate, the control cabinet nameplate may be consulted for proper jumper configuration.

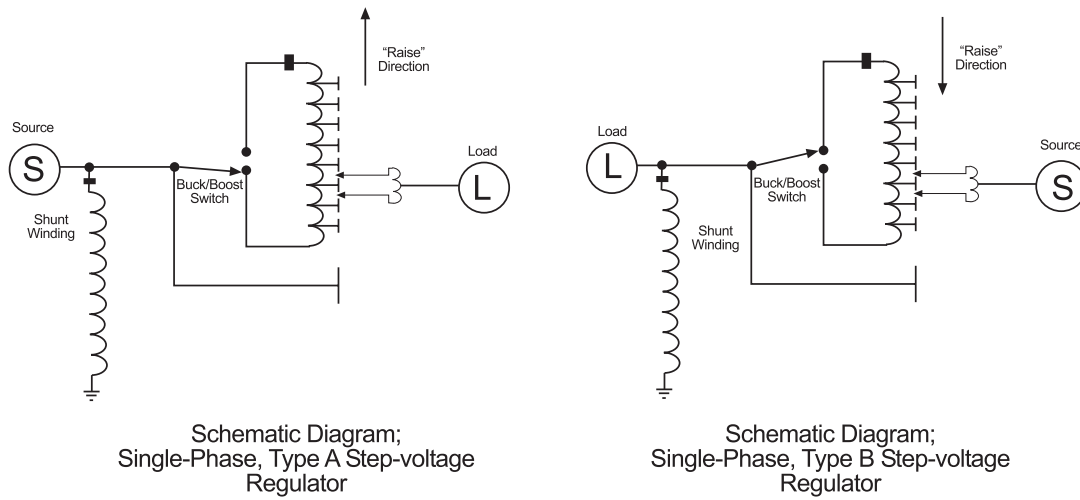


Figure 4-13 Regulator Type

5 Status

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5.3	Real Time Clock.....	5-3
5.4	Line Frequency	5-3
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5.6	Removal of Select Status Screens.....	5-4

5.0 Introduction

Refer to Figures 5-1 and 5-2.

The control has the capability of displaying measured and calculated secondary quantities and calculated primary quantities.

5.1 Metering

Secondary

The display will show local voltage, source voltage, compensated voltage, line frequency, and load current in secondary quantities along with load power factor. The voltage is displayed on a 120 V base and the current is displayed on a 200 mA base.

■ **NOTE:** The local voltage displayed will not match the voltage measured at the test terminals on the adapter panel if a sensing VT ratio correction other than 0.0 V has been entered.

Primary

Refer to the Appendix, Figure A-5. In order to use the calculated primary quantities feature, the user must enter the following data in the **Configuration** Menu:

1. Select line-to-line or line-to-ground VT configuration.
2. Select single-phase quantities based on measured inputs, or three-phase quantities based on measured inputs and assume a balanced system.
3. Select primary voltage and current multipliers needed to calculate primary quantities.

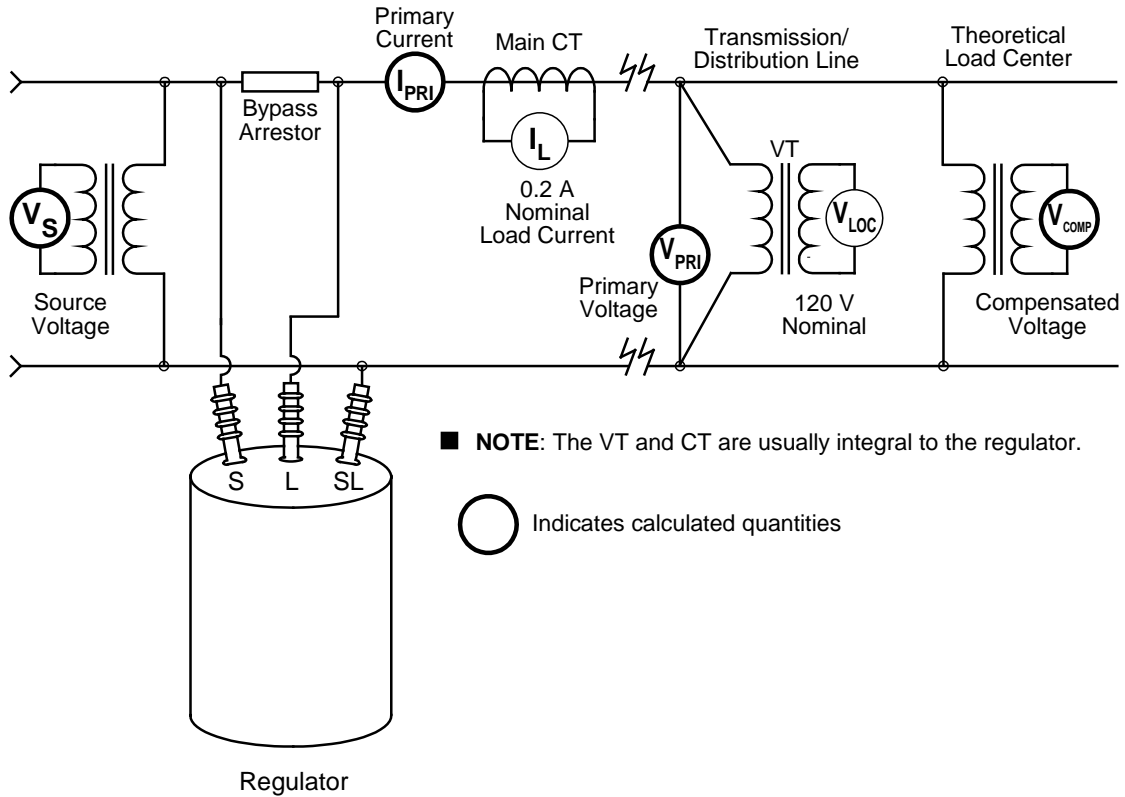


Figure 5-1 Secondary Quantity Metering and Primary Quantity Calculations for Regulator Applications

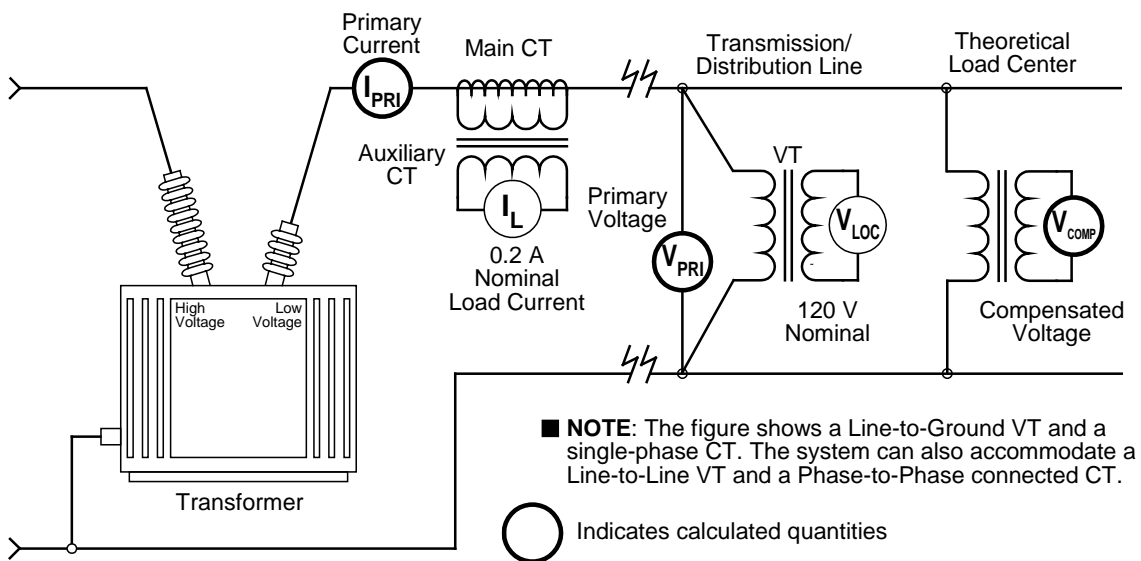


Figure 5-2 Secondary Quantity Metering and Primary Quantity Calculations for Transformer Applications

Demand Metering

Refer to the Appendix, Figure A-5. The demand metering capability provided in the control follows the concept of a lagged demand meter. The demand time interval is selected by the user as 15, 30 or 60 minutes. This is the time it takes for a thermal meter to indicate 90% of a change in load.

Quantitative Metering

Refer to Appendix A, Figure A-2. The quantitative metering function of the control displays the following measured values on the individual status screens:

- Total Reverse VAr Hours (KVArHR, MVArHR or GVArHR)
- Total Forward VAr Hours (KVArHR, MVArHR or GVArHR)
- Total Reverse Watt Hours (KWHR, MWHR or GWHR)
- Total Forward Watt Hours (KWHR, MWHR or GWHR)

The measured values are retained in non-volatile memory. A real time clock is utilized to record a date/time stamp for each quantity to indicate when the period of measurement was initiated.

When a quantitative metering screen is selected, three screens cycle continuously to indicate the total value, date and time the measurement was initiated. The **E** indicates that the measured value can be reset by pushing **ENT**.

5.2 Drag-Hand Display Quantities

Refer to the Appendix, Figure A-5. Drag-hand quantities are the maximum and minimum values for the period since the last reset command. These are retained in non-volatile memory. A real-time clock allows the recording of a date/time stamp with each drag-hand quantity. The following are available for drag-hand use:

- Min/Max tap position (when Tap Position is enabled)
- Min local voltage (120 V base)
- Max local voltage (120 V base)
- Max load current
- Max watts, kW or MW
- Max VAr, kVAr or MVAr
- Max VA, kVA or MVA
- Power Factor at max VA

Where primary quantities are used, values displayed are single-phase or three-phase as defined in the Pri Pwr Display Screen of the Configuration Menu.

▲ **CAUTION:** When the M-2001C Tapchanger Control is used with a Beckwith Electric adapter panel, the panel's drag hands reset button only resets the mechanical drag hands of the regulator or LTC transformer. The button does **not** reset the tap draghands information stored in the control. The maximum and minimum tap position of the control should always be reset when the mechanical drag hands are reset.

The values retained in memory are time-tagged quantities that are calculated using the demand period selected (15, 30 or 60 minutes). For voltage, values are the average of samples taken over a period of 32 seconds which avoids undue retention of momentary voltage transients. The load power factor retained is the value at the time of max VA.

When selected, three screens for each parameter cycle continuously and indicate the value, date and time of each parameter. The **E** indicates that the drag-hand can be reset by pushing **ENT**.

5.3 Real-Time Clock

Refer to the Appendix, Figure A-2. The control is equipped with a real-time, 24-hour clock which is used with the drag-hand feature to record date/time stamp information on quantities saved in memory. The power source for the clock is maintained for at least 24 hours during a system power outage by a charged capacitor (no battery). If the power outage lasts longer than 24 hours, check the clock and reset if necessary.

5.4 Line Frequency

Refer to the Appendix, Figure A-2. The control provides for real-time metering of the line frequency. If the control is a 60 Hz model, the operating frequency is 55 to 65 Hz; if the control is a 50 Hz model, the operating frequency is 45 to 55 Hz.

5.5. Voltage Reduction Status

▲ **CAUTION:** Enabling this function may shorten the life of the screen.

Refer to Figure A-5. The control has a flashing voltage reduction status which can be enabled/disabled in the Flash V Red Mode screen of the **Configuration** menu. When enabled, and voltage reduction mode is active, the display will show the local voltage for approximately two seconds, then turn off for approximately 7 seconds. Then the voltage reduction status will be displayed for approximately two seconds, then turn off for about 7 seconds. Then the cycle will repeat, as long as voltage reduction mode is active and the front panel pushbuttons have not been used in the past five minutes.

5.6 Removal of Select Status Screens

Select status screens can be removed by pressing and holding the **ENT** pushbutton, and then also pressing the **↓** pushbutton. This will cause the present status screen to be removed from the status menu for quicker status access. Only the screens that do not use the **ENT** button in any way can be removed. The status screens that can be removed are: Comp. V, Source V, Circ I, Load I, Power Factor, Primary screens (V, I, VA, Watts, VAr), Total Op Count, Pf at Max VA, and Timers. All of the screens can be restored from the "Restore Status Screens" menu item in the **Configuration** menu.

6 Connections

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6.0 Installation

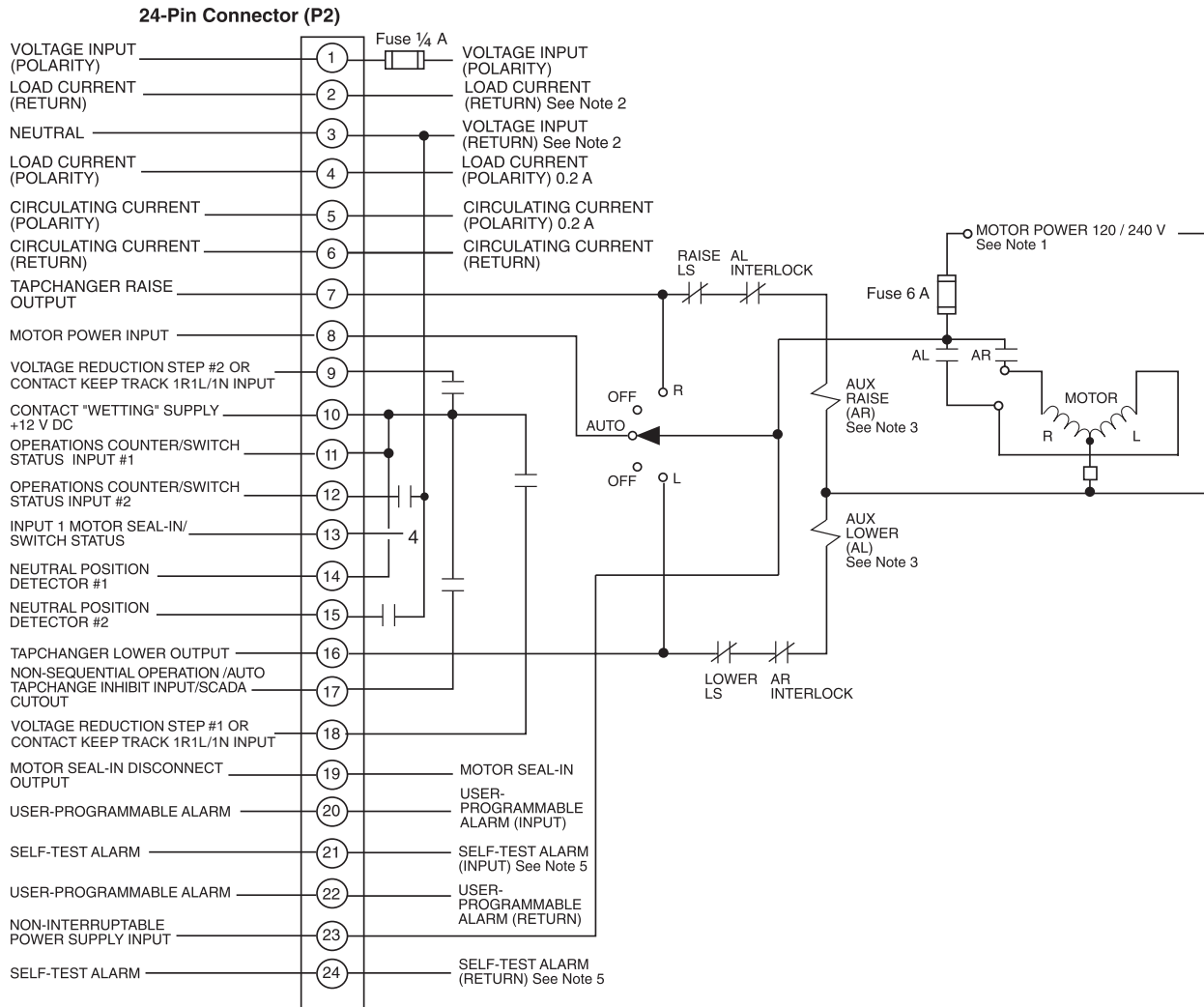
An adapter panel or a M-2050/M-2054 Surface Mounting Kit must be used with the M-2001C Tapchanger Control. Each panel adapts the control as a transformer or regulator control replacement and provides the external connections necessary for operation via terminal blocks on the rear of the adapter panel.

In lieu of using one of the M-2000 series adapter panels to mount the control, the M-2050 or M-2054 Surface Mounting Kit permits surface mounting. The kit consists of two right angle mounting brackets which bolt to the rear top and bottom of the control. All necessary hardware is included in the kit. Also included is a 24-pin, in-line female connector with six-foot pigtailed on each pin to facilitate custom connection of the control in original equipment manufacturers' applications.

6.1 External Connections

Available connectors include: one RS-485, one Fiber Optic connection, one RJ-45, one 24-pin blue connector, two RS-232 DE9S connectors, an in-line, 6-pin connector for the M-2025B(D) Current Loop Module and a Control Power Backup Input option. See Figure 2-1 for the locations of these external connectors.

The external connections for the control are made to the 24-pin connector, P2. For example, if external dry contacts are being used to control the voltage reduction step #1 function, connections for these contacts may be made between Pin 10 and Pin 18 as shown in Figure 6-1. The dry contact inputs for non-sequential input, voltage reduction, motor seal-in, counter input and neutral detection must be "wetted" by connecting to terminal Pin 10.

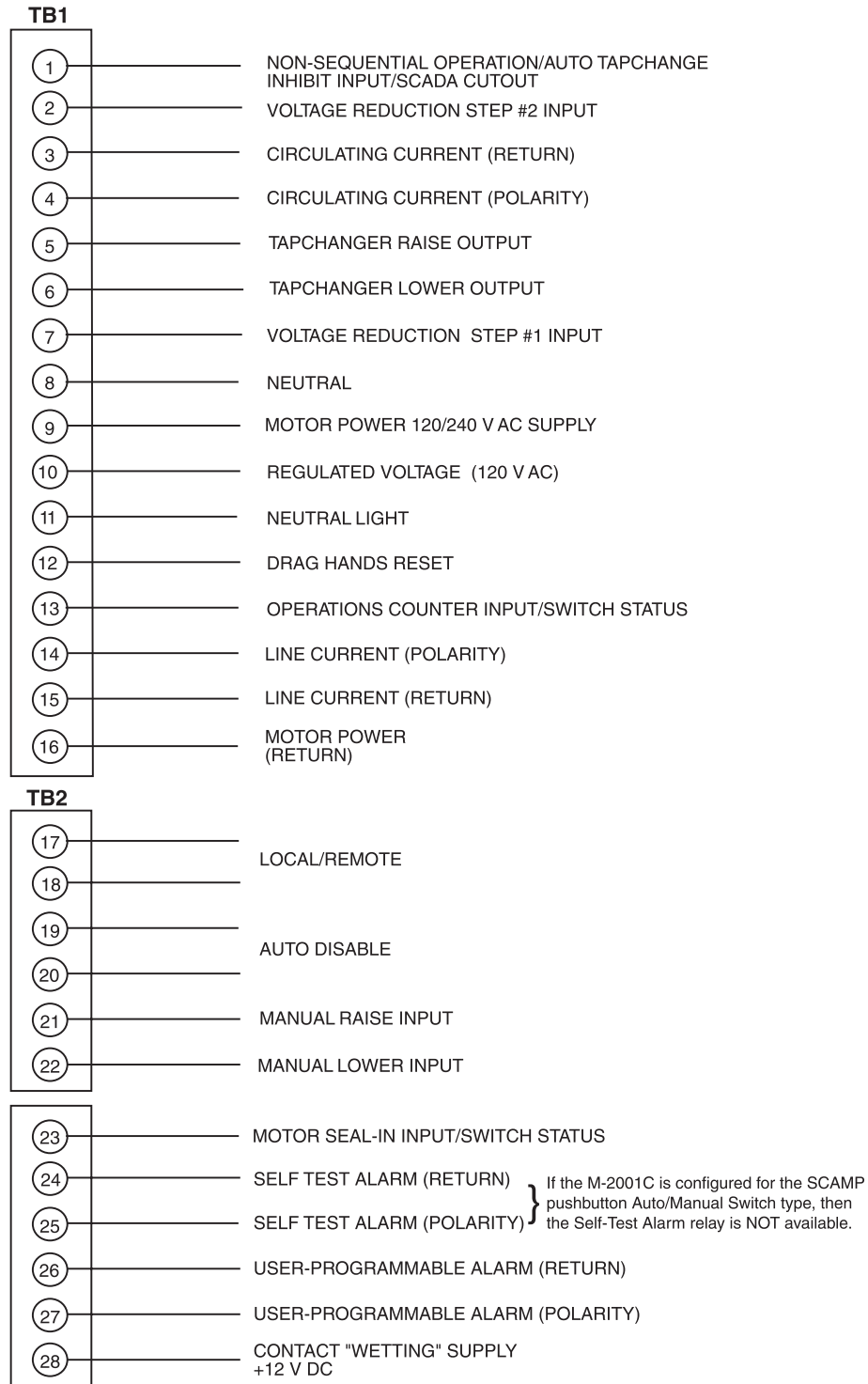


■ NOTES:

1. Motor voltage may be 120 or 240 V to neutral, or 240 V phase-to-phase.
2. The customer is to provide an earth ground connection to the CT/VT's neutral connection, external to the control.
3. Due to leakage current through the output triac's protection circuitry, auxiliary relays with high impedance, coils may not drop out. See Section 6.7, Interposing Relay Specification.
4. To Motor Power Seal-In board.
5. If the M-2001C is configured for the SCAMP pushbutton Auto/Manual Switch type, then the Self-Test Alarm relay is NOT available.

● **WARNING:** When an adapter panel is not used, automatic shorting of CT inputs is not provided by the M-2001C/M-2050; the customer must provide a method for shorting the CT's before the control is disconnected.

Figure 6-1 Typical M-2001C (Comprehensive) Stand-Alone Connections



● **WARNING:** Open CT secondary will result in high voltage at CT terminals. Death, severe injury or damage to equipment can occur.

▲ **CAUTION:** Do not operate with CT secondary open. Short circuit or apply burden at CT secondary during operation.

Figure 6-2 Typical Adapter Panel External Connections

M-2001C Control (Blue Connector)

▲ **CAUTION:** These binary inputs must be "wetted" by connection to Pin 10 only—a nominal 12 V dc source. If the contacts are connected to a 120 V ac source, it will result in damage to the control.

The external connections for the control are shown in Figure 6-1.

The communication ports provide remote access to the tapchanger control using the M-2029A TapTalk® Communications Software.

Pin 1 Voltage Input

This input accepts nominal 120 V ac, 60 Hz (or 50 Hz as ordered) to operate the control's power supply and voltage sensing input. The acceptable voltage range for proper control operation is from 90–140 V ac.

Power consumption is less than 8 VA. The input voltage is referenced to line neutral (Pin 3).

Control users may encounter situations where actuating the Drag Hands Reset pushbutton on one of any of our adapter panels results in the loss of a Voltage Sense fuse. The Drag Hands reset solenoid is power from the circuit that powers the control, and provides the control with sensing voltage. Initially, a 1/4 Ampere fuse was used in this circuit, and most recently a 1 Ampere fuse was substituted to prevent further loss of the fuse. This phenomenon is due to the fact that, as solenoids age, they may become sticky due to mechanical misalignment, hardened grease, or shortened windings.

The adapter panels include a one ampere fuse in the voltage sense circuit. This value should be adequate for all but the most extreme problems. When a Drag Hands Reset Solenoid that consistently blows a one amp fuse is encountered, it is recommended that the customer either remove the solenoid for cleaning and adjustment, or replace it completely.

Pin 2 Load Current Return

This is the non-polarity input to the load current measuring transformer. The companion polarity input is Pin 4. The line current transformer input is isolated from other pins.

Pin 3 Neutral

This is the return for the Voltage Input (Pin 1), and nominal +12 V dc "wetting" voltage (Pin 10).

Pin 4 Load Current Polarity

The line current input range is 0–640 mA (200 mA continuous) with 200 mA representing the 1.0 per-unit value. The measured current value is used for line drop compensation and metering calculation.

▲ **CAUTION:** The current input to the M-2001C is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

Pin 5 Circulating Current Polarity

The circulating current transformer measures a relative reactive current flow between transformers in parallel configuration. Maximum anticipated current input is 200 mA.

▲ **CAUTION:** The current input to the M-2001C is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

Pin 6 Circulating Current Return

This is the return path for Pin 5. The circulating current transformer input is isolated from other pins.

Pin 7 Tapchanger Raise

This switched output connects the tapchanger raise winding to the source of motor power. When the control calls for a raise, it is capable of switching up to 6 A at 120/240 V ac.

Pin 8 Motor Power Input

The source for powering the tapchanger motor is connected here. It may have a maximum voltage of 240 V ac.

Pin 9

- Voltage Reduction Step #2

This digital input is typically enabled by connecting it to the nominal +12 Vdc wetting source (Pin 10), through an external Form "a" dry contact. The amount of voltage reduction implemented is determined by the setting.

When "Contact KeepTrack™ 1R1L" or "Contact KeepTrack 1N" tap position knowledge is selected the Voltage Reduction Step #2 Input is utilized as an "Auxiliary Lower Contact Input" in the "Contact KeepTrack" method of tap position knowledge. Voltage Reduction Step #2 is still available through communications.

- Neutral Input Operation

When the parallel configuration mode is set to Δ VAR[®]2 + KeepTrack™, this input becomes the neutral input. This is due to the standard neutral input being used for Δ VAR2 disable input when Δ VAR2 configuration is used.

Pin 10 +12 V dc Wetting Voltage

This is the output of an unregulated dc power supply internal to the control. It is referenced to neutral and can supply up to 100 mA. It is used for powering the digital inputs of the control through external relays. Depending on the voltage supplied to Pin 1 and loading, its output can vary from +10 to +18 V dc. It is not fused in the control.

Pins 11 & 12 Operations Counter Inputs 1 and 2

▲ **CAUTION:** When "Input Selection 1" configuration is set to "Seal-In," the Counter Input is used as the Switch Status Input and the Seal-In Input will cause the counter to increment.

This digital input registers the counter contact closure. The pins are isolated from neutral to permit placing the external contact in series with either the wetting voltage or neutral. The operation count will increment when Pin 12 is grounded via the transformer or regulator dry operation count switch.

This contact is needed for using the intertap time delay. Once the contact is opened, the intertap time delay will begin counting down.

Pin 13 Input 1 - Motor Seal-In/Switch Status Input

When the **Input Selection (1)** screen in the **Configuration** menu is set to **Seal-In Input**, this input will operate as a seal-in input and Counter Input. In this configuration, the digital input is referenced to line neutral, but is unique in that it is configured to accept only the output of the motor seal-in current detection transformer, from the B-0553 motor seal-in printed circuit board subassembly. The B-0553 is a supplemental circuit board used in the appropriate adapter panels.

When the **Input Selection (1)** screen in the **Configuration** menu is set to **Switch Status Input**, this input will only operate as a switch status input. All seal-in input functions will be disabled. In this mode, the switch status on the adapter panel can be read to determine if it is in Auto or Manual ON/OFF. The status can be read through the seal-in/switch status data point in the communications protocols.

Pins 14 & 15 Neutral Position Detector Inputs 1 and 2/ Δ VAR[®]2 Disable Input

■ **NOTE:** This input will only perform one function, either the Neutral Detect or the Δ VAR2 Disable Input.

This digital input registers neutral position switch closures on regulators. The pins are isolated from neutral to permit placement of the external

contact in series with either the wetting voltage or neutral. Normally the wetting supply (Pin 10) will be connected to Pin 14.

When using the Δ VAR2 paralleling method, this input becomes the disable input for Δ VAR2. This is used to keep the paralleled devices from running to their limits (max raise or lower) if they have been un-paralleled for maintenance, etc.

Pin 16 Tapchanger Lower Output

This switched output connects the tapchanger lower winding to the source of motor power. When the control calls for a lower, it is capable of switching up to 6 A at 120/240 V ac.

Pin 17 Input 2 - Non-Sequential Operation/ Auto Tapchange Inhibit/Block SCADA

Non-Sequential Operation

When the **Input Selection (2)** screen (in the **Configuration** menu) is set to **NONSEQ INPUT**, non-sequential operation is invoked by momentarily connecting this input to the nominal +12 V dc wetting source (Pin 10) through an external Form "a" dry contact. When this function is enabled, the tapchanger control times out with the Time Delay setting between every tapchange.

Auto Tapchange Inhibit

When the **Input Selection (2)** screen (in the **Configuration** menu) is set to **NONSEQ INPUT**, auto tapchange inhibit is invoked by closing and maintaining a Form "a" dry contact connected to this input and to the nominal +12 V dc wetting source (Pin 10). As long as this contact is closed, the tapchanger will not time out, thereby prohibiting raise and lower commands.

SCADA Cutout Input

When the **Input Selection (2)** screen (in the **Configuration** menu) is set to **SCADA CUTOUT INPUT**, all writes using SCADA will be blocked when the non-sequential input is present. Any read operations using SCADA will still be allowed regardless of the input state. When the "SCADA Blk Input" input mode is selected, all non-sequential input functions will be disabled.

Pin 18 Voltage Reduction Step #1

This digital input is typically enabled by connecting it to the nominal +12 V dc wetting source (Pin 10) through an external Form "a" dry contact. The amount of voltage reduction implemented is determined by the setting.

■ **NOTE:** Enabling both voltage reduction step #1 and step #2 inputs simultaneously will result in the level of voltage reduction as specified on the voltage reduction step #3 screen of the control.

When "Contact KeepTrack™ 1R1L" or "Contact KeepTrack 1N" tap position knowledge is selected the Voltage Reduction Step #1 Input is utilized as an "Auxiliary Raise Contact Input" in the "Contact KeepTrack" method of tap position knowledge. Voltage Reduction Step #1 is still available through communications.

Pin 19 Motor Seal-In Disconnect Output

This output connects to the B-0553 motor seal-in printed circuit board subassembly. When the seal-in detector input is actuated, this output drives a triac on the B-0553 motor seal-in printed circuit board subassembly to temporarily disconnect the motor power to the control. The B-0553 is a supplemental circuit board used in the appropriate adapter panels.

Pins 20 & 22 User-Programmable Alarm

This pair of terminals is a Form "A" alarm relay contact rated for 3 A at 120 V ac, or 100 mA at 120Vdc. This alarm indicates when any of eight programmable alarm conditions are detected. Refer to the Appendix, Figure A-8 or A-10.

Pins 21 and 24 Self-Test Alarm

■ **NOTE:** If the M-2001C is configured for the SCAMP pushbutton Auto/Manual Switch type, then the Self-Test Alarm relay is NOT available.

This pair of terminals is a held-open Form "b" alarm relay contact rated for 6 A at 120 V ac, or 100 mA at 120 V dc. Failure of the power supply or the microcontroller results in loss of power to the alarm relay, allowing the contact to close.

Pin 23 Non-Interruptible Power Supply Input

This input is normally connected to Pin 8, the motor power input. The power to Pin 8 is interrupted by the motor seal-in process of the B-0553 motor seal-in printed circuit board. The purpose of Pin 23 is to provide continuous power to the raise and lower KeepTrack™ detection circuits. It should be connected ahead of any motor power interruption (for example, auto/manual, local/remote) of the seal-in circuitry to maintain KeepTrack raise and lower operation. The motor seal-in function is used in the following adapter panels: M-2109, M-2324 and M-2355.

6.2 Non-Sequential Operation

▲ **CAUTION:** Voltage applied through dry contacts to actuate non-sequential input, voltage reduction inputs, counter contacts and neutral contacts *must* be nominal +12 V dc obtained from Pin 10 of the M-2001C Tapchanger Control. The use of 120 V ac will result in damage to the M-2001C.

The operation of the control can be interrupted during tapchanger operation by applying the "wetting" voltage of Pin 10 to Pin 17 (timer reset for non-sequential operation input) on the control through an external contact. This causes the output to de-energize and reinitialize the time delay circuit when the reset signal is removed. This function can be used to cause the LTC transformer, if so equipped, to wait for the unit to time out between tapchanges.

6.3 Multi-Step Voltage Reduction

▲ **CAUTION:** Voltage applied through dry contacts to actuate non-sequential input, voltage reduction inputs, counter contacts and neutral contacts *must* be nominal +12 V dc obtained from Pin 10 of the M-2001C Tapchanger Control. The use of 120 V ac will result in damage to the control.

On the M-2001C Tapchanger Control, Pin 9 and Pin 18 on connector P2 are used together to provide up to three levels of voltage reduction. The external connections to achieve these steps are shown in Table 6-1. Voltage reduction amounts are set

Voltage Reduction Setpoint: Multiplier Range	Apply "Wetting Voltage" from Pin 10 to Pin #
Voltage Reduction Setpoint #1: 0 to 10%	Pin 18
Voltage Reduction Setpoint #2: 0 to 10%	Pin 9
Voltage Reduction Setpoint #3: 0 to 10%	Pins 18 and 9

Table 6-1 Multi-Step Voltage Reduction External Connections

within the M-2001C Tapchanger Control software. If these voltage reduction steps are instituted by communications, the contacts are not being used simultaneously.

When Contact KeepTrack™ tap position knowledge is selected, Voltage Reduction Step #1 (Pin 18) and Voltage Reduction Step #2 (Pin 9) are reassigned as Auxiliary Tap Position inputs.

6.4 LTC Backup Control

The M-0329B is a single-phase, solid-state backup control that prevents a defective tapchanger control from running the voltage outside the upper and lower voltage limits. The Block Raise and Block Lower voltage levels are set by accurately calibrated dials. Refer to the M-0329B Instruction Book for details.

The M-0329B LTC Backup Control or M-5329 Multiphase Backup Relay are connected as a two-terminal device to the voltage transformer.

6.5 Communication Ports

The control includes three communication ports, COM1, COM 2, and COM3. COM1 supports RS-232, RS-485, and fiber optic lines (ST connector only). COM 3 supports Ethernet using an RJ-45 connector. Selection of specific communication apparatus may be made through the **COM1 PORT** configuration screen or the **COM3 Port** screen if the optional

Ethernet port is installed. COM2 is an internal port, and supports only BECO 2200 protocol and software updates. COM1 and COM2 support baud rates from 300 to 19200.

Fiber Optic Interface

There are two screens associated with this feature. These screens are located next to all the communications configuration points. The **COM1 PORT** screen enables the user to select the specific communication equipment to be used: RS-232 (factory default), RS-485 (2 wire), Ethernet, and Fiber Optics (ST connector).

The control can be connected to fiber optics in two ways. If Fiber Repeat screen is set to OFF, the fiber interface is set in a point-to-point configuration. Example: A PC to one control. If Fiber Repeat screen is set to ON, the control can be connected in a loop or daisy chain (the TX of one control connected to the RX of the next, etc.). When connecting the control in this manner through TapTalk®, **Echo Cancel** should be set to ON. The type of fiber used with these optical transceivers is multimode fiber. It was tested with fiber size 62.5/125. A manufacturer of this product is Amphenol Corporation. A typical part number tested by Beckwith Electric is 943-32255-10030 from Amphenol Corporation, Lisle, Illinois. This is a dual-fiber with a total of four ST connectors. See Figure 6-3 for part number selection.

NOTE: The baud rate for fiber optic and RS-485 connections must be equal to or greater than 1200 baud.

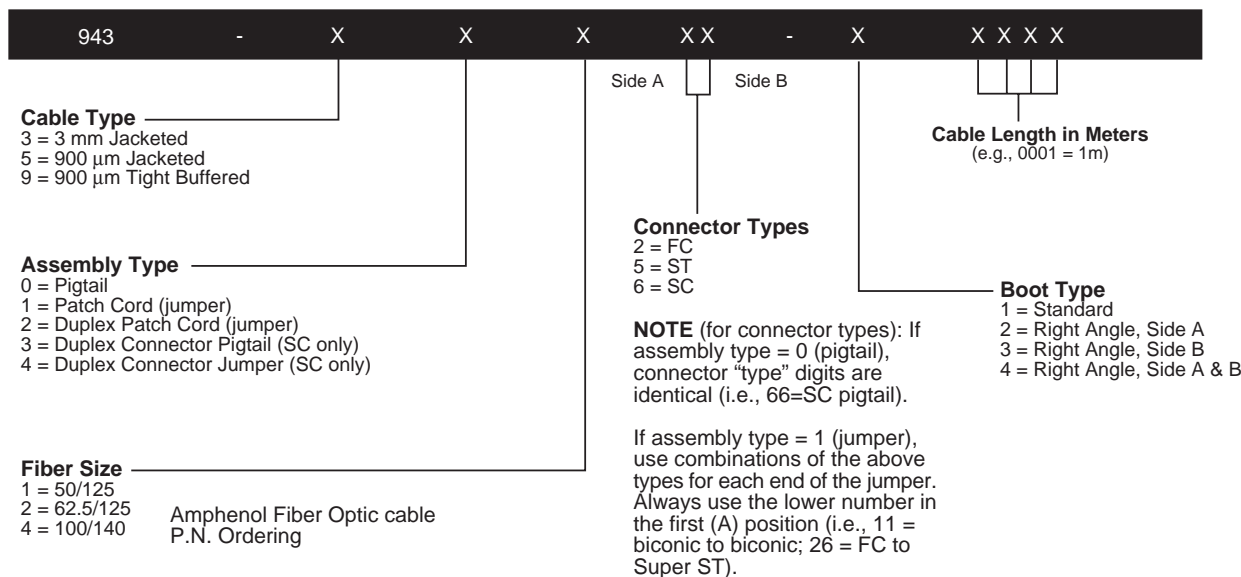


Figure 6-3 Communication Connections

Ethernet (RJ-45 Interface)

■ **NOTE:** When any settings relating to the Ethernet port are changed, power to the control must be cycled.

■ **NOTE:** When the Ethernet port is selected, the COM3 baud rate will be fixed at 19200.

The control includes an optional Ethernet Port (COM3) which will work with all protocols in the control. There are three configuration screens for setting up the ethernet port: IP Address, IP Netmask, and IP DHCP Mode. The IP Address screen is used to set the address used to communicate with the control (when DHCP is disabled). The IP Netmask screen is used for multicasting. The DHCP Mode screen, when enabled, will allow the control to use any available IP address (which will be shown while booting the Ethernet during control power up. When DHCP is disabled, it will cause the control to use the IP address from the IP Address screen.

RS-485 Interface (Additional Communication Port)

The communication protocols BECO 2179, Cooper 2179, GP 2179, BECO 2200, MODBUS, IEC 61850, and DNP3.0 were set up to work with a 2-wire, half duplex RS-485 link of the M-2001C COM1.

A port-powered converter made by B & B Electronics of Ottawa, IL (Model 485LP9TB) was used to test the two-wire RS-485 link. This converter is available in commercial and extended temperature ranges. When connecting the RS-485, a 120 Ω resistor must be connected at the last control connector across A/B. The two-wire RS-485 port assigns Pin A (+) and Pin B (-). The SH connection on the RS-485 plug should be connected to the cable shield. The shield should only be connected on one end of the RS-485 cable. If more than one M-2001C control is connected via RS-485, only one shield/SH connection should be made. One screen is directly associated with setting an RS-485 network. COM1 port should be set to RS-485. If using TapTalk®, under PORTS menu, RS-485 should be selected. When selecting RS-485 transmission lines, there are cables specifically made for this purpose. These cables have a shunt capacitance of 16 pF or less per foot, and are usually solid wire. Plenum-rated cabling is recommended. The RS-485 connector is designed to hold 12 to 24 AWG wire.

To provide both transverse and common mode SWC protection to the RS-485 port, the B-0777 adapter cable assembly must be used. This cable provides a three position Phoenix connection to the M-2001C, and a DB-9 connection for customer interface.

The cable assembly is as follows:

Phoenix Connector			DB-9 Connector
No.	Terminal	Wire Color	
P1-1	A	White	P2-3
P1-2	B	Red	P2-2
P1-3	SH	Black	P2-5

Table 6-2 B-0777 Adapter Cable Assembly

Provided with the interface cable are crimp on pins and DB-9 mating housing. The tools needed for installing the mating connector are:

Crimping Tool: Amp Pro-Crimper II hand tool #68448-2, or Amp Certi-Crimp hand tool #90302-1 (red dot).

Insertion Tool: Amp #91285-1

■ **NOTE:** The baud rate for fiber optic and RS-485 connections must be equal to or greater than 1200 baud.

6.6 Grounding

Ground the control by connecting a suitably sized wire from the ground stud on the bottom of the control case, to a solid connection to ground. Do not rely on mounting screws for grounding.

6.7 Interposing Relay Specification

The RAISE and LOWER outputs of the Beckwith Electric M-2001 series of tapchanger controls are triac-driven. Triacs were chosen because of their unlimited operation life versus electromechanical relays that are limited in their number of operations. Triacs have essentially zero leakage current in the "OFF" state. However, to avoid false triggering by transients, all triacs must be properly designed with a "snubber" circuit.

The snubber circuit is a simple RC series circuit placed across the output of the device to attenuate high frequency noise transients that could cause the triac to false trigger. The triacs in the M-2001 series are properly designed with a snubber circuit according to the device manufacturers' recommendations. These snubber circuits allow a small leakage current to flow while the triac is in the "OFF" state. In the M-2001 series, this is under 4 mA, at 240 V ac motor power.

When using industrial interposing relays such as the GE Multilin HGA series of relays, the pull-in current is over 50 mA at 240 volts, with a drop-out voltage of 40 to 50% of nominal. This indicates a dropout current of 20 to 25 mA. Such relays operate correctly with our control.

On the other hand, relays manufactured for the electronics industry have smaller armatures that reduce the pull-in current down to the 8 to 15 mA level for 240 V ac coils. Unfortunately, these relays have drop-out voltages rated as low as 10 to 15% of nominal. This would indicate drop-out currents as low as 1 to 2 mA. This extremely low drop-out ratio means that these relays still remain picked up even down to the low levels of leakage current of the triac snubber circuit.

Beckwith Electric does not recommend the use of this type of relay for several reasons. Using a sensitive low-current relay with a low drop-out ratio reduces the safe operating margin of the relay, as the holding current operating range is 85 to 90% of the total nominal level. The critical function of the control of a tapchanging transformer requires an interposing relay with clearly differentiated pull-in versus drop-out zones. The low operating currents also make these relays more susceptible to extraneous noise from any source.

If sensitive coil relays must be used, please note that Beckwith Electric Co., Inc. recommends using an auxiliary load resistor of 25,000 Ohms (Beco Part # 350-00130) at 10 Watts across the 240 V ac coils of these relays, or 12,500 Ohms (Beco Part # 350-00129) at 5 Watts for 120 V ac coil relays.

6.8 Typical LTC Connection

Figure 6-4 illustrates an example of connections for a control with an adapter panel. This example does not cover all situations. Motor Power and sensing voltage can be obtained from a common source or from independent sources having a nominal 120 V ac output. Normally, this is line-to-neutral voltage, although line-to-line voltage can be used if recognition is made of any phase shift between the voltage and current signals when using line drop compensation, to avoid introducing an unintentional grounding into the control circuitry that could result in shorting a VT secondary. It is strongly recommended that a 1:1 ratio isolation transformer of 25 VA or greater with required voltage accuracy be used between the control and any line-to-line PT connections. Beckwith Electric has a suitable

isolation transformer available in Beckwith Electric model M-0362. Please consult factory for availability.

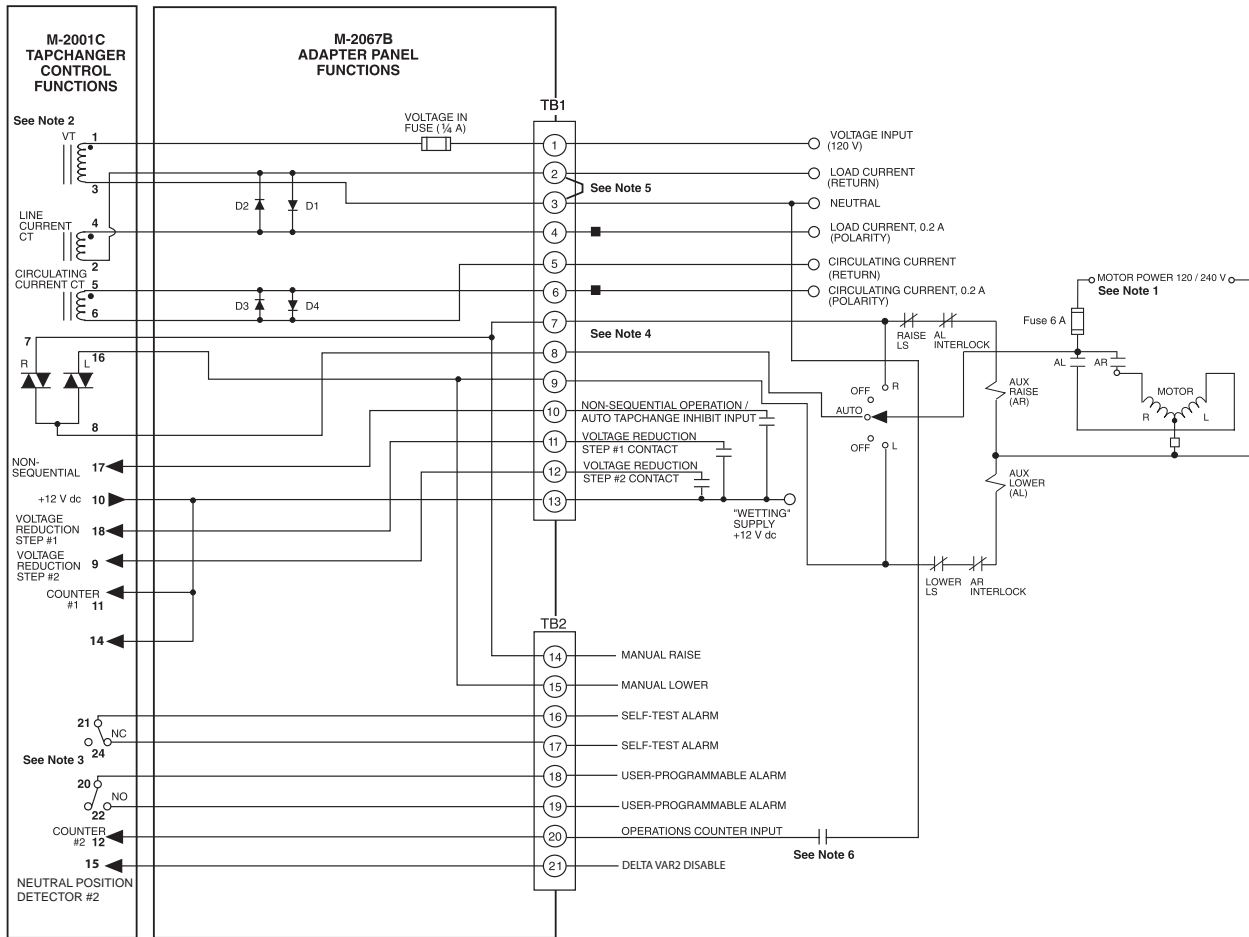
Load current must be reduced by an appropriate auxiliary transformer to 0.2 A "full scale" before connecting to the adapter panel currents. Please obtain an application guide specific to your LTC control adapter panel and follow those instructions.

6.9 Typical Regulator Connection

Figures 6-4 and 6-5 show examples of connections for a control with a transformer/regulator control adapter panel. Motor Power and sensing voltage can be obtained from a common source or from an independent source having a nominal 120 V ac output. Normally, this is line-to-neutral voltage, although line-to-line voltage can be used if recognition is made of any phase shift between the voltage and current signals when using line drop compensation, to avoid introducing an unintentional grounding into the control circuitry that could result in shorting a VT secondary. It is strongly recommended that a 1:1 ratio isolation transformer of 25 VA or greater with required voltage accuracy be used between the control and any line-to-line PT connections. Beckwith Electric has a suitable isolation transformer available in Beckwith Electric model M-0362. Please consult factory for availability.

▲ CAUTION: The current input to the M-2001C is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

Load current must be reduced by an appropriate auxiliary transformer to 0.2 A "full scale" before connecting to the adapter panel current inputs. Scaling factors may be chosen to resemble 200 mA, 100 mA, or 5 A current transformers in readouts and current magnitude settings. It is important that you obtain an application guide on an adapter panel specific to your regulator application and follow those instructions.

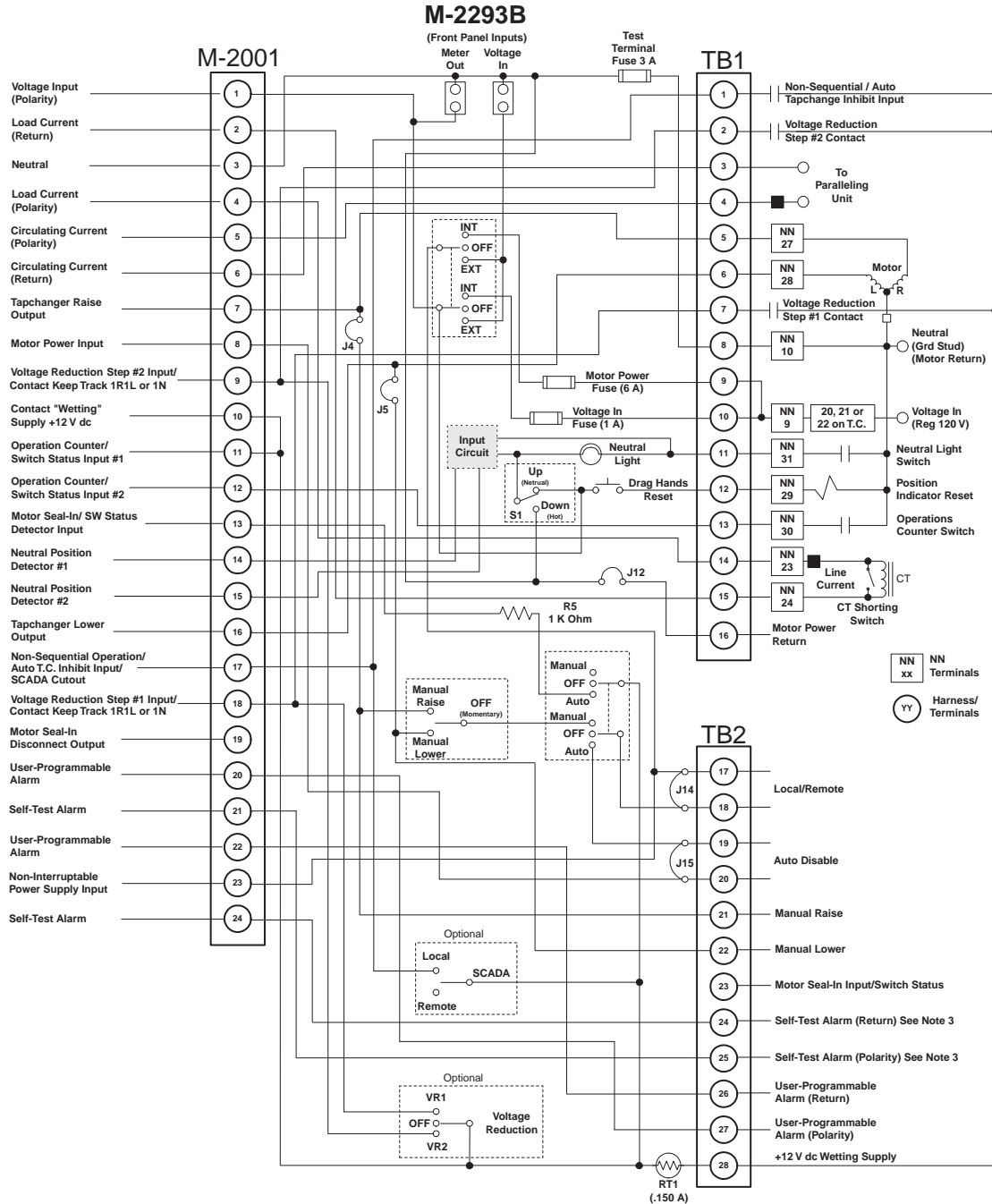


WARNING: In no case should the line current circuit be interrupted with the regulator or transformer energized. Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

NOTES:

1. Motor voltage may be 120 or 240 V to neutral or 240 V phase to phase.
2. The customer is to provide earth ground connection to CT/VT's neutral connection, external to the control.
3. The self-test alarm and user-programmable alarm contacts are shown in the de-energized state (no voltage applied). The self-test alarm contacts open after the control passes the internal self-test.
4. The wiring from terminal 7 and 9 may or may not go directly to the motor. Depending on installation, local codes and standards, the wiring may go to interposing relay contacts, limit switch, seal-in circuits, starters contactors, SCADA, test switches etc.
5. To isolate the load current, remove the jumper from TB1-2 to TB1-3.
6. For counter operation, connect TB2-20 to neutral TB1-3 through an external dry contact. This connection is required for the intertap time delay operation.

Figure 6-4 M-2001C and LTC Transformer Control Typical Connections



■ NOTES:

1. The wiring from terminal 5 and 6 may or may not go directly to the motor. Depending on installation, local codes and standards, the wiring may go to interposing relay contacts, limit switch, seal-in circuits, starters contactors, SCADA, test switches etc.
2. The self-test alarm and user-programmable alarm contacts are shown in the de-energized state (no voltage applied). The self-test alarm contacts open after the control passes the internal self-test; the user-programmable alarm contacts close when an alarm is recognized.
3. If the M-2001C is configured for the SCAMP pushbutton Auto/Manual Switch type, then the Self-Test Alarm Relay is not available.

Figure 6-5 M-2001C and Regulator Control Typical Connections

6.10 Control Power Backup Input Connection

The Control Power Backup Input option is designed to sustain communication port operation in the event of the loss of AC control power. In the event of a loss of AC input power to the control, the option permits uninterrupted operation of the control by supplying +12 V dc to the control. In addition, the control retains functionality with the exception of the actual operation of the tapchanger mechanism.

When the AC input voltage drops below approximately 85 Vrms, the Control Power Backup Input will activate and all automatic tapchange operations will then be suspended. If Motor Power is available, manual tapchanges may be initiated.

When the control is being powered from the Control Power Backup Input, it will continue to read any input voltage present.

The control retains full functionality, and if the control's Motor Power remains energized then Raise and Lower commands are possible. Fiber-Optic port operation is maintained. All communication ports, data-logging, status monitoring, configuration, and set-point capability are also maintained.

The Control Power Backup Input option is installed at the factory, and is wired through the two-pin connector located on the top rear of the control.

Beckwith Electric offers two Control Power Backup supplies for use with the M-2001C when the Control Power Backup Input option is purchased. The M-2026 AC-DC Control Power Backup Supply is a fused, surge protected and reverse polarity protected AC-DC Control Power Supply that accepts an AC or DC input (21 to 32, 42 to 60 and 105 to 145 V) and outputs regulated +12 V dc at up to 1.5 Amp.

The M-2027 Control Power Backup Supply - AC Only is a fused and surge protected Control Power Backup Supply that will accept an AC input range of 105 to 140 V ac, 50/60 Hz and output +12 V dc to 1 A.

Both the M-2026 and M-2027 are housed in non-weather-tight enclosures and are equipped with screw terminal blocks for both input and output connections.

▲ CAUTION: Use of Non-Beckwith Electric converters to provide +12 V to the Control Power Backup Input may compromise system integrity due to a lack of adequate protection of the power converter. For reliability of the M-2001C, the power converter must meet the following requirements:

Temperature: -40° C to + 80° C

IEC 60068-2-1 Cold, -40° C for 96 hours

IEC 60068-2-2 Dry Heat, +80° C for 96 hours

IEC 60068-2-3 Damp Heat, +40° C @ 95% RH for 96 hours

Transient Protection

High Voltage – All input and output terminals will withstand 1500 V ac rms to chassis or instrument ground for one minute with a leakage current not to exceed 25 mA, for all terminals to ground. Input and output circuits are electrically isolated from each other, from other circuits and from ground.

Surge Withstand Capability

IEEE C37.90.1-2002	2,500 Vpk-pk Oscillatory 4,000 Vpk Fast Transient Burst
--------------------	---

IEEE C37.90.1-1989	2,500 Vpk-pk Oscillatory 5,000 Vpk Fast Transient
--------------------	--

Radiated Electromagnetic Withstand Capability –

All units are protected against electromagnetic radiated interference from portable communications transceivers.

Electrostatic Discharge Test

EN 60255-22-2-1997 (EN61000-4-2)

Class 4	(8 Kv) – Point Contact Discharge (15 Kv) – Air Discharge
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Fast Transient Disturbance Test

EN 60255-22-4-2002 (EN61000-4-4)

Class A	(4 Kv, 2.5 kHz)
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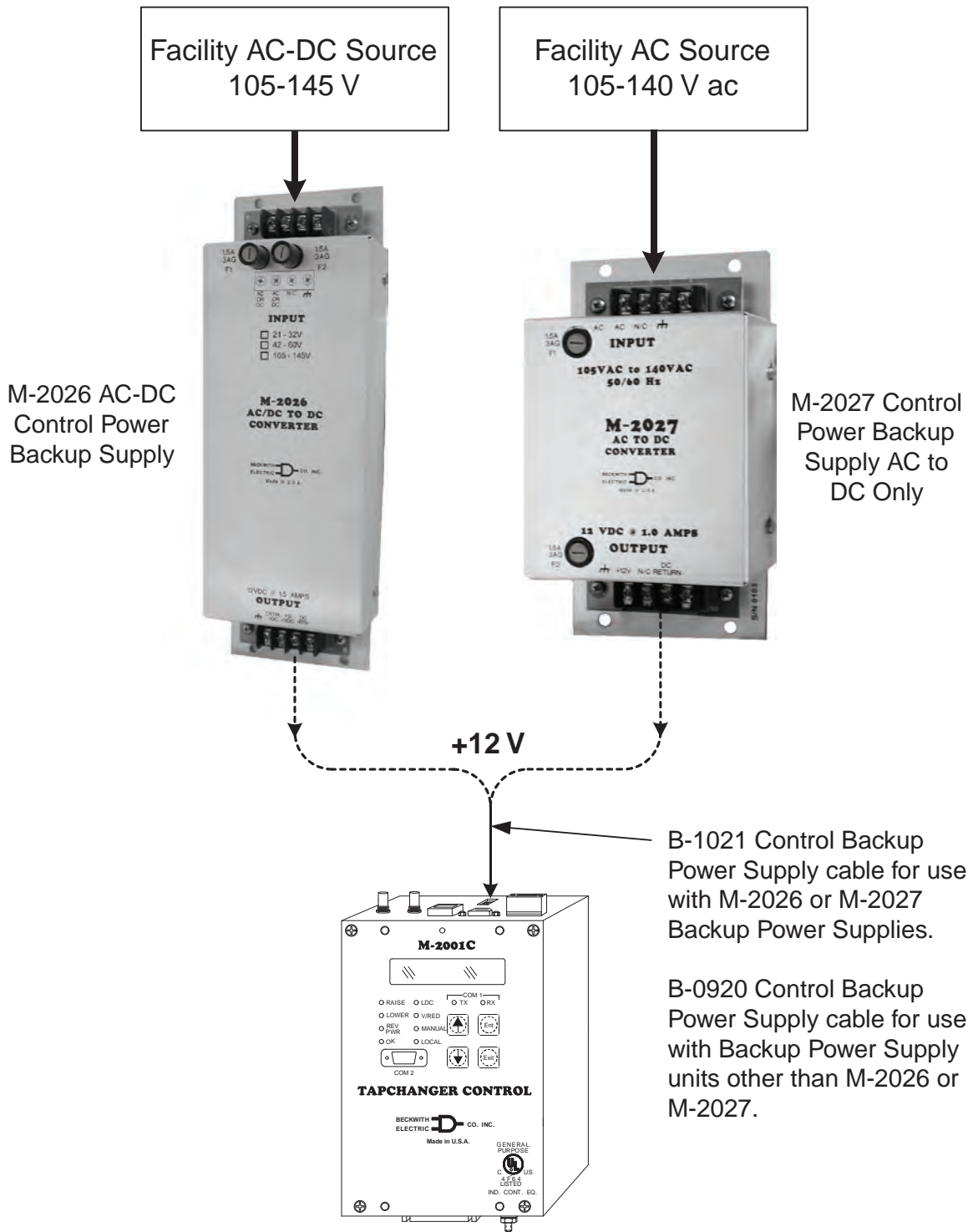


Figure 6-6 Typical Control Power Backup Connection for M-2001C

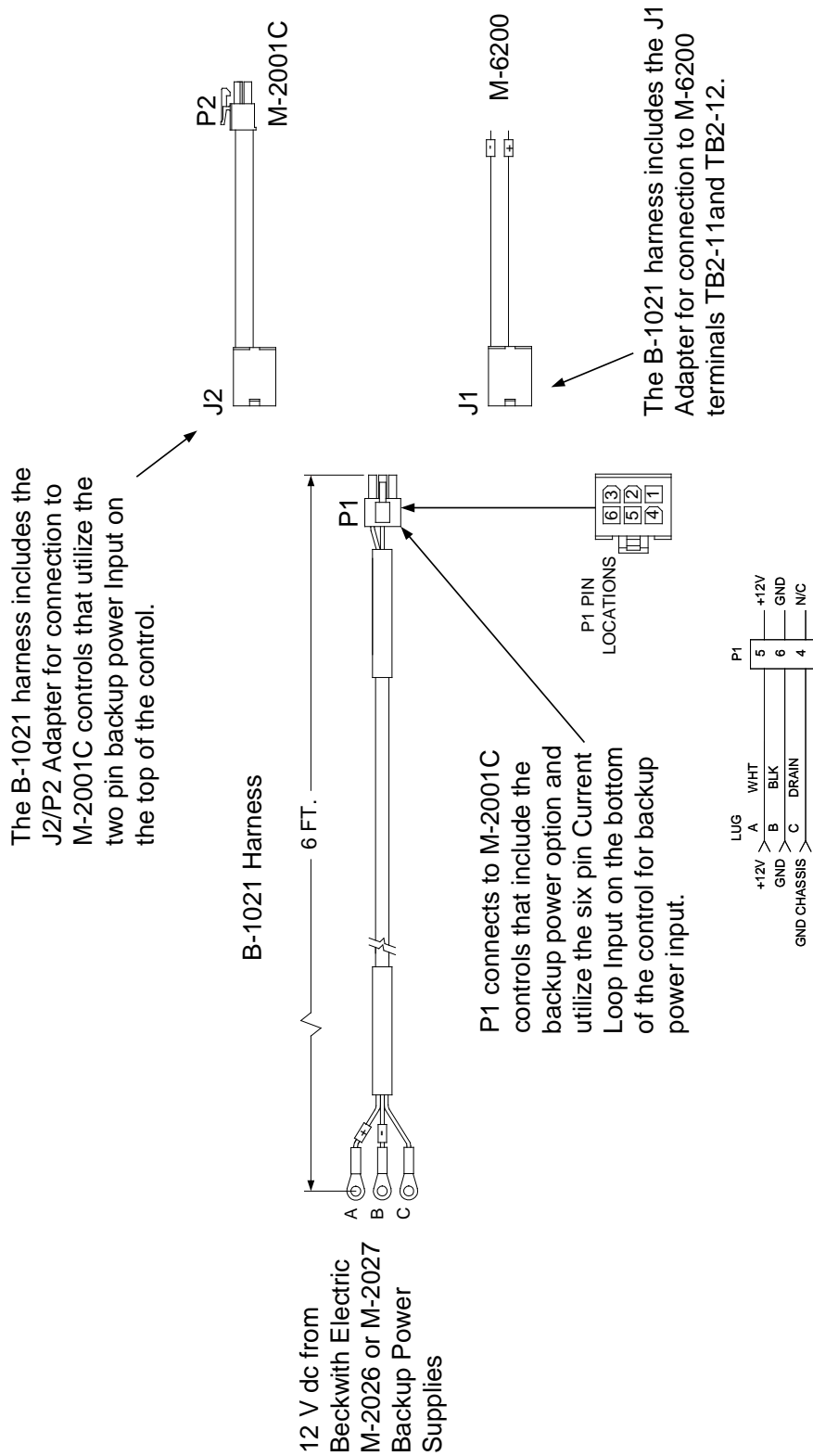


Figure 6-7 Control Power Backup Input Cable Assembly

7 Test Procedure

7.0 Set-up Procedure 7-1

7.1 Bench-Test 7-3

7.2 Check-out Procedure 7-4

7.3 Operational Test 7-4

7.4 In-Service Test 7-5

This chapter assumes that the M-2001C (Comprehensive) Tapchanger Control is **not** being used with an M-2050 Mounting Kit or an adapter panel (for example, when used by an original equipment manufacturer for use in a control panel). If the control is being used with an M-2050 Mounting Kit or an adapter panel, refer to the Test Procedures chapter of the corresponding Application Guide rather than this chapter.

7.0 Set-up Procedure

Equipment List

▲ **CAUTION:** The current input to the M-2001C is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

- 0–200 mA current supply with phase angle settings of 0° to +90°
- 90–145 V ac voltage source at 60 Hz
- High impedance true RMS voltmeter with accuracy on ac of at least ±0.2% of reading
- Accurate stop watch

Procedure

1. Make electrical connections as shown in Figure 7-1, External Connections for Test Procedure.

■ **NOTE:** Refer to the Appendix, Figures A-1 through A-13, for the locations of screens within the software.

■ **NOTE:** There is a one-second delay between the out-of-band condition and panel LED indication.

2. Enter initial settings:

Function	Initial Setting
Bandcenter	120.0 V
Bandwidth	2.0 V
LDC Resistance	0.0 V
LDC Reactance	0.0 V
Paralleling	Circulating Current Method
Block Raise	135.0 V
Block Lower	105.0 V
Deadband	2.0 V
Time Delay	5.0 seconds

Table 7-1 Initial Settings

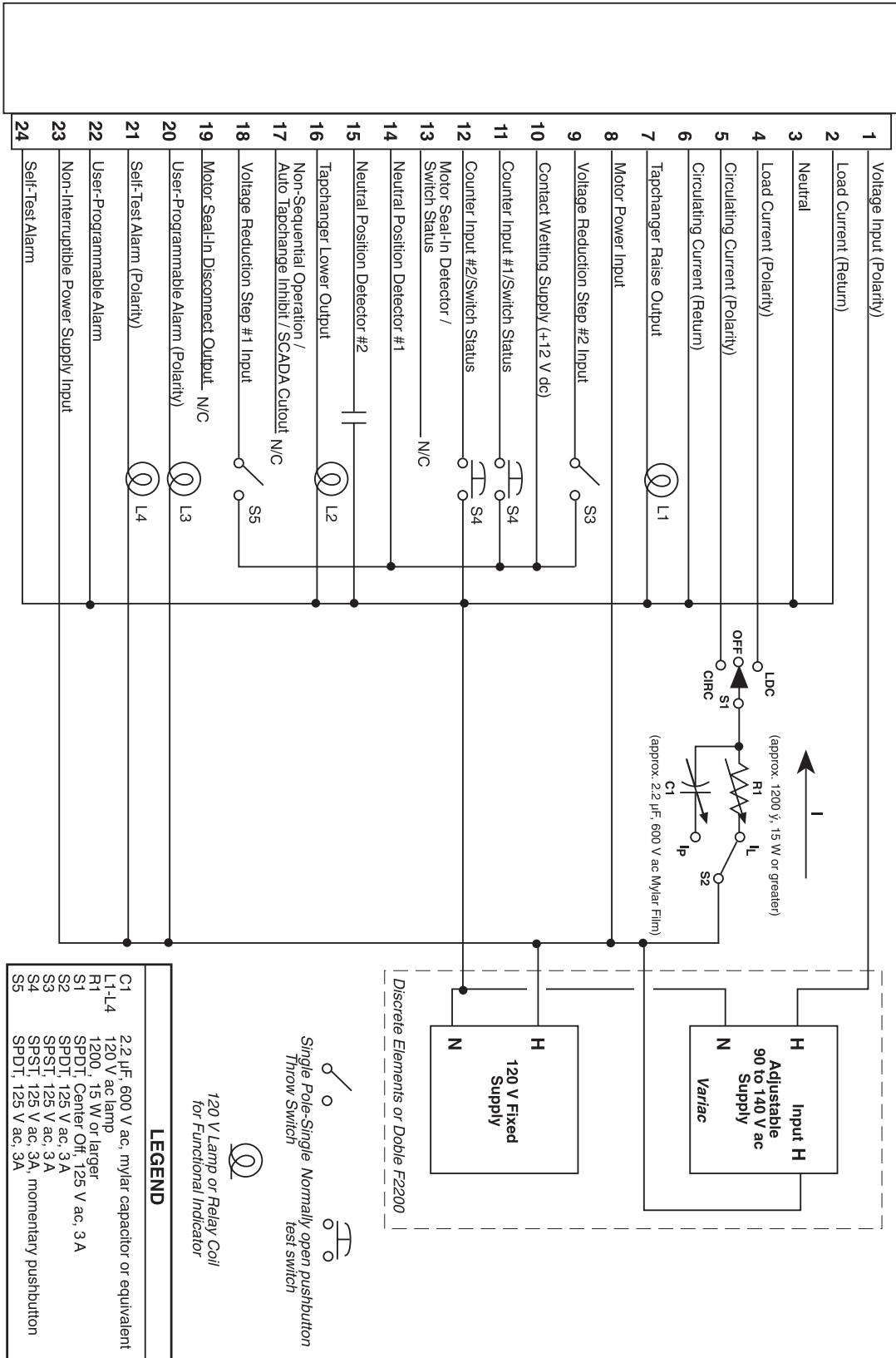


Figure 7-1 External Connections for Test Procedure

7.1 Bench Test

▲ **CAUTION:** Do not reverse the ground and hot wires when connecting an external source.

1. Apply 120 V ac from power source. The display of the M-2001C (Comprehensive) will automatically advance to the Local Voltage screen.
2. Increase voltage to 121.2. The **LOWER** LED should illuminate.
3. Decrease voltage to 118.8. The **RAISE** LED should illuminate.
4. Set the input voltage to 120.0 V ac. Wait for **RAISE** and **LOWER** LEDs to extinguish.
5. Increase voltage to 122.0 V ac, then start timing when voltage passes 121.0 V.
6. Stop timing when the lamp connected to the **LOWER** output illuminates (should be approximately 5 seconds).

Resistance

1. Apply a 100.0 mA in-phase current to Pin 4 (load current-polarity) and Pin 2 (load current-return) of the P2 connector.
2. Set S_1 to LDC and S_2 to I_L .
3. Set LDC Resistance to 24.0 V. The **RAISE** LED should illuminate.
4. Increase the input voltage to 132.0 V ac. The **RAISE** and **LOWER** LEDs should be extinguished.
5. Set the LDC Resistance to –24.0 V. The **LOWER** LED should light.
6. Decrease the input voltage to 108.0 V ac. Both **RAISE** and **LOWER** LEDs should extinguish.
7. Set the LDC Resistance to 0.0 V.
8. Decrease the input voltage to 120 V ac.

Reactance

1. Apply 100.0 mA 90° leading current to Pin 4 (load current-polarity) and Pin 2 (load current-return) of the P2 connector.
2. Set S_1 to LDC and S_2 to I_L .
3. Set LDC Reactance to 24.0 V. The **LOWER** LED should illuminate.

4. Decrease the input voltage to 108.0 V ac. The **RAISE** and **LOWER** LEDs should be extinguished.
5. Set LDC Reactance to –24.0 V; the **RAISE** LED should illuminate.
6. Increase input voltage to 132.0 V ac. Both **RAISE** and **LOWER** LEDs should be extinguished.
7. Set the LDC Reactance to 0.0 V.
8. Decrease the input voltage to 120 V ac.

Voltage Reduction

1. Set Voltage Reduction Step #1 to 2.5% (default setting).
2. Close S_5 to enable Voltage Reduction Step #1. The **LOWER** LED should illuminate.
3. Decrease the voltage to 117.0 V ac. The **LOWER** LED should be extinguished.
4. Open S_5 and decrease the input voltage to 120.0 V.
5. Set Voltage Reduction Step #2 to 5% (default setting).
6. Close S_3 to enable Voltage Reduction step #2. The **LOWER** LED should illuminate.
7. Decrease voltage to 114.0 V ac. The **LOWER** LED should extinguish.
8. Open S_3 and decrease the input voltage to 120.0 V ac.

Paralleling

1. Apply 100.0 mA 90° leading current to Pin 5 (circulating current-polarity) and Pin 6 (circulating current-return) of the P2 connector.
2. Set S_1 to CIRC and S_2 to I_P . The **LOWER** LED should illuminate.
3. Decrease the voltage to 108.0 V ac. Both **RAISE** and **LOWER** LEDs should be extinguished.
4. Set S_1 to OFF.

Counter

1. Set the M-2001C Tapchanger Control to display the Operations Count screen for the Total Operations Counter.
2. Verify counter operation by depressing S4 wired to Pin 11 and Pin 12 (counter in).
3. The operations counter should increment.

Block Raise/Block Lower/Deadband

1. Set Block Raise to 126.0 V.
2. Set Block Lower to 114.0 V.
3. Set the unit to display the Bias Voltage screen.
4. Press **ENT**.
5. Increase voltage to 126.5 V. BR should be displayed on the screen.
6. Increase voltage to 128.5 V. FL is displayed on the screen.
7. Decrease voltage to 113.5 V. BL is displayed on the screen.

—Bench Test Complete—

7.2 Check-out Procedure

NOTE: All Beckwith Electric units are fully calibrated at the factory. There is no need to recalibrate the units before initial installation.

Applying Power

1. Remove any external connection between Pin 1 (voltage input) and Pin 8 (motor power input).
2. Using a voltmeter, ensure that the voltage applied to Pin 1 is nominal 120 V ac with respect to Pin 3 (neutral).

▲ CAUTION: Do not reverse the ground and hot wires when connecting an external source.

3. Apply motor auxiliary voltage to Pin 8 (motor power input) and Pin 3 (neutral).
4. Verify that the motor runs in the proper direction when conditions of sensed voltage result in activation of Raise and Lower outputs.

● WARNING: In no case should the load current circuit be interrupted with the regulator or transformer energized.

● WARNING: Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

5. As shown in Figure 7-2, Setup for Current Checkout Procedures, temporarily place a shorting device across the LDC-CT secondary to short the line drop compensator circuit, and place another shorting device to short the circulating current paralleling output, for the load current check.
6. Insert an ammeter between the polarity input and Pin 4.
7. Open the load current shorting device and with a known load on the transformer or regulator, measure the current in the load current circuit to ensure that this current is correct for 0.2 A full load.

▲ CAUTION: The current input to the control is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

8. Replace the shorting device across the load current input and remove the ammeter.
9. Reconnect polarity to the unit and remove both jumpers. The Line Drop Compensator will be activated. Correct CT polarity can be checked by simply incorporating sufficient +R compensation. The regulator should time out and run so as to raise the output voltage.

7.3 Operational Test

1. Set VT Ratio Correction = 0 V; CT/VT phasing = 0° from the appropriate screen in the software.
2. Return to the Local Voltage screen.
3. Apply 120.0 V ac to Pin 1 (hot) and Pin 3 (neutral) of the adapter panel.
4. Verify local voltage = input voltage ±0.3 V.
5. Apply 100.0 mA in-phase current to Pin 4 (load current-polarity) and Pin 2 (load current-return).

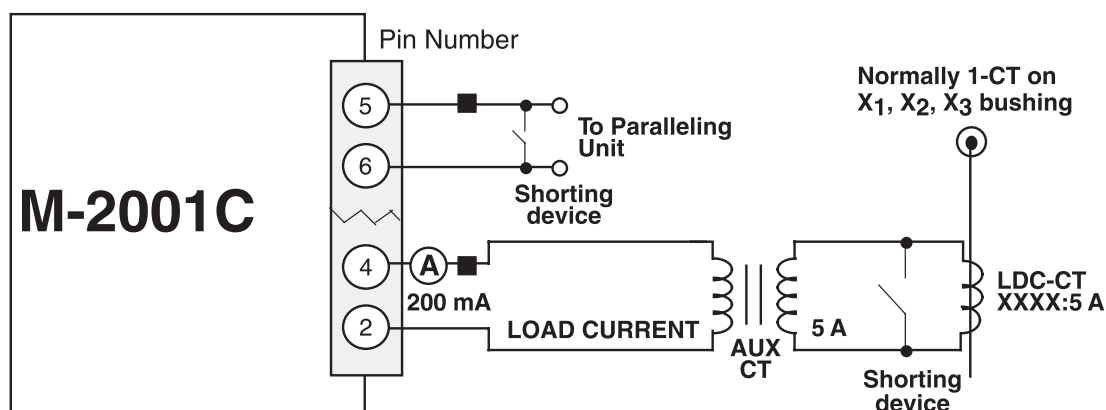
6. Verify Control Load I =100 mA and Power Factor =1.0 ±0.02 from the appropriate software screens.
7. Apply 100.0 mA 90° leading current to Pin 5 (circulating current-polarity) and Pin 6 (circulating current-return).
8. Verify Control Circ I = 100.0 mA ±2 mA.
9. Verify the **↑** , **↓** and **ENT** pushbuttons function properly.
10. De-energize the current source.

—Checkout Procedure Complete—

7.4 In-Service Test

1. Set the M-2001C Tapchanger Control to display the Bias Voltage screen.
2. Press **ENT**.
3. Use the **↑** and **↓** pushbuttons to cause **RAISE** and **LOWER** outputs.
If either output is blocked, verify that the unit is not at the maximum tap position.
4. Press **ENT** to return to the Local Voltage screen.

—In-Service Test Complete—



■ **NOTE:** Pin numbers indicated above are accurate for the M-2050 Mounting Kit only; check the Application Guide of the specific adapter panel used for proper pin numbers.

Figure 7-2 Setup for Current Checkout Procedure

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8 Design Changes

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8.0 Design Changes

Beckwith Electric maintains a system whereby customers can obtain information concerning all design changes to our units. Documentation on each unit is kept on file by model number, serial number, and software version (if applicable).

Each unit has a model number consisting of a letter and four numbers. Significant enhancements are marked with a suffix letter. It must be possible to use any later version as a replacement for an earlier version. The opposite may not be true because of features added. If later units are not fully interchangeable for older units, a change in the model number is made.

The release of the M-2001C (Comprehensive) indicates that significant enhancements were made to the unit from the M-2001B model. These enhancements are:

- EXIT button added
- LDC LED added
- Voltage Reduction LED added
- COM Block LED added
- COM1 TX/RX LED's added
- LCD or Vacuum Fluorescent Displays
- Ethernet Port (COM3) option added
- A or B regulator type selection added
- Third type of operational counter configuration ("Count Window" added)
- SCADA blocking input added (uses non-seq input)
- Enable/Disable of select status screens added
- Bandwidth range changed from 6.0 to 10.0 volts
- Display time out increased to 15 minutes
- DNP scan tags expanded

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9 M-2029A TapTalk®

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This chapter contains information necessary to configure and interrogate Beckwith Electric digital tapchanger controls using a personal computer, running M-2029A TapTalk® Communications Software. TapTalk is backward compatible with older Digital Tapchanger Controls. Firmware version is displayed when power is applied to the control or through the display panel. While the software has been carefully designed for easy use and installation, we suggest that first-time users acquaint themselves with its operation prior to use by carefully reading this chapter.

9.0 Availability

M-2029A TapTalk Communications Software is available on CD-ROM. Also included on the CD-ROM is the companion Instruction Book in Adobe® Acrobat™ (*.pdf) format.

9.1 Hardware Requirements

TapTalk will run on any Windows™ based computer that provides at least the following:

- Microsoft® Windows™ 95, 98, NT 4.0, 2000, XP or Windows 7
- one CD-ROM drive
- one serial (RS-232) communications port
- for remote communication, either a modem or TCP/IP connection is required

Hardware Required for Modem Communication

In order to use TapTalk to communicate with a Beckwith Electric digital tapchanger control using a modem, the control must be equipped with the following:

- A compatible modem (300, 600, 1200, 2400, 4800, 9600, or 19200 baud)
- Serial modem cable with 9-pin connector for the control and the applicable connector for the modem or fiber-optic cable with RS-232 converter.

Similarly, the host computer must also have access to a modem and an appropriate cable.

■ **NOTE:** Pinouts for communications cables are provided in Section 9.9, Communication Cables.

Hardware Required for Direct Serial Communication

To use TapTalk to communicate with a Beckwith Electric digital tapchanger control using a direct serial connection, a serial "null modem" cable is required with a 9-pin connector (DB9P) for the control and an applicable connector for the computer (usually DE9S or DE25S).

The M-2001C Digital Tapchanger Control also includes a fiber optic port and RS-485 port which support direct communications. See Section 6.5, Communications Ports, for detailed information regarding the use of these connections.

■ **NOTE:** Pinouts for a null modem adapter are provided in Section 9.9, Communication Cables.

Hardware Required for RJ45 Ethernet Communication

The RJ45 Ethernet connection uses a 10-Base T type connection that accepts an RJ45 connector using CAT 5 twisted pair cable.

9.2 Installing TapTalk

The TapTalk installation program has been written to overwrite previous versions of TapTalk. However, considering variations in installed software, hardware and operating systems, if you are upgrading from a previous version of TapTalk, it is recommended that any older versions of the TapTalk program be removed before installing the new TapTalk.

TapTalk runs with the Microsoft Windows 95, 98, NT 4.0, 2000, XP or Windows 7 operating system. Familiarity with Windows is important in using TapTalk, as the conventions defined in the Windows documentation are strictly followed therein.

TapTalk will be installed on the host computer's hard disk. While it does not require special installation procedures, an installation utility has been provided to make the process easier.

To install TapTalk:

1. Insert the TapTalk software into your CD-ROM drive.
2. Select **Run** from the **Start Menu**.
3. In the **Run** dialog box, initiate software installation by typing **D:\Setup.exe** (or other drive designator:\Setup.exe, depending on the letter designation for the CD-ROM drive).

- The Installation Wizard will prompt the user through the installation process. After installation, the TapTalk® program icon (located in the Becoware folder) can be placed on the desktop (Figure 9-1).

Starting TapTalk

- Select the TapTalk program-item icon from the Becoware group in the Program Manager, or select TapTalk from the program list using the **Start** Menu. The TapTalk toolbar is displayed along with the **Communication Access** dialog screen (Figure 9-10).

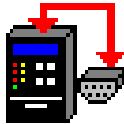


Figure 9-1 TapTalk Program-Item Icon

When the control is first energized, the quickest way to properly initialize the control prior to entering the setpoints is to set the real-time clock. This action will initiate a prompt from the control to perform a reset operation for the following items:

- Demand Metering
- Energy Metering
- Drag Hands Reset Registers
- Resettable Operations Counter

It is then easy to proceed with the remainder of the control setup.

9.3 Communications using Direct Serial Connection

To use TapTalk to interrogate, set, or monitor the M-2001C Digital Tapchanger Control using a direct serial connection, the control and the TapTalk software must be setup for serial communications. Elements of the setup process include protocol definitions and communication port settings. Refer to Section 4.11, Protocols/Communication, Section 6.5, Communication Ports, and Figure A-5, Communication Screens, for additional setup information. The steps necessary to configure the control, and TapTalk, for communication using a direct serial connection are outlined below.

Configuring the Control for Communication Using Direct Serial Connection

- Ensure the control is energized.
- From the Human-Machine Interface (HMI) panel, located on the front of the control, access the **Configuration** Menu, and set the control's **Baud Rate** (19,200 bps maximum) to a value that can match the baud rate of the host computer.
- From the control's **Configuration** Menu, set the **Communication Address** of the control to a number not used by any other control sharing the same modem (serial connections can be shared through the use of a communications line splitter, refer to Figure 9-4).

■ **NOTE:** All M-2001 Series Digital Tapchanger Controls are shipped with communications password disabled (set to 0000).

- If desired, set the **Communication Password**.
- Determine the type of control, then proceed as follows:
 - If using COM1 on a M-2001C, then set the control's Communications Protocol to BECO 2200.
 - If using COM2 on a M-2001C, only BECO 2200 is supported, therefore Communications Protocol configuration is not required.

▲ **CAUTION:** Control serial communication is disabled when the control is in the local mode. (M-2001C may be set to disable local control mode remote communication blocking)

- Position the control menu to the **EXIT** Screen, then select **ENT** (the control will display a blank screen even though the unit remains operational).

■ **NOTE:** Communication cable connections are provided in Section 9.9, **Communication Cables**.

▲ **CAUTION:** Successful operation cannot be guaranteed for RS-232 cable lengths exceeding 50 feet in length. Every effort should be made to keep cable length as short as possible (< 50 feet).

- Connect the host computer to the desired control Com Port utilizing a RS-232 null modem cable.

Configuring TapTalk® for Communication using Direct Serial Connection

After the control has been correctly configured for serial communication, TapTalk and the host computer can be configured. TapTalk utilizes the resident Windows™ operating system COM port configuration setup features. Com Port settings made in either the Windows environment or from TapTalk affect all programs on the host computer that have direct serial communication.

1. Start the TapTalk program, TapTalk will display the **Access** dialog screen (Figure 9-8).
2. Select **Serial COM Port** from the **PC Communication Device** drop-down menu.
3. Ensure that the correct COM port is displayed.
4. Some devices that include extended service ports require a character string prior to the COM Port value for COM10 and higher. If applicable, then check the appropriate box and input the appropriate character string.

9.4 Communication using an Ethernet Connection

If the control is to be connected to a network that does not support DHCP protocol, then the following information must be obtained from the Network Administrator, to be entered locally at the control:

- IP Address
- IP Net Mask

Configuring the Control's Ethernet Port for use on a network that supports DHCP Protocol

1. Ensure the control is energized.
2. From the Human-Machine Interface (HMI), located on the front of the control, access the **Configuration** Menu, and set the following:

■ **NOTE:** All M-2001 Series Digital Tapchanger Controls are shipped with communications password disabled (set to 0000).

- a. **COMM PASSWORD**, if desired
- b. **IP DHCP MODE** to **ENABLE**
- c. **COMM ADDRESS** of the control to a number not used by any other control sharing the same network.

■ **NOTE:** When DHCP Protocol is enabled, the IP Address assigned to the control by the network is displayed momentarily during the control boot sequence.

3. Remove power to the control, then reapply power to the control. The control will start the bootup sequence.
4. The control is now addressable from TapTalk over the network

Configuring the Control's Ethernet Port for use on a network that does not support DHCP Protocol

1. Ensure the control is energized.
2. From the HMI panel, located on the front of the control, access the **Configuration** Menu, and set the following:

■ **NOTE:** All M-2001 Series Digital Tapchanger Controls are shipped with communications password disabled (set to 0000).

- a. **COMM PASSWORD**, if desired
- b. **IP DHCP MODE** to **DISABLE**
- c. Input the **IP ADDRESS**
- d. Input the **IP NETMASK**
- e. **COMM ADDRESS** of the control to a number not used by any other control sharing the same network.
3. Remove power to the control, then reapply power to the control. The control will start the bootup sequence.
4. The control is now addressable from TapTalk over the network.

9.5 Communications using a Modem

To use TapTalk® to interrogate, set or monitor the M-2001C Digital Tapchanger Control using a modem, the control and the TapTalk software must be setup for modem communications. Elements of the setup process include protocol definitions, communication port settings and modem commands. Refer to Section 4.11, Protocols/Communication, Section 6.5, Communication Ports, and Figure A-5, Communication Screens, for additional setup information. The steps necessary to configure the control and TapTalk for communication using a modem are outlined below.

Configuring the Control for Communication Using a Modem

1. Ensure the control is energized.

■ **NOTE:** Any compatible modem may be used; however, it is not recommended to communicate at less than 2400 bps.

2. From the control's **Configuration** Menu, set the control's **Baud Rate** (19200 bps maximum) to a value that can be matched by the baud rate of both the control's modem and the host computer's modem.
3. From the control **Configuration** Menu, set the **Communication Address** of the control to a number not used by any other control sharing the same modem (serial connections and modems can be shared through the use of a communications line splitter, refer to Figure 9-4).

■ **NOTE:** All M-2001 Series Digital Tapchanger Controls are shipped with communications password disabled (set to 0000).

4. If desired, set the **Communication Password**.
5. Determine the type of control, then proceed as follows:
 - a. If using COM1 on a M-2001C, then set the control's Communications Protocol to BECO 2200.
 - b. If using COM2 on a M-2001C, only BECO 2200 is supported, therefore Communications Protocol configuration is not required.

▲ **CAUTION:** Control remote communication is disabled when the control is in the local mode. (M-2001C may be set to disable local control mode remote communication blocking).

6. Position the control menu to the **EXIT** Screen, then select **ENT** (the control will display a blank screen even though the unit remains operational).

■ **NOTE:** Communication cable connections are provided in Section 9.9, Communication Cables.

▲ **CAUTION:** Successful operation cannot be guaranteed for RS-232 cable lengths exceeding 50 feet in length. Every effort should be made to keep cable length as short as possible (< 50 feet).

7. Connect the modem to the desired control COM Port utilizing a standard RS-232 cable.
8. Connect the modem to the desired telephone line, then energize the modem.

■ **NOTE:** The control does not issue or interpret modem commands, or adjust modem baud rate. The control should be considered a "dumb" peripheral. The control communicates utilizing 1 Start, 8 Data and 1 Stop Bit.

9. Configure the modem connected to the control to the following AT Command settings (these settings are mandatory):
 - E0 No Echo
 - Q1 Don't return result code
 - &D3 ON to OFF DTR, hang-up and reset
 - &S0 DSR always on
 - &C1 DCD ON when detected
 - S0=2 Answer on second ring
 - V0 Number Codes

There are variations in the AT commands supported by modem manufacturers. The following commands may be required at the modem:

- &Q6 Constant DTE to DCE speed
- N0 Answer only at specified speed
- \J Disable serial data rate adjust
- \Q3 Bidirectional RTS/CTS control
- \N0 Normal mode
- &B1 Fixed serial port rate
- &D2 ON to OFF DTR, hang up and reset
- B1 U.S. Answer Tone

It is recommended that the user save these settings to the profile that is recalled at boot-up.

The modem connected to TapTalk® should be set as follows:

- E0 No Echo
- Q0 Return Reset Code
- V1 Verbal Codes

Configuring TapTalk for Communication using a Modem

After the control and the control's modem have been correctly configured for remote communication, TapTalk and the host computer modem can be configured. TapTalk utilizes the resident Windows™ operating system modem configuration setup features. Modem, Com Port and dialing settings made in either the Windows environment or from TapTalk affect all programs on the host computer that have modem communication capabilities.

■NOTE: The following instructions are based on the existence of an installed and functioning modem. If the host computer is *not* equipped with a functioning modem then install a modem following the modem manufacturers instructions and then return to this instruction to configure TapTalk.

1. Start the TapTalk program, TapTalk will display the **Communication Access (Serial)** dialog screen (Figure 9-10).

2. Select modem from **PC Communication Device** section, TapTalk will display Figure 9-11, **Communication Access (Modem) Dialog Screen**, then proceed as follows to input information required for modem communication:

- a. Ensure that the correct modem is displayed, then select **Setup**, TapTalk will display the **Modem Communication Setup** screen (Figure 9-12).
- b. Select **Add Number**, TapTalk will display the **Edit Phone Book** dialog screen (Figure 9-13).
- c. Input the telephone number of the remote modem associated with the control, then select **OK** to save the telephone number to the **Phone Book** or **Cancel** to return to the **Modem Communication Setup** screen.

■NOTE: The **Configure Line** and **Dialing Properties** section of the **Modem Communication Setup** screen are used to access Windows modem settings. If it becomes necessary to modify modem settings ensure that the Baud Rate, Data bits, Parity and Stop Bit values required by TapTalk are maintained.

- d. Select **Configure Line...**, TapTalk displays the **Modem Connection Preferences** dialog screen (Figure 9-2).

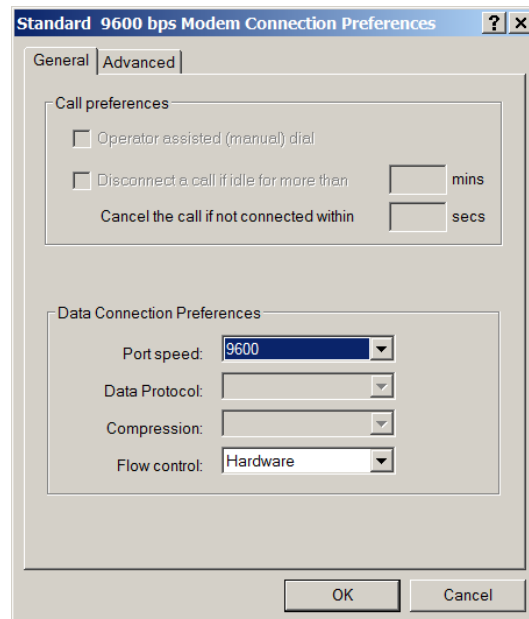


Figure 9-2 Modem Connection Preferences Dialog Screen

- e. Select the **Advanced** tab (for Windows 2000 or later), TapTalk® displays the **Advanced** dialog screen, then enter the following:
 - Data Bits = **8**
 - Parity = **None**
 - Stop Bits = **1**

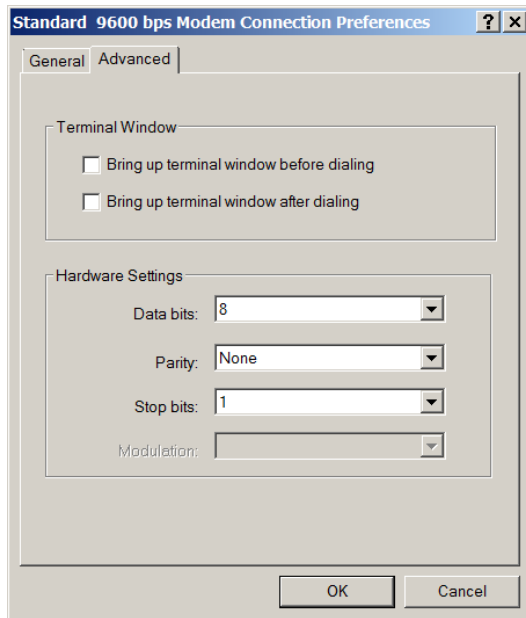


Figure 9-3 Modem Connection Preferences
Advanced Dialog Screen

- f. Select **OK** to save **Advanced Preferences** or **Cancel** to return to the **Modem Connection Preferences** dialog screen.
 - g. Select **OK** to save modem communication settings or **Cancel** to return to the **Control Access** dialog screen.
3. TapTalk is now configured to communicate with M-2001 Series controls using a modem.

9.6 Communications with Multiple Controls

▲ **CAUTION:** Each control connected to either a direct or modem connection configuration must have a unique communications address. If two or more controls share the same address, corrupted communication will result.

The remote addressing capability of TapTalk and the digital tapchanger control allows multiple controls to share a direct or modem connection. This can be done with standard RS-232 connections using a communications line splitter (see Figure 9-4, Multiple Control Addressing Using Communications Line Splitter). If using an M-2001C Tapchanger Control, a fiber optic loop network (see Figure 9-6, Fiber Optic Connection Loop) or RS-485 tree configuration (see Figure 9-5, RS-485 Connection Tree) may also be used. See Chapter 3, **Setting the Control** for more information on specific menu commands.

A control address of zero is a "wild card" that will illicit a response from all controls on a shared connection and result in corrupted communication.

With these arrangements, any control can be selected from within TapTalk by specifying it's unique communications address, ranging from 1 to 200. The communications address must have previously been set from the control's front panel.

9.7 Cautions

Control and TapTalk® Compatibility

Every attempt has been made to maintain compatibility with previous control software versions. In some cases (most notably, with older controls), compatibility cannot be maintained. However, TapTalk should work correctly with more than one version of the M-2001 Series Digital Tapchanger Controls on a single bus, provided that the controls are all set to use the same protocol. If there is any question about compatibility, contact the factory.

Control Priority

Control conflicts will not occur as local commands initiated from the front panel receive priority recognition. While the unit is in local mode, communication via the serial ports is suspended, unless local mode is disabled. TapTalk displays an error message to indicate this fact.

Time and Date Stamping

Time and date stamping of events is only as useful as the validity of the control's internal clock. Under the **Utilities** menu, the Set Control Date/Time command allows you to manually set the control's clock. For reference, the computer's clock is also displayed.

Local Mode

In the control's **Configuration** menu, there is an option to enable or disable **Local Mode**. If Local Mode is disabled, the user may access the control via the local screen as well as through communication SCADA.

Serial Port Connections

- If the serial port is connected to something other than a modem and a TapTalk modem command is executed, the results are unpredictable. In some cases, the computer may have to be reset.
- If the computer's communications options (baud rate, serial communications port, and communications address) do not match those on the control, the control will return an error message.

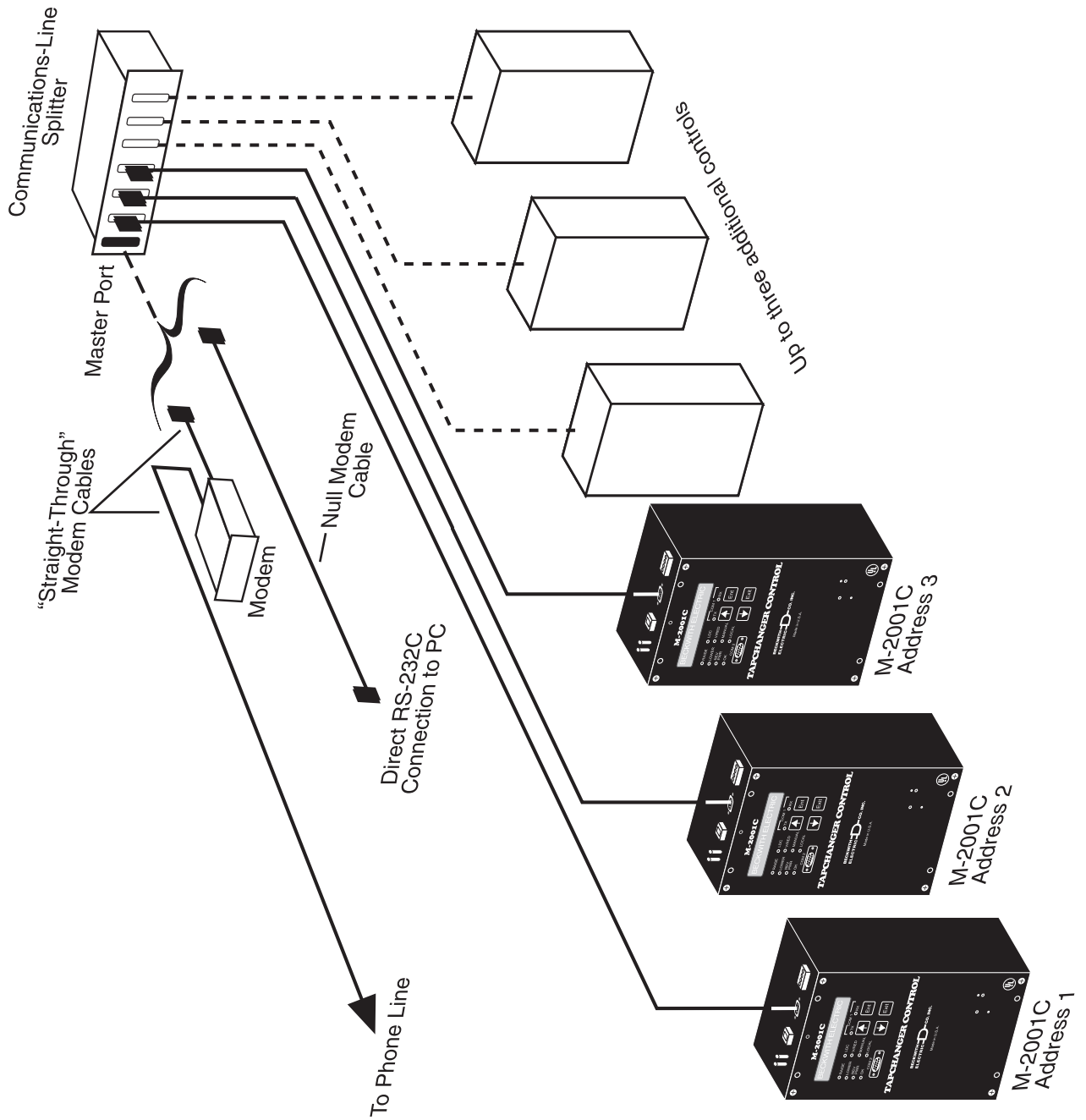


Figure 9-4 Multiple Control Addressing Using Communications-Line Splitter

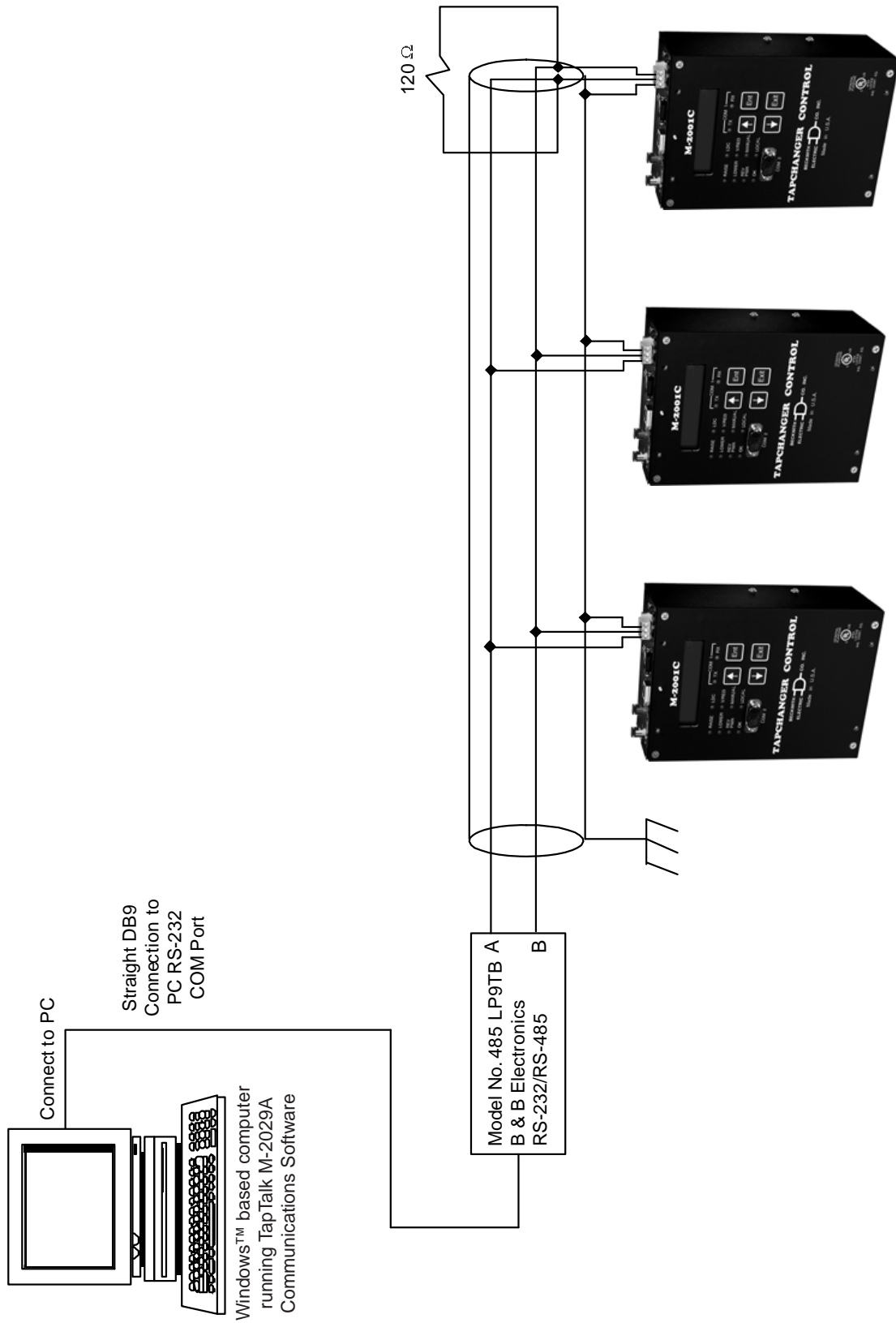


Figure 9-5 RS-485 Connection Tree

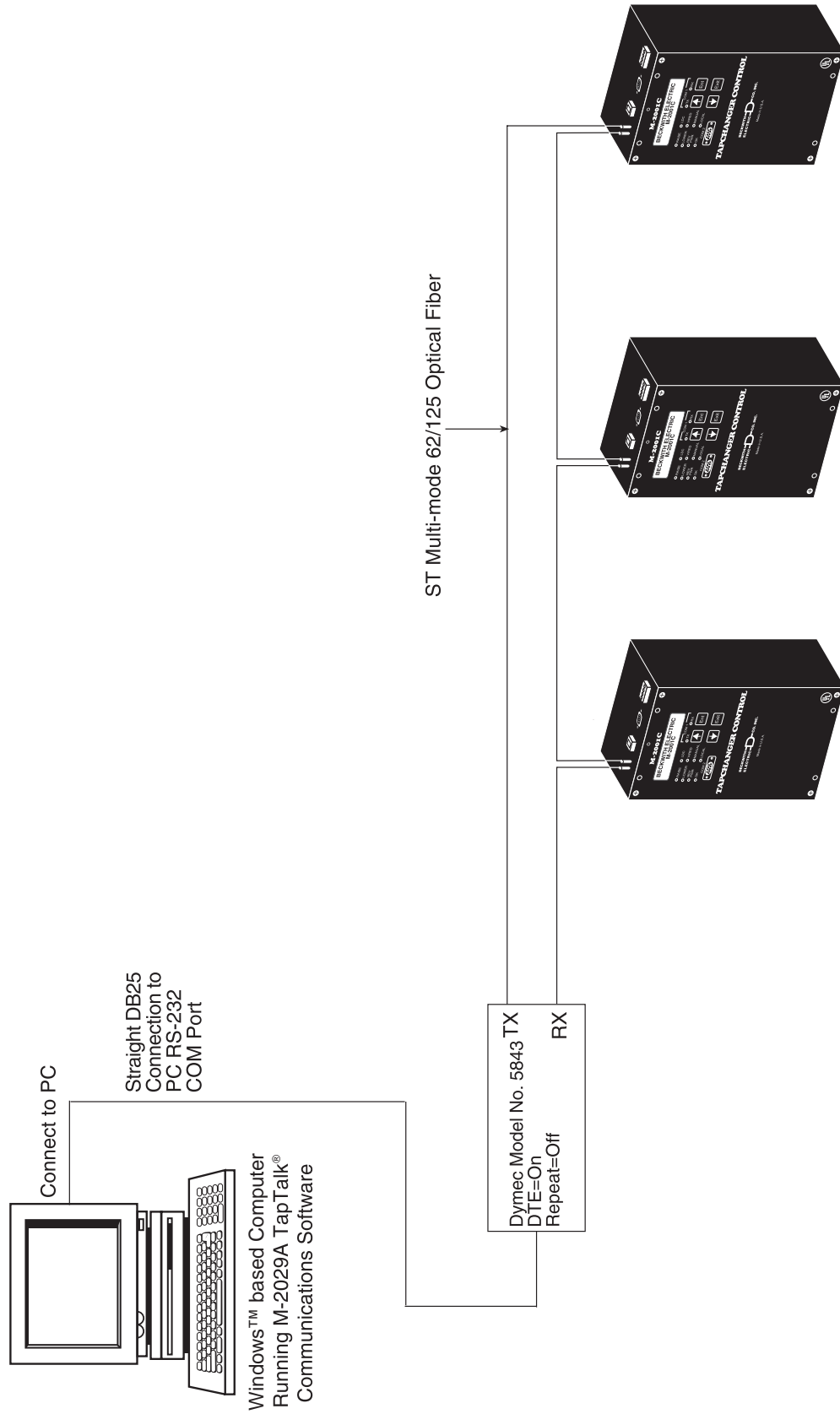


Figure 9-6 Fiber Optic Connection Loop

9.8 Overview of Operation

■ **NOTE:** If not connected and no file is open, items relating to settings, utilities, or monitoring are disabled. If not connected but a file is open, monitoring and utilities screens are displayed without data (Tap and Harmonics display simulated data.)

Once installed, the TapTalk® program-item icon is available from the Program Manager and TapTalk can be run like any other Windows™ program. (The installation utility places TapTalk in a Program Manager group named Becoware.) When TapTalk is run, the following menu bar is displayed. Each of the main menu selections is discussed briefly below.

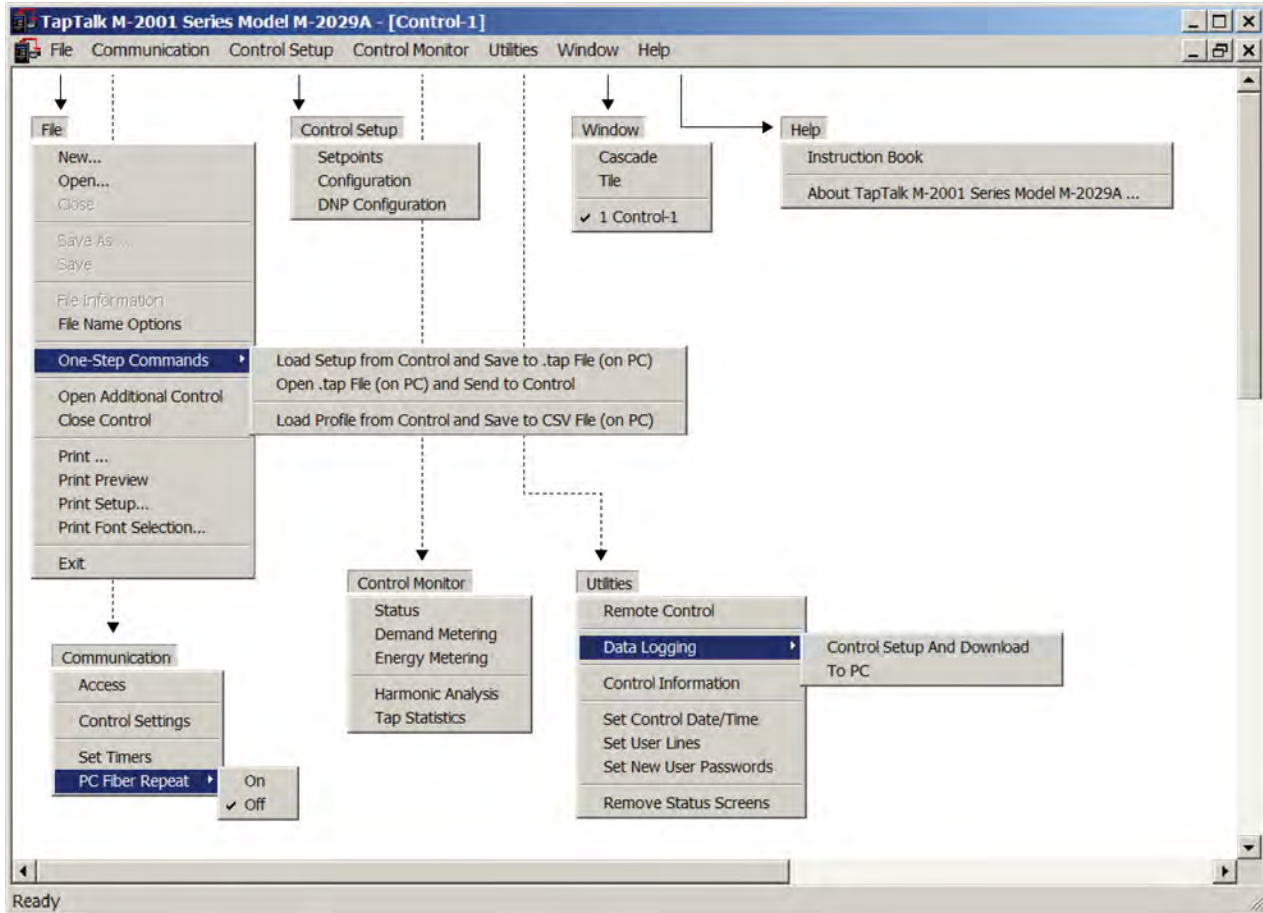
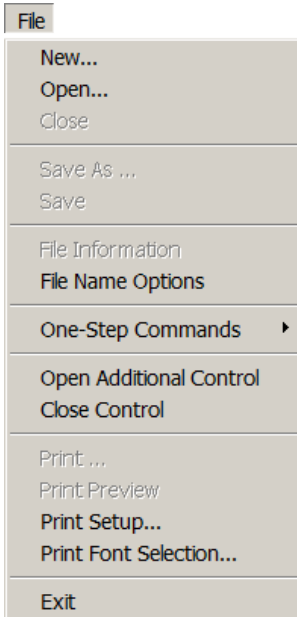


Figure 9-7 TapTalk Menu Selections

File



The **File** toolbar item provides the user with the ability to perform the following functions:

- **New...** Opens the File Information Box to allow the user to pick the Serial #, User Lines, Version Mod and other options.
- **Open...** Opens the file browser window to allow the user to select an existing file. It will not allow the user to create a new file.
- **Close** – Closes the open file in the control window.
- **Save As...** Allows the user to save the open file with a different file name.
- **Save** – Saves the open file.
- **File Information** – Displays the file name, user lines, firmware version, Mod number, 12 Volt DC Backup, and Δ VAR[®] associated with the open file.
- **File Name Options** – Allows user to select the parameters that will be included in the suggested file name.
- **One Step Commands** –

Load Setup from Control and Save to *.tap File (on PC): When connected to a control and no file is previously open, this function allows the user to recall the setpoints, configuration and DNP configuration (if applicable) and save the data to a file in one step.

Open *.tap File (on PC) and Send to Control: When connected to a control and no file is previously open, this function allows the user to open a file and send

the setpoints, configuration and DNP configuration (if applicable) to the control in one step.

Load Profile from Control and Save to CSV File (on PC): When connected to a control and no file is previously open, this function allows the user to recall the control profile and save the data to a comma-separated value file.

- **Open Additional Control** – Opens another TapTalk[®] window to allow the user to connect to multiple controls.
- **Close Control** – Closes the active window.
- **Print...** Prints the control information.
- **Print Preview** – Displays a preview of what will be printed.
- **Print Setup...** Allows the user to set up printer options.
- **Print Font Selection...** Allows the user to select a font for printouts.
- **Exit** – Exits the TapTalk program.

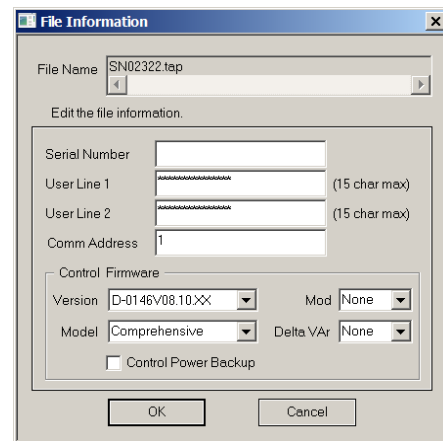


Figure 9-8 File Information Dialog Screen

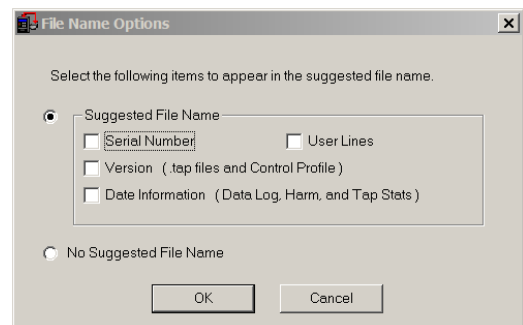
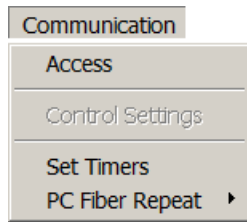


Figure 9-9 File Name Options Screen

Communication



The **Communication** menu provides the user with access to the screens that are necessary to set control communication parameters.

The **Access** menu selection initiates the **Access** dialog screen. The user is prompted to input the necessary communications information to open serial, modem or ethernet (TCPIP) communications with the target control.

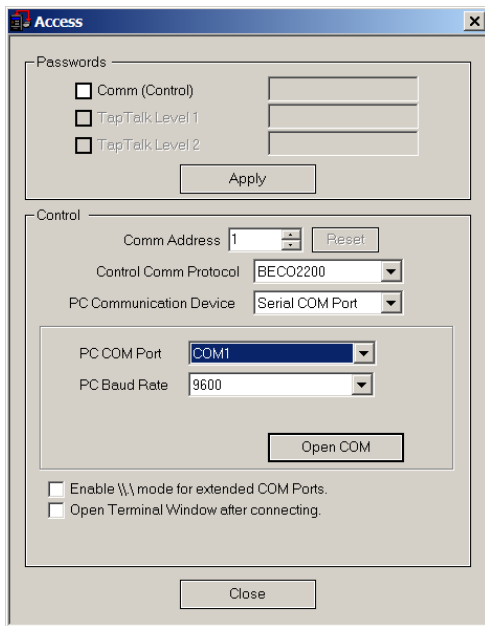


Figure 9-10 Communication Access (Serial) Dialog

To establish or change host computer or modem communication parameters perform the following:

1. Ensure that communication with the control is closed.
2. Select **Access** from the **Communication** menu to display the **Access** dialog screen.

■ **NOTE:** All M-2001 Series Digital Tapchanger Controls are shipped with the communication password disabled (set to 0000).

3. Select the desired password protection (Comm, TapTalk Level1, TapTalk Level2) by checking the corresponding checkbox.
4. Enter the required passwords. See Utilities/Set New User Passwords section of this chapter.

▲ **Caution:** Entering a Comm Address of zero (0) where multiple controls can be addressed will cause communication to be corrupted.

5. Input the **Comm Address** identification number (between 1 and 200) of the desired control.
6. Select **Control Comm Protocol** (BECO 2200)
7. Select **PC Communication Device** (Serial Comm Port, Modem or TCPIP)
8. If **Serial COM Port** has been selected, then select the desired COM Port and Baud Rate.
9. If **Modem** has been selected, then proceed as follows to input information required for modem communication:

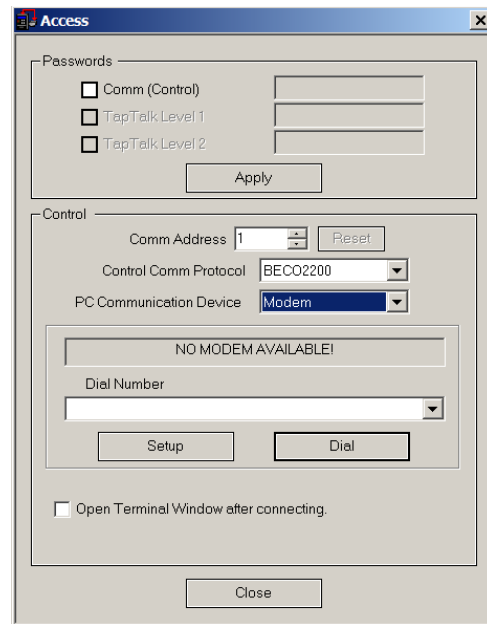


Figure 9-11 Communication Access (Modem) Dialog

- a. Ensure that the correct modem is displayed, then select **Setup**, TapTalk® will display the **Modem Communication Setup** screen.

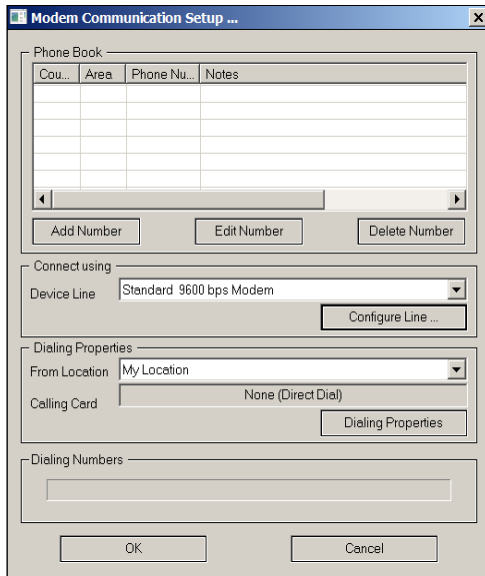


Figure 9-12 Modem Communication Setup

- b. Select **Add Number** or **Edit Number**; TapTalk® will display the **Edit Phone Book** dialog screen.

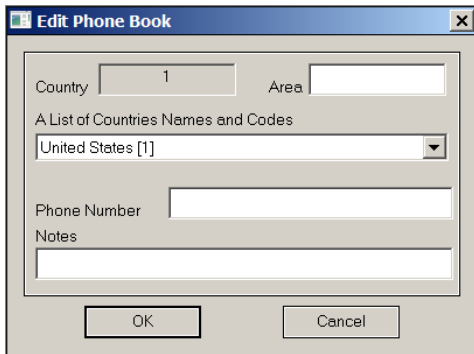


Figure 9-13 Edit Phone Book Dialog Screen

- c. Input the telephone number of the remote modem associated with the control, then select **OK** to save the telephone number to the Phone Book or **Cancel** to return to the **Modem Communication Setup** screen.
- d. If it becomes necessary to modify modem Windows™ settings, then select either the **Configure Line** or **Dialing Properties** section of the **Modem Communication Setup** screen to access modem settings.
- e. Select **OK** to save modem communication settings or **Cancel** to return to the **Communication Access** dialog screen.

- f. If terminal commands are to be issued to the corresponding terminal device (via modem), then check the **"Open Terminal Window After Connection"** box on the **Access Dialog Screen**.

When connected to another terminal device, the Terminal Window allows the user to send messages or commands. Outgoing communications are displayed in the top pane and incoming messages are displayed in the bottom two panes, in ASCII and HEX format.

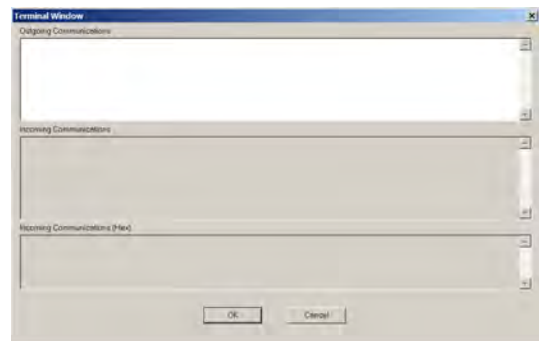


Figure 9-14 Terminal Window

- 10. If TCP/IP has been selected, then input an IP port value of 8800 (for internal ethernet cards) and the desired IP Address. If a third-party device (i.e., Lantronix DS-10) is used, then the port will have to match the setting of the device.

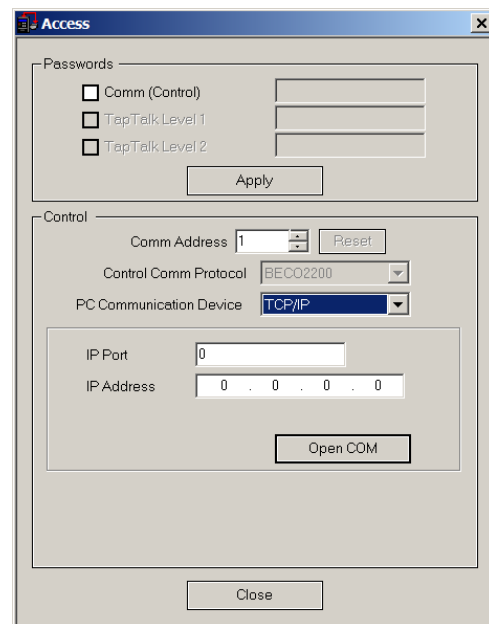


Figure 9-15 TCP/IP Communication Setup

11. To open serial communications, select **Open**. The passwords are sent to the control.
 - a. If proper passwords and Control Address have been sent, TapTalk® will respond with a confirming dialog screen.
 - b. If improper passwords and Control Address have been input, TapTalk will respond with an error screen.

12. To open modem communications, select **Dial**. The passwords and Control Address are sent to the control.
 - a. If proper passwords and Control Address have been sent, TapTalk will respond with a confirming dialog screen.
 - b. If improper passwords and Control Address have been input, TapTalk will respond with an error screen.

13. To open Ethernet communications, select **Open**. The IP Address, Control Address and passwords are sent to the control.
 - a. If proper IP Address, Control Address and passwords have been sent, TapTalk will respond with a confirming dialog screen.
 - b. If improper IP Address, Control Address and passwords have been input, TapTalk will respond with an error screen.

Multiple Control Addressing

To address additional controls at the same location (Not applicable to Ethernet connections), the user must reset the control address from the Communication Access Screen (Figure 9-10). When RESET is selected, TapTalk will respond with a confirming dialog screen, shown below. As long as communication to the remote location is maintained, the user can switch between controls.

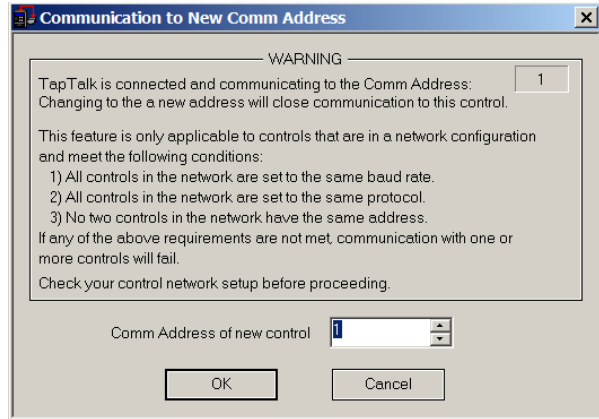


Figure 9-16 Communication To New Control Address Dialog Screen

Communication/Control Settings

The **Control Settings** menu selection initiates the **Control Settings** dialog screen which allows the user to set protocols and toggle fiber repeat on and off.

The **Control Settings** dialog screen also contains the settings necessary to Enable/Disable SCADA HeartBeat and select regulator or LTC. See Chapter 3, Section 3.7 SCADA HeartBeat for additional information

■ **NOTE:** The **Control Settings** screen may look differently depending on what version of control is connected. TapTalk identifies which COM Port it is connected to and writes the settings if applicable.

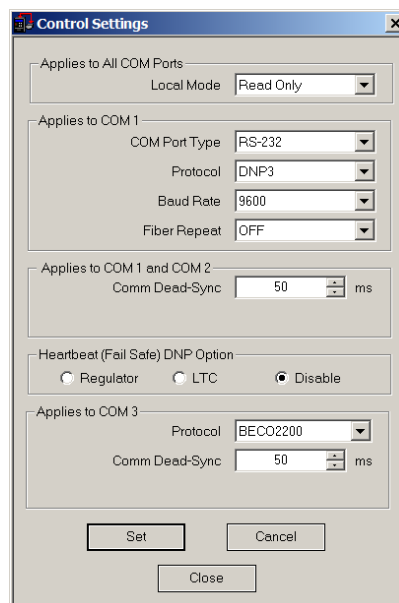


Figure 9-17 Control Settings Dialog Screen

Local Mode – Allows control of reading/writing setpoints and configurations using communications. There are 4 settings associated: **Disable**, **Read Only**, **Always Read Only**, and **No Read or Write**. When set to **Disable**, read/write communication will be available at all times. When set to **Read Only**, read/write communications will be available only when the front panel of the control is inactive. If the front panel is active, only reads via communications will be allowed. When set to **Always Read Only**, only reads via communications will be allowed, regardless of whether the front panel is active or not. When set to **No Read or Write**, read/write communication will be available only when the front panel to the control is inactive. If the front panel is active, no communication will be allowed.

COM Port Type – Allows the user to select the remote connection mode for COM Port 1. COM Port 1 can be selected to RS-232, RS-485 or Fiber.

COM1 Protocol – Allows selection between the standard protocols: BECO 2200, BECO 2179, Cooper 2179, Cooper 2179A, MODBUS, DNP3.0 and the Custom Protocols GP 2179, GP DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0 or the optional IEC 61850/UCA 2.0 Protocol.

COM1 Baud Rate – Selects baud rate (1200, 2400, 4800, 9600, 19200). When Com Port Type is selected to Ethernet, the baud rate defaults to 19200.

Fiber Repeat COM1 – This setting is used when several controls are connected using a fiber optic loop network. Selecting ON allows masking of the sender's echo.

COM1/2 Dead-Sync Time – This time delay improves robust operation when communication lines are intermittent. Communication dead-sync time is the time that the control will wait from the last received character and continue without attempting to resynchronize.

COM3 Protocol – Allows selection between the standard protocols: BECO 2200, BECO 2179, Cooper 2179, Cooper 2179A, MODBUS, DNP3.0 and the Custom Protocols GP 2179, GP DNP3.0 and AL PWR DNP3.0, MISS PWR DNP3.0 or the optional IEC 61850/UCA 2.0 Protocol.

COM3 Dead-Sync Time – This time delay improves robust operation when communication lines are intermittent. Communication dead-sync time is the time that the control will wait from the last received character and continue without attempting to resynchronize.

COM3 Ethernet Port (Port Number) – The Port Number can be set only when DNP protocol has been selected. DNP Port settings are either "8800" or "20000" with one session available.

For MODBUS protocol the Port setting is "502" with 2 sessions available. For all other protocols the Port setting is fixed at "8800" with 1 session available.

Communication/Set Timers

The **Set Timers** menu feature initiates the display of the Set Timers dialog box which displays the current timeout values, and allows the user to change timing values.

The **Time Out** setting determines time period at which TapTalk® will stop attempting to establish communication with the target control.

The **Wait Time** setting determines the time between individual commands when multiple commands are being performed. If errors occur, then increase the wait time setting before adjusting the timeout setting.

This feature also includes the capability to adjust the timing (**Monitoring Timer**) at which TapTalk refreshes control monitoring screen parameters.

The screenshot shows a 'Set Timers' dialog box with the following fields and values:

Section	Parameter	Value	Unit
Current Setting	Time Out	1000	milliseconds
	Wait Time	50	milliseconds
	Monitoring Timer	3000	milliseconds
New Setting	Time Out	1000	milliseconds
	Wait Time	50	milliseconds
	Monitoring Timer	3000	milliseconds
	# of Attempts	5	

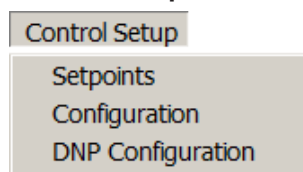
Buttons at the bottom: Set, Undo, Default, Close.

Figure 9-18 Set Communication Timers Screen

Communication/PC Fiber Repeat menu selection allows user to toggle Fiber Repeat on and off.

The PC Fiber Repeat feature is used only when several controls are connected using a fiber optic loop network. Selecting **On** allows masking of the sender's returned echo.

Control Setup



The **Control Setup** menu selection provides the user with means to access and modify **Setpoints**, **Configuration** and **DNP Configuration**.

Control Setup/Setpoints

The **Setpoints** submenu item displays the **Setpoints** Dialog Screen. The **Setpoints** screen includes the Control Identification Number, the Comm Address, and User Lines #1 and #2 information. The setpoint information displayed is from the control or from an open TapTalk® file.

Elements of the **Setpoints** screen are described on the following page.

The **Setpoints** screen commands include:

- **Read from Control** – This command is available to read setpoints from the target control when the Setpoints screen is selected to "Read From File". When this command is selected, the button will change to "Connected to Control."
- **Write to Control** – This command writes the values displayed/modified on the screen to the control.
- **Update File/Update Default** – If an existing file is open, **Update File** will write the values to the file. If a new file with default values is open, **Update Default** will update the values in RAM to be saved later.
- **Read Setpoints from File/Read Default Setpoints** – If a file is open, **Read Setpoints from File** reads the values from the open file. When no new file is open, **Read Default Setpoints** reads the default values from RAM.
- **Undo/Reload** – This command reloads setpoints from either the control or TapTalk file (whichever is selected) prior to any **Write to Control** or **Write to File** command.

Setpoints

Power Flow/Forward

Band Center – Adjustable from 100 V to 135 V in 0.1 V increments with a factory setting of 120 V.

Band Width – Adjustable from 1 V to 10 V in 0.1 V increments with a factory setting of 2.0 V.

LDC Resistance – Adjustable from –24 V to +24 V in 1 V increments with a factory setting of 0 V.

LDC Reactance – Adjustable from –24 V to +24 V in 1 V increments with a factory setting of 0 V.

Time Delay – Adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 sec.

Inverse Time Delay – Adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 seconds.

Power Flow/Reverse

Band Center – Adjustable from 100 V to 135 V in 0.1 V increments with a factory setting of 120 V.

Band Width – Adjustable from 1 V to 10 V in 0.1 V increments with a factory setting of 2.0 V.

LDC Resistance – Adjustable from –24 V to +24 V in 1 V increments with a factory setting of 0 V.

LDC Reactance – Adjustable from –24 V to +24 V in 1 V increments with a factory setting of 0 V.

Time Delay – Adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 sec.

Inverse Time Delay – Adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 seconds.

Voltage/Limit Runback

Block Raise – Over voltage limit is adjustable from 95 V to 135 V in 0.1 V increments with a factory setting of 128 V.

Block Lower – Under voltage limit is adjustable from 95 V to 135 V in 0.1 V increments with a factory setting of 114 V.

Dead Band – Adjustable from 1 V to 4 V in 0.1 V increments with a factory setting of 2.0 V.

Current Limit – Depending on the Current Transformer configuration point, adjustable from 200 mA to 640 mA (200 mA CT), in increments of 1 mA, from 1.0 A to 3.2 A (1 A CT), in increments of 0.1 A, or from 5.0 A to 16.0 A (5 A CT) in increments of 0.1 A. If the value of the current exceeds the current limit setpoint, the unit will not permit automatic control in either the raise or lower direction. Factory setting is 400 mA.

Voltage/Reduction

Step 1 – First of three independent steps of voltage reduction adjustable from 0% to 10% in 0.1% increments of the bandcenter setpoint. Factory setting is 2.5%.

Step 2 – Second voltage reduction step, adjustable from 0% to 10% in 0.1% increments of the bandcenter setpoint. Factory setting is 5.0%.

Step 3 – Third voltage reduction step, adjustable from 0% to 10% in 0.1% increments of the bandcenter setpoint. Factory setting is 7.5%.

Tap Limits

Block Raise/Lower – For M-2001C controls, both are adjustable from the Tap Maximum configuration point to the Tap Minimum value in 1 step increments (Tap Limit Block Raise cannot be lower than Tap Limit Block Lower +4. Tap Limit Block Lower cannot

be higher than Tap Limit Block Raise –4). For all other controls, Block Raise is adjustable from 16 to –12 Raise with a factory setting of 16 Raise, and Block Lower is adjustable from 12 to –16 Lower with a factory setting of 16 Lower. Both have 1 step increments.

Miscellaneous

LDC-Z – Adjustable from 0 V to 24 V in 1 V increments with a factory setting 0 V.

Output Pulse Width – Adjustable from 0.2 seconds to 12 seconds in 0.1 second increments with a factory setting of 1.5 second. C When the output is set to pulse and the control is calling for Raise/Lower (and no non-sequential or counter input is applied), an output will turn on for the preprogrammed time, and then turn off for 0.5 seconds, plus the intertap time delay. A square wave is generated on the output.

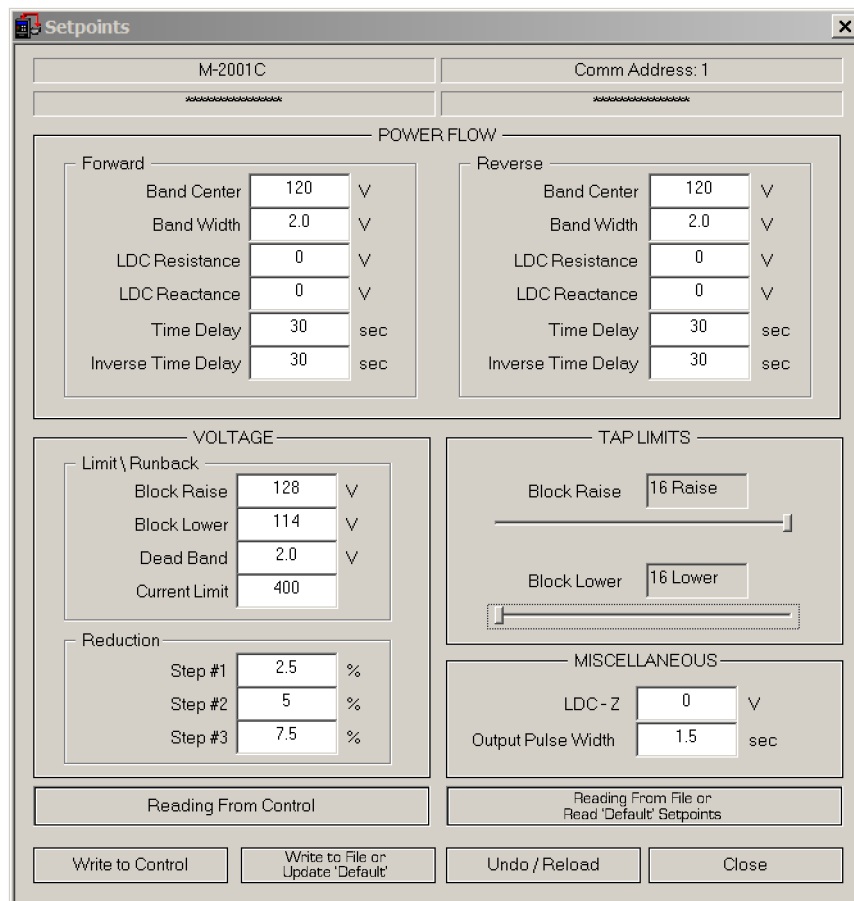


Figure 9-19 Setpoints Dialog Screen

■ **NOTE:** TapTalk® is designed to communicate with all M-2001 Series controls. However, due to the generational differences between controls, some features may not be available on the target control, and will appear greyed out in the display.

Control Setup/Configuration

The **Configuration** submenu item displays the **Configuration** Dialog Screen. The **Configuration** screen includes the Control Identification Number, the Comm Address, and User Lines #1 and #2 information. The configuration information displayed is default values if no TapTalk® file is open, from the control, or from an open TapTalk file. Elements of the Configuration screen are described on the following page.

The **Configuration** screen commands include:

- **Read from Control** – This command is available to read configuration settings from the target control when the Setpoints screen is selected to "Read From File". When this command is selected, the button will change to "Connected to Control."
- **Write to Control** – This command writes the values displayed/modified on the screen to the control.
- **Update File/Update Default** – If an existing file is open, **Update File** will write the values to the file. If a new file with default values is open, **Update Default** will update the values in RAM to be saved later.
- **Read from File/Read Default Config** – If a file is open, **Read from File** reads the values from the open file. When no new file is open, **Read Default Config** reads the default values from RAM.
- **Undo/Reload** – This command reloads configuration settings from either the control or TapTalk file (whichever is selected) prior to any **Write to Control** or **Write to File** command.

Configuration

Primary Status

Voltage Multiplier – Adjustable from 0.1 to 3260 in 0.1 increments with a factory setting of 60. User selection must include knowledge of VT ratio, sensing VT-ratio correction and indication of either line-to-line or line-to-ground voltage.

Current Multiplier – Adjustable from 1 to 32600 in 1.0 increments with a factory setting of 6000. User selection must include knowledge of CT ratio, from primary rating to 0.2 A rating of control.

Power Display – Toggles between two modes of operation: **SINGLE PHASE**, based on measured inputs; and **THREE PHASE**, based on measured inputs and presumed balanced system. Factory setting is **SINGLE PHASE**.

VT/CT

VT Correction – Adjustable from –15 V to +15 V in 0.1 V increments with a factory setting of 0 V.

VT Configuration – Toggles between **LINE-TO-LINE** and **LINE-TO-GROUND** with a factory setting of **LINE-TO-GROUND**.

CT/VT Phasing – Adjustable from 0° to 330° in 30° increments with a factory setting of 0°.

Tap

InterTap Delay – Adjustable from 0 to 60 seconds in 1.0 second increments with a factory setting of 0 seconds.

Tap Information – Toggles between ten modes of operation:

- **DISABLED**, to disable all tap position-related functions.
- **REG. INTERNAL**, to use Motor Direct Drive Keep Track™ tap position knowledge.
- **REG. EXTERNAL #1**, for use with the Beckwith Electric M-2025B(D) Current Loop Interface Module (allows input signal range from 0 to 1, 0 to 2, or -1 to 1 mA).
- **REG. EXTERNAL #2**, for use with the Beckwith Electric M-2025B(D) Current Loop Interface Module (allows input signal range from 4 to 20 mA).
- **REG. EXTERNAL #3**, is only for use on a regulator that has +/- 16 taps, a voltage divider tap position sensor, and a separate raise/lower output.
- **XFMR EXTERNAL #1**, for use with the Beckwith Electric M-2025B(D) Current Loop Interface Module (allows input signal range from 0 to 1, 0 to 2, or -1 to 1 mA).
- **XFMR EXTERNAL #2**, for use with the Beckwith Electric M-2025B(D) Current Loop Interface Module (allows input signal range from 4 to 20 mA).
- **XFMR EXTERNAL #3**, for use with Crompton Instruments absolute tap transducer. Adjustable from 0 to 1 mA.
- **Contact KeepTrack™ 1R1L**, for use with external tap position contacts.
- **Contact KeepTrack 1N**, for use with external tap position contacts.

BasicTimerType – Toggle between **INTEGRATING** (factory setting) or **INSTANT RESET**.

Figure 9-20 Configuration Dialog Screen

Tap Max/Tap Min – Tap Max is adjustable from 0 to 33R, and Tap Min is adjustable from 33L to 29R, both in 1 step increments. Note that Tap Max must be 4 taps greater than Tap Min (–33 to +29).

PROGRAMMABLE ALARM RELAY

The programmable alarm function provides alarm monitoring for one or more of eight conditions: Block Lower (voltage), Block Raise (voltage), Block Lower (tap), Block Raise (tap), Current Limit, Reverse Power, Voltage Reduction, and Comm Block. Alarm conditions are continuously displayed in the **Control Status Monitoring** screen.

Miscellaneous

Demand Interval – Toggles between 15, 30 and 60 minute intervals with a factory setting of 15 minutes. The time interval is that amount of time it takes for a thermal meter to indicate 90% of a change of load.

Operation Counter – Selects the contact operation sequence that will cause the software counter to increment by one. Open/close/open (X1), open/close or close/open contact operation (X2). The count window mode registers any activity as a valid

input within the count window time setting. Factory setting of X1.

Count Window – Operation count will increment by only one count during a set time period or "Count Window". This is true no matter how many counter inputs occur during the count window time period. After a counter input is accepted, the count window timer begins and another count won't be accepted until the count window time period expires. The count window time period can be set from 0.5 to 10.0 seconds.

Reverse Power – Toggles between five modes of operation: **BLOCK**, to inhibit automatic tapchange operation; **IGNORE**, to continue unit action as though forward power flow continued to exist; **REG REVERSE**, to detect a reverse power condition and regulate according to reverse power settings; **NEUTRAL**, to detect a reverse power operation and drive tap position to neutral and then stop; **DIST GENERATION**, allows alternate LDC R and X values to be applied to the control when reverse power is detected. The factory setting is **BLOCK**.

Time Delay Selection – Toggle between two modes of operation: **DEFINITE** (factory setting) and **INVERSE**.

Current Transformer – Toggle between three modes of operation: 200 mA (factory setting), 1 A and 5 A.

Line Drop Compensation – Toggle between two modes of operation: R, X (factory setting), and Z.

Output Selection – Toggle between two modes of operation: **CONTINUOUS** (factory setting) and **PULSE**.

Input Selection 1 – Toggle between two modes of operation: **Seal-in Input** and **Switch Status** (factory setting).

Input Selection 2 – Toggle between two modes of operation: **SCADA Cutout** and **Non-Sequential** (factory setting).

Input Selection 3 – Allows **VR2 Input** to be used as an **Aux Status Input** that can be read via DNP, BECO 2200 or MODBUS.

Power Direction Bias – The Power Direction Bias Configuration feature includes three settings to determine how the control will switch between forward and reverse power operation. The three settings are **None**, **Forward**, and **Reverse**.

Paralleling – Toggles between four modes of operation: **CIRC. CURRENT**, $\Delta\text{VAR}^{\text{R}}/1/\Delta\text{VAR}2$ (when option is purchased), and **DISABLE**, to select the method of paralleling. Factory setting is **DISABLE**.

Regulator Type – Allows the regulator type to be selected as Type A or B for correct source voltage calculation. Factory setting is Type **A**.

Flash Voltage Reduction Mode – Allows the flashing voltage reduction status screen to be enabled or disabled. Enabling this function may shorten the life of the display screen.

Daylight Savings – Allows the user to enable or disable the daylight savings feature in the control.

Auto/Man Switch Type – Allows the user to set the function of the Auto/Manual switch to None, Toggle or SCAMP.

Prog. Alarm Relay Mode

When the Auto/Man Switch Type is set to "SCAMP", then the Programmable Alarm Function can be set to "Normal" or "As a Deadman Output". This option is used since the Deadman Output is not available.

VR Turnoff Timer

Selectable from 0 to 999 minutes (0 = disabled). When set from 1 to 999 it turns off any voltage reduction invoked (via Comms) after the set time expires.

Delta VAR 2

Sensitivity – Controls how much the voltage bandcenter is shifted relative to the delta vars present between the circulating current input and the load current input. The settings for this screen are -4.0 to $+4.0$ in 0.1 increments, which correspond to a sensitivity of 0.5 to 2 times as sensitive.

Cir. Curr. Limit Reactive – The $\Delta\text{VAR}2$ **Circ Limit I** setpoint establishes a limit on the calculated reactive current difference between transformers. If the reactive current reaches this setpoint, the operation of the M-2001C will be blocked, and the alarm output function will be activated, if enabled. The settings for this screen are 5 mA to 200 mA in 1 mA increments. The default setting is 200 mA. (Section 4.9)

Input Ratio (Load/par) – Adjusts the sensitivity of the circulating current input versus the load current input. When the setting is 0.50, the control will be 0.50 times as sensitive to the VARs from the circulating current versus the load current input at 1.00, the control will be equally sensitive both current inputs. At 2.00, the control will be 2.00 times as sensitive to the VARs from circulating current input versus the load current input. The settings for this screen are 0.50 to 2.00 in 0.01 increments. The default setting is 1.00 to obtain equally sensitive current inputs.

Control Setup/DNP Configuration

■ **NOTE:** M-2001 firmware version must be D-0067V07.08.XX or later, or D-07.03.20, or D-07.03.21 to configure DNP points from TapTalk®.

The **DNP Configuration** submenu item displays the **DNP Configuration** Dialog Screen . The DNP Configuration screen includes the Control Identification Number, File Name, the Comm Address, and User Lines #1 and #2 information. The DNP information displayed is default values if no TapTalk file is open, from the control, or from an open TapTalk file.

DNP Configuration Screen includes:

DNP Comm Address

- **Set** – This command writes the DNP Comm Address to the control.

Checkbox Selections

- **Set All** – Sets all the checkboxes for the DNP points.
- **Clear All** – Clears all the checkboxes for the DNP points.
- **Undo/Reset** – This command reloads DNP configuration settings from either the control or TapTalk file (whichever is selected) prior to any **Write to Control** or **Write to File** command.

Write Selected Points

- **Write to Control** – Writes the selected checkboxes to the control.
- **Update File/Update Default** – If an existing file is open, **Update File** will write the values to the file. If a new file with default values is open, **Update Default** will update the values in RAM to be saved later.

Enable All Points – Sends a command to the control to enable all available DNP points.

Disable All Points – Sends a command to the control to disable all available DNP points.

Read from Control/Connected to Control – If a file is selected, **Read from Control** will reacquire data from the control and display it. If the data displayed is from the control, **Connected to Control** is displayed on the button.

Read Default DNP Config/Read DNP Config from File – If a file is open, **Read from File** reads the values from the open file. When no new file is open, **Read Default Config** reads the default values from RAM.

Create DNP Point List – Creates a text file based on the selected DNP points.

DNP Point Object Buttons

- **S** – Set all the available checkboxes in the DNP Object list.
- **C** – Clears all the available checkboxes in the DNP Object list.

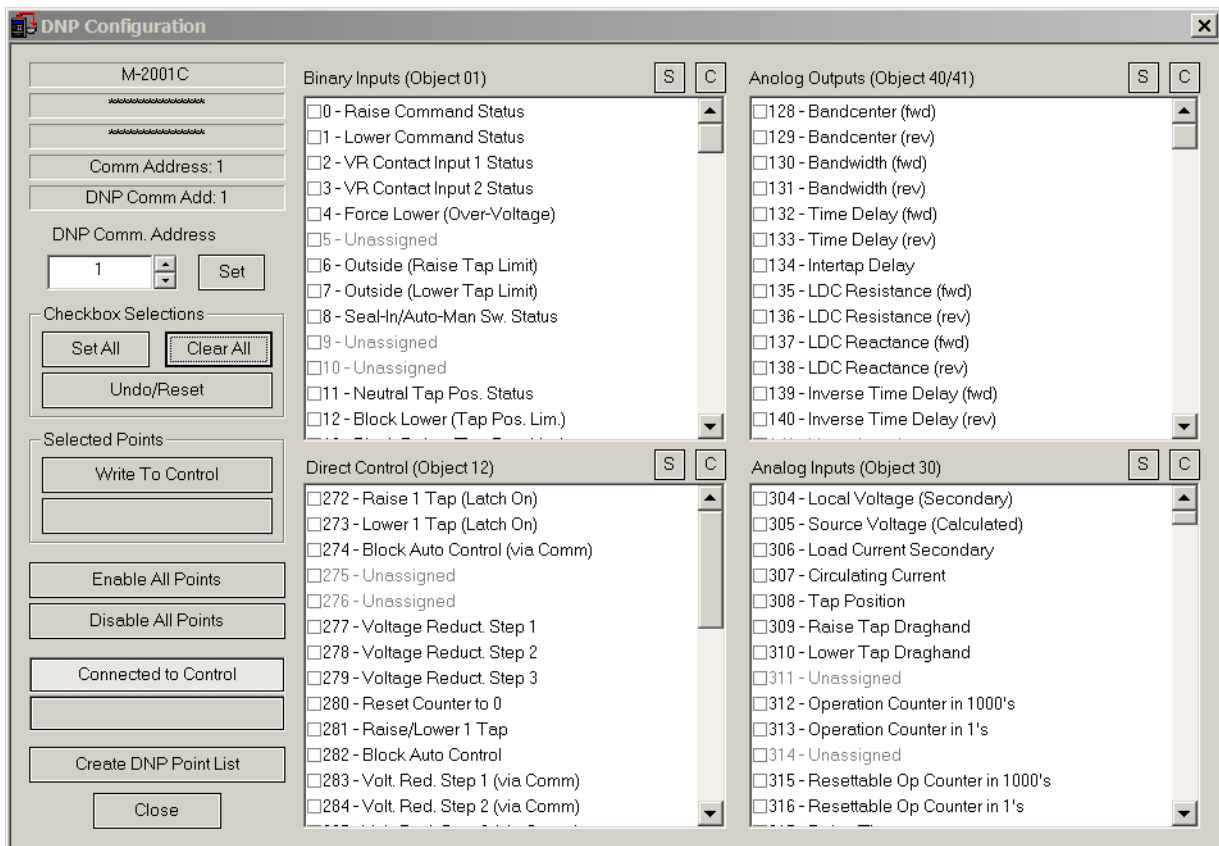
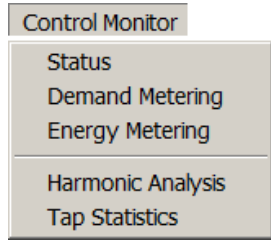


Figure 9-21 DNP Configuration Dialog Screen

Control Monitor






The **Control Monitor** toolbar item provides the user with the means to display the control's **Status**, **Demand Metering** and **Energy Metering** screens. The screens include the Control Identification Number, the Comm Address, and User Lines #1 and #2 information. These screens and the data that is displayed are available only when communication is established between the control and the host computer.

Control Monitor/Status

The **Status** submenu item displays the **Status** Screen. Values displayed are updated based on the monitoring setting in the timers section, and also depending on communication system capabilities.

Each Status screen will also display Communication Status Indicator icons:

-  Unit is connected.
-  Communication lost, attempting to reconnect (time allowed for reconnect attempt is set in the Timers dialog box.)
-  Reconnect failed.

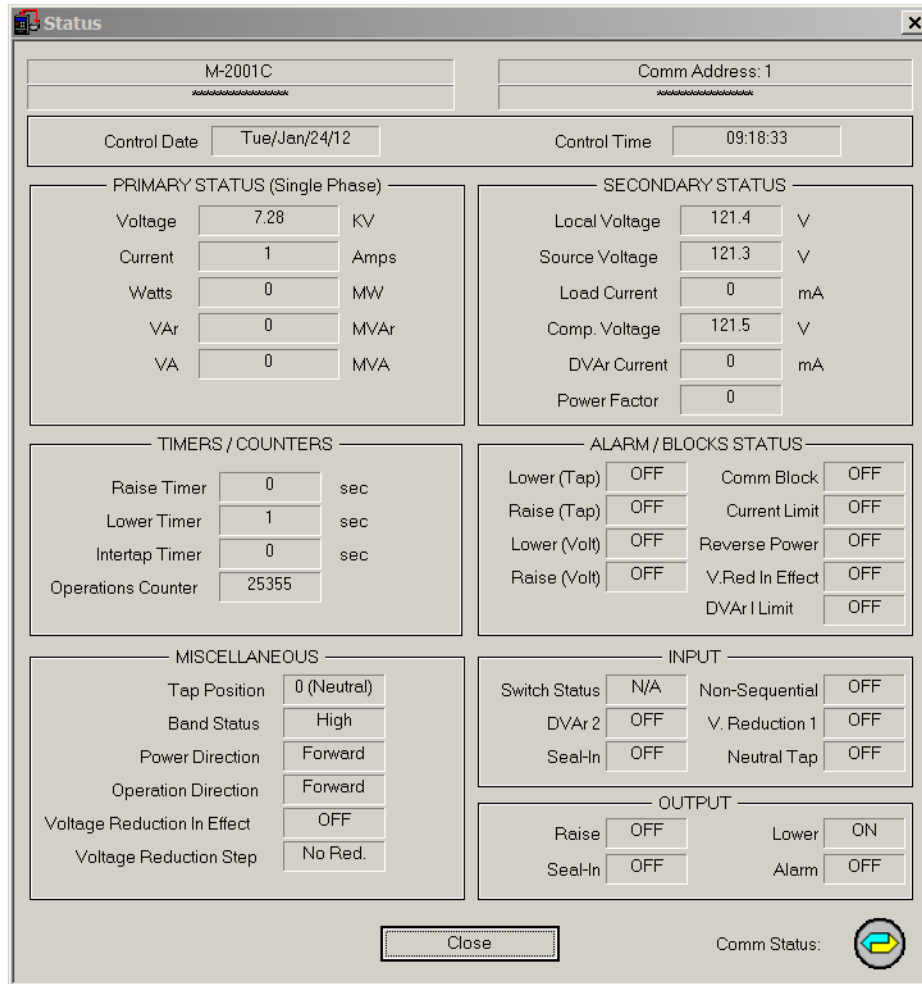


Figure 9-22 Status Screen

Primary Status (single or three phase)

Local Voltage – Displays the calculated primary voltage based on the user-selected voltage multiplier, VT corrections, and measured secondary voltage.

Primary Current – Displays the calculated primary current based on the user-selected current multiplier, and measured secondary current.

Primary Watts – Displays the calculated primary quantity based on the user-selected voltage and current multipliers; VT configuration (line-to-line or line-to-ground), single-phase or three-phase, and measured secondary voltage and current.

Primary VAR – Displays the calculated primary quantity based on the user-selected voltage and current multipliers, VT configuration (line-to-line or line-to-ground), single-phase or three-phase, and measured secondary voltage and current.

Primary VA – Displays the calculated primary quantity based on the user-selected voltage and current multipliers, VT configuration (line-to-line or line-to-ground), single-phase or three-phase, and measured secondary voltage and current.

Timers/Counters

Raise Timer – Displays the integrated out-of-band time for a voltage excursion greater than the upper band limit up to the value of the time delay setpoint.

Lower Timer – Displays the integrated out-of-band time for a voltage excursion less than the lower band limit up to the value of the time delay setpoint.

Intertap Timer – In the sequential mode of operation, displays the integrated out-of-band time for a voltage excursion and the subsequent tap change. Adjustable from 0 to 60 seconds, in 1.0 second increments, with a factory setting of 0 seconds.

Operations Counter – Records the number of raise and lower operations. The operation counter will advance by one or two counts, as set by the user, for each open-close-open contact operations. This counter is not resettable.

Miscellaneous

Tap Position – Displays the tap position of the tapchanger when any method of KeepTrack™ is used. Recognizes tapchanges commanded via manual, automatic or external (SCADA) means.

Band Status – Indicates one of three conditions: **High**, when voltage is out of band high, **Low** when voltage is out of band low, and **OK** when voltage is within band.

Power Direction – Indicates one of two power directions: **Forward** (forward power condition) and **Reverse** (reverse power condition).

Operation Direction – Indicates one of two modes of operation: **Forward**, indicating forward power regulation, due to either actual forward power flow, an Ignore configuration forcing unit action as though forward power flow exists when a reverse power flow is detected, or a Block configuration inhibiting automatic tapchange operation when reverse power flow is detected, or **Reverse**, detecting a reverse power condition, while control is configured for reverse regulation.

Voltage Reduction In Effect – Indicates voltage reduction (any step) is invoked.

Voltage Reduction Steps – No Reduction indicates voltage reduction is not active, blocked either by non-sequential input, a reverse power condition, or by communicated command. Steps 1, 2, and 3 indicate that voltage reduction is in effect for the stated step value.

Secondary Status

Local Voltage – Displays the real-time measured value of voltage at the regulator or transformer and includes any corrections made using the user-selected VT correction voltage.

Source Voltage – Displays the real-time calculated source voltage and includes any corrections made using the user-selected VT correction voltage.

Load Current – Displays the real-time measured value of current.

Compensate Volts – Displays the calculated voltage at the "load center".

Circulating Current – Displays a representative value of circulating current, if the control is used with the Beckwith Electric M-0115A Parallel Balancing module, or its equivalent.

Power Factor – Displays the real-time calculated value of power factor.

Alarm Blocks Status

There are three available states for each of the Alarm Blocks Status screens: **Off**, **On**, and **Alarm**.

Lower (Tap) – **Off**: the tap position is not exceeding the block lower tap limit setting. **On**: the tap position equals or exceeds the block lower tap limit setting with no alarm output. **Alarm**: the tap position equals or exceeds the block lower tap limit setting and the alarm output is on due to this condition.

Raise (Tap) – **Off**: the tap position is not exceeding the block raise tap limit setting. **On**: the tap position equals or exceeds the block raise tap limit setting with no alarm output. **Alarm**: the tap position equals or exceeds the block raise tap limit setting and the alarm output is on due to this condition.

Lower (Volt) – **Off**: the tap position is not exceeding the block lower voltage limit setting. **On**: the tap position equals or exceeds the block lower voltage limit setting with no alarm output. **Alarm**: the tap position equals or exceeds the block lower voltage limit setting and the alarm output is on due to this condition.

Raise (Volt) – **Off**: the tap position is not exceeding the block raise voltage limit setting. **On**: the tap position equals or exceeds the block raise voltage limit setting with no alarm output. **Alarm**: the tap position equals or exceeds the block raise voltage limit setting and the alarm output is on due to this condition.

Comm Block – **Off**: the control has not had its automatic operation blocked via communications. **On**: the control has had its automatic operation blocked via communications and is now in manual operation mode with no alarm output. **Alarm**: the control has had its automatic operation blocked via communications and is now in manual operation mode and the alarm output is on due to this condition.

Current Limit – **Off**: the load current and Δ VAR[®]2 reactive current (if enabled) is not exceeding the respective maximum current limit setting. **On**: the load current or the Δ VAR2 reactive current (if enabled) is exceeding the respective maximum current limit setting with no alarm output. **Alarm**: the load current or the Δ VAR2 reactive current (if enabled) is exceeding the respective maximum current limit setting and the alarm output is on due to this condition.

Reverse Power – **Off**: reverse power is not present at the control. **On**: reverse power is present at the control with no alarm output. **Alarm**: reverse power is present at the control and the alarm output is on due to this condition.

V. Red in Effect – **Off**: voltage reduction is not active in the control. **On**: voltage reduction is active in the control with no alarm output. **Alarm**: voltage reduction is active in the control and the alarm output is on due to this condition.

Input

Screen will display any of the following based on the **Configuration** settings.

Switch Status – Provides the user feedback on the position of the Auto/Manual switch. When the M-2001C is configured for a switch status input, the switch status is read using the seal-in input on the control.

Counter – Indicates operation counter contact input is closed.

DVAR 2 – Indicates that the Paralleling method is selected to Δ VAR2.

Seal-in – Indicates Input Selection 1 is set to Seal-in.

Non-Sequential – Indicates non-sequential contact input is closed. Tapchanger control blocks raise or lower operation on a sustained closed contact.

SCADA Cutout – Indicates Input Selection 2 is set to SCADA Cutout. All non-sequential functions are disabled.

Volt Reduction 1 – Indicates Step 1 voltage reduction contact output is closed.

Volt Reduction 2 – Indicates Step 2 voltage reduction contact output is closed.

Neutral Tap – Indicates neutral position contact input is closed.

Output

Raise – Indicates Raise output is active.

Lower – Indicates lower output is active.

Seal-In – Indicates seal-in feature is active, if the control is used with a Cooper (McGraw-Edison) regulator.

Alarm – Indicates one or more user-selected alarm conditions.

Control Monitor/Demand Metering

The **Demand Metering** submenu item displays the **Demand Metering** screen. Real-time demand metering information can be monitored from an addressed control.

Control Date and **Control Time** displays current time and date of the addressed control.

Demand Metering parameters are described on the following page.

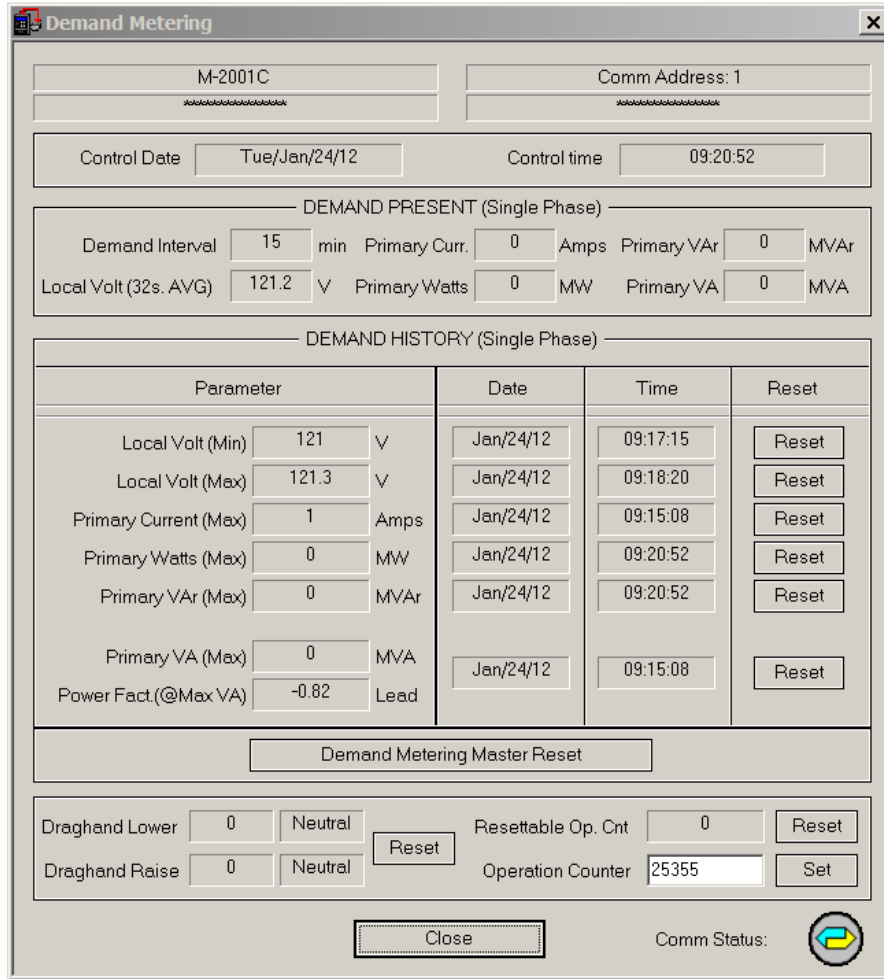


Figure 9-23 Demand Metering Dialog

Demand Metering

Demand Present (Single Phase)

Demand Interval – Indicates the time interval required for a thermal meter to indicate 90% of a change of load, adjustable from 15, 30, and 60 minutes.

Local Volt – Displays the real-time measured value of voltage at the regulator or transformer. This value continuously averaged over consecutive 32-second intervals.

Primary Curr – Displays the calculated primary demand current based on the user-selected current multiplier and measured secondary current.

Primary Watts – Displays the demand value base on the user-selected voltage and current multipliers; VT configuration (line-to-line or line-to-ground), single-phase or three-phase, and measured secondary voltage and current.

Primary VAR – Displays the demand value based on the user-selected voltage and current multipliers, VT configuration (line-to-line or line-to-ground), single-phase or three-phase, and measured secondary voltage and current.

Primary VA – Displays the demand value based on the user-selected voltage and current multipliers, VT configuration (line-to-line or line-to-ground), single-phase or three-phase, and measured secondary voltage and current.

Demand History (Single-Phase or Three-Phase)

– All demand history values include the date and time at which each occurred. A draghand value is the maximum or minimum value of a measured quantity recorded since the last reset.

Local Volt (Min) – Displays minimum local voltage at the regulator or transformer. This value continuously averaged over consecutive 32-second intervals.

Local Volt (Max) – Displays draghand maximum local voltage at the regulator or transformer. This value continuously averaged over consecutive 32-second intervals.

Primary Current (Max) – Displays draghand maximum primary current.

Primary Watts (Max) – Displays draghand maximum primary watts.

Primary VAR (Max) – Displays draghand maximum primary VARs.

Primary VA (Max) – Displays draghand maximum primary VA. Resets automatically when Power Factor at (Max) VA value, below, is reset.

Power Factor at (Max) VA – Displays draghand power factor at time of maximum VA.

Miscellaneous

Master Reset – Resets all Demand History date and time stamps and values.

Draghand Lower – Displays the lowest tap since last reset.

Draghand Raise – Displays the highest tap since last reset.

Resettable Op Cnt – Displays the number of operations since the last reset.

Operation Counter – Displays the number of operations. Can be set to a specific number by the user.

Control Monitor/Energy Metering

■ **NOTE:** M-2001 firmware version must be V-07.03.20 or later.

The **Energy Metering** submenu item displays the **Energy Metering** screen. This feature enables the user to review real-time and historical demand metering information. The screen includes the current date and time, Watt Hour (Single-Phase or Three-Phase) forward and reverse, and VAr Hour (Single-Phase or Three-Phase) forward and reverse metered values.

Each element can be reset individually by selecting **Reset** for the desired parameter. When a **Reset** command is issued, the metered value is reset to zero and the time and date are updated.

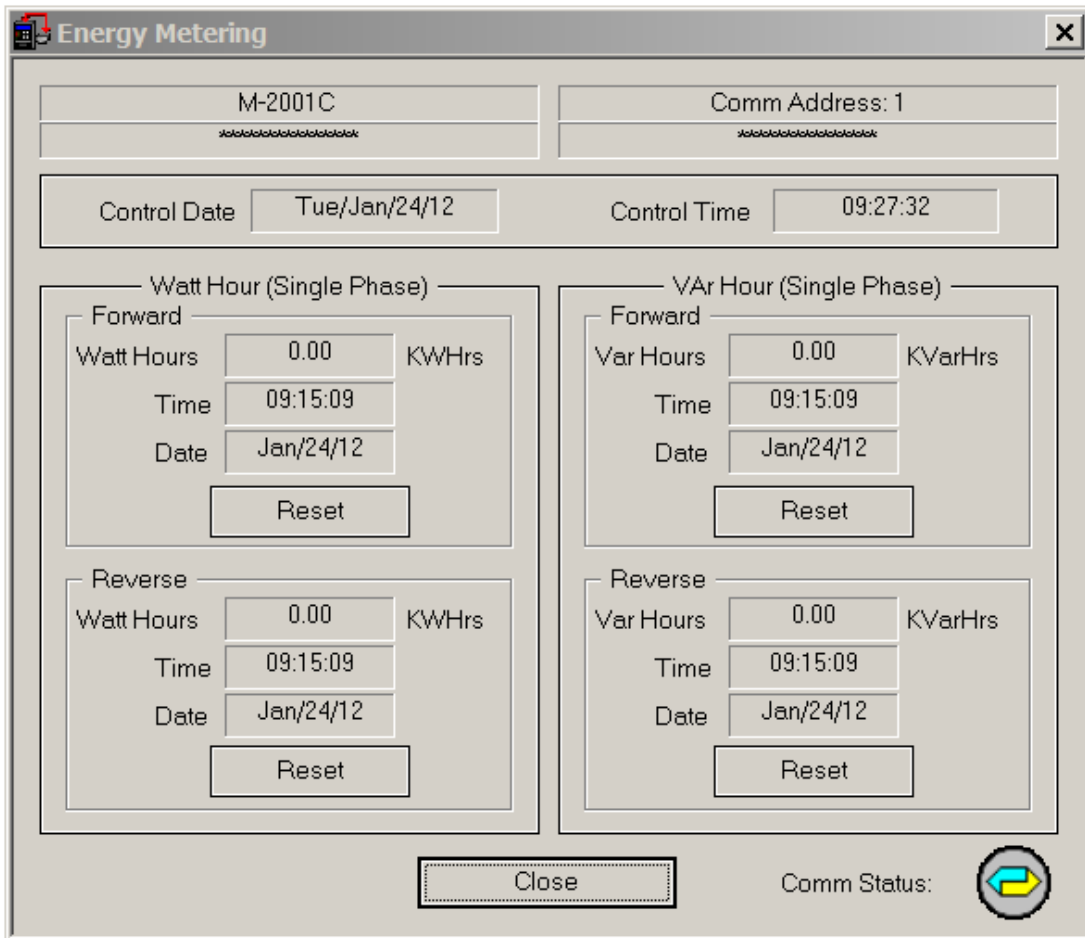


Figure 9-24 Energy Metering Screen

Control Monitor/Harmonic Analysis

■ **NOTE:** M-2001 firmware version must be V-07.09.XX or later .

The **Harmonic Analysis** submenu item displays the **Harmonic Analysis** screen. This feature enables the user to review voltage and current harmonics as a function of % fundamental or RMS. When this feature is selected, TapTalk acquires 4 cycles of data and

calculates the harmonic spectrum for each cycle, and then displays the average of the four cycles of data for each harmonic. The user can select and view detailed information for each harmonic, save the data to file (text file) for viewing at a later time, or acquire a more current data set for display. When "Show Graph As RMS" is selected, the graph displays RMS values in Volts and mAmps.

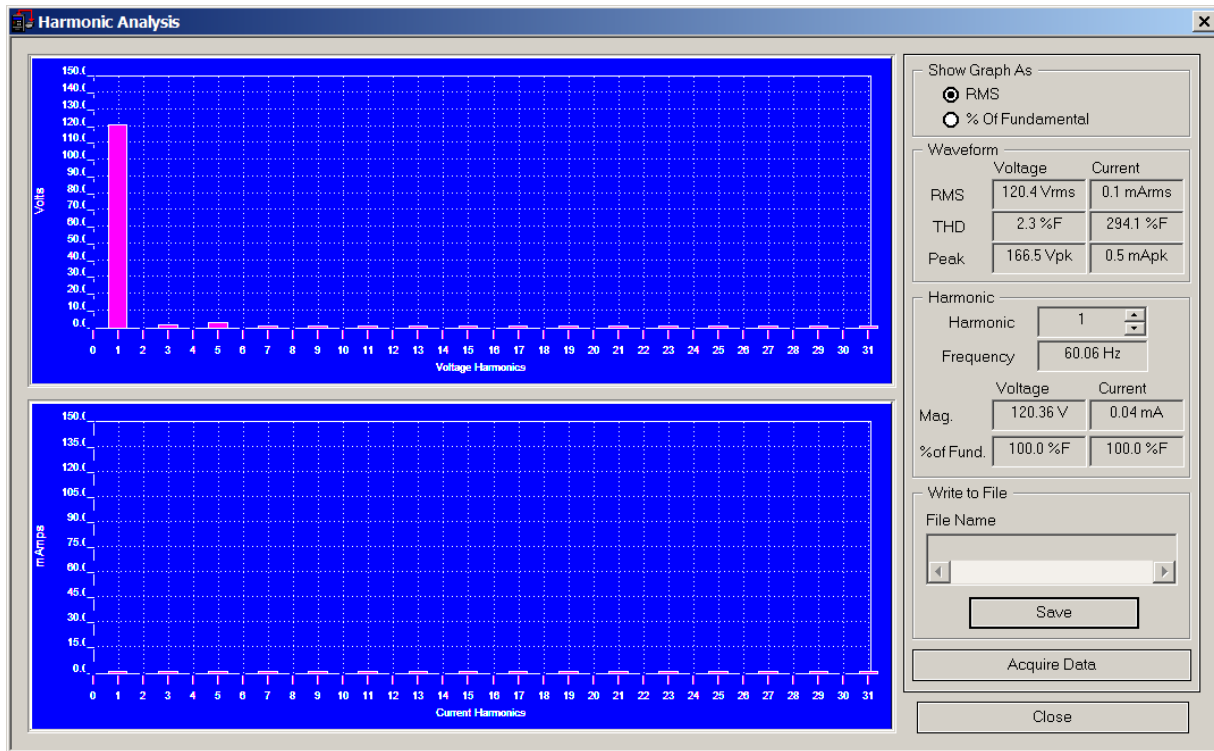


Figure 9-25 Harmonic Analysis Dialog Screen

Control Monitor/Tap Statistics

▲ **CAUTION:** Selecting RESET COUNTER will permanently delete all tap change statistics.

■ **NOTE:** M-2001 firmware version must be V-07.09.XX or later .

The **Tap Statistics** submenu item displays a statistical representation of the Tapchanger operation. The cumulative (since last visit) number of tapchanges for each tap position is displayed both graphically and numerically. Selecting **REFRESH** updates tap statistical data. Selecting **RESET COUNTER** resets all tap statistic counters to zero.

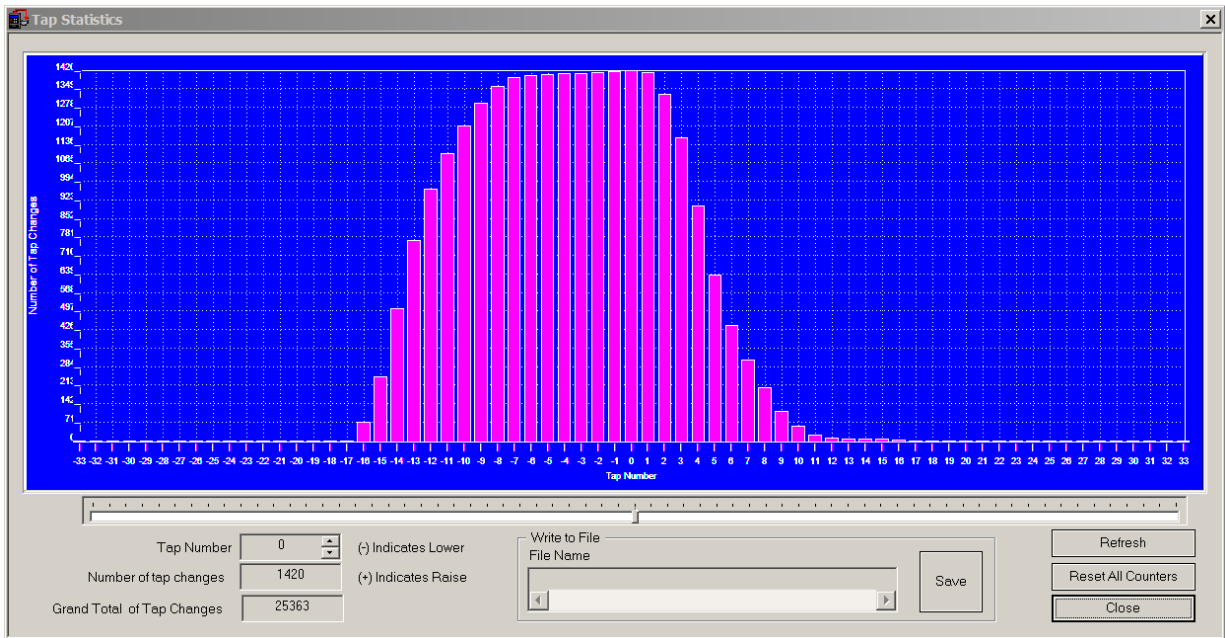


Figure 9-26 Tap Statistics Screen

Utilities

Utilities
Remote Control
Data Logging ▶
Control Information
Set Control Date/Time
Set User Lines
Set New User Passwords
Remove Status Screens

The **Utilities** menu includes the **Remote Control**, **Data Logging**, **Control Information**, **Set Control Date and Time**, **Set User Lines**, and **Set New User Passwords** commands.

Utilities/Remote Control

▲ **CAUTION:** This feature should be used with extreme caution.

The **Remote Control** menu item displays the **Remote Control** screen. The **To Current Comm Address** selection enables the user to remotely raise or lower the tap position as well as apply voltage reduction to an individual control. The **Broadcast** selection allows the user to remotely apply voltage reduction to one or more controls. Also included is the **Tap Calibrate** command which enables the user to initialize the tap position for a transformer or regulator when the control is installed. Tap calibration is required for keeping accurate tap positions when using any KeepTrack™ method.

Remote Control and Automatic Mode Blocking

The Automatic Mode Blocking feature using Remote Control will cause the control to respond in a predefined manner to either a serial communication interruption or power loss to the control. The Control will respond as follows:

- If Automatic control has been Blocked using TapTalk®, then Automatic Control will remain Blocked if serial communication is disrupted or lost.
- If Automatic Control has been Blocked using TapTalk, and the **Save Comm. Blk** feature is **Enabled**, then the Automatic Control Block will be reinstated at power up.
- If Automatic Control has been Blocked using TapTalk, and the **Save Comm. Blk** feature is **Disabled**, then the Automatic Control Block will not be reinstated at power up.

Restoring Automatic Operation (Local)

Automatic operation can be restored from the front panel by removing the "Block Auto Control via Communication" through TapTalk or by performing the following:

1. From the control front panel pushbuttons change the **Comm Block Auto** setting in the **Configuration** menu to **DONT SAVE**.
2. Remove power to the control, then reapply power to the control. Automatic operation will then be restored.

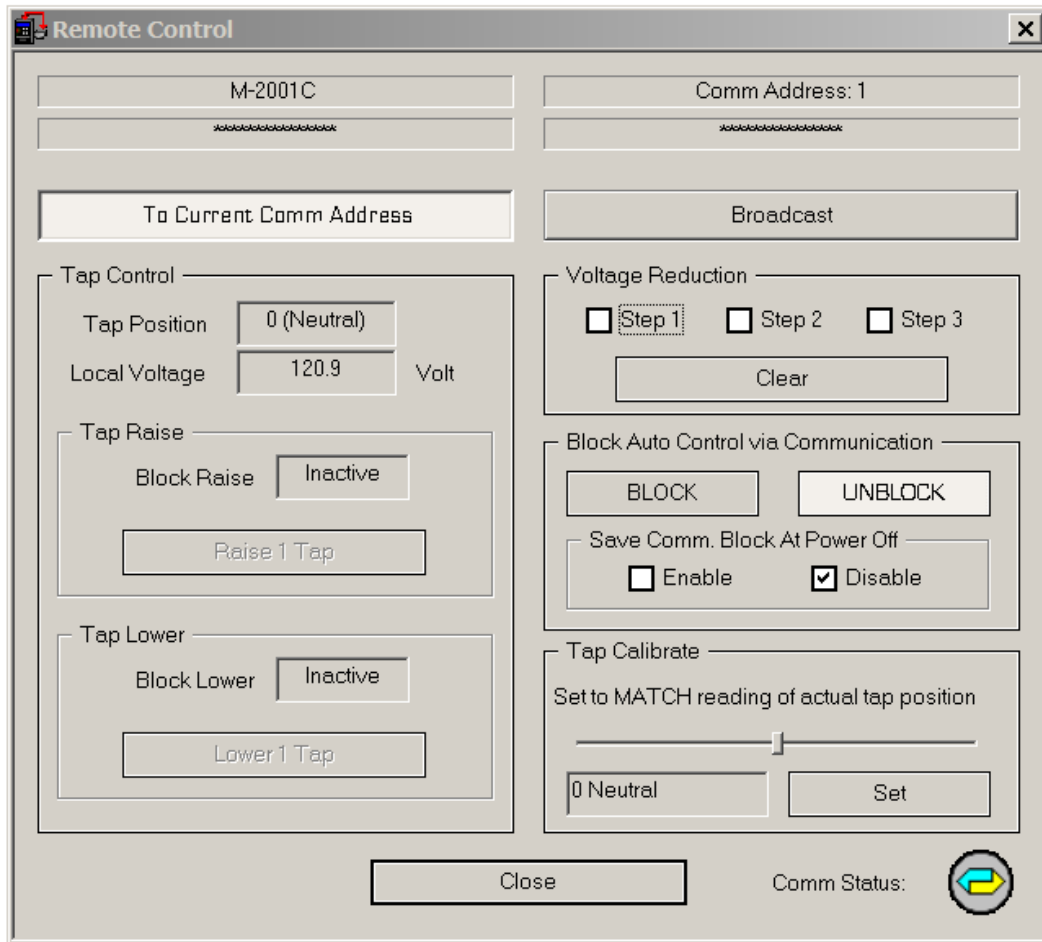


Figure 9-27 Remote Control Screen

Remote Control

▲ **CAUTION:** This feature should be used with extreme caution.

The **Remote Control** feature enables the user to remotely raise or lower tap position, as well as apply voltage reduction when the control is in Automatic.

Remote Voltage Reduction

Step #1 – Initiates first step voltage reduction command for addressed control.

Step #2 – Initiates second step voltage reduction command for addressed control.

Step #3 – Initiates third step voltage reduction command for addressed control.

Clear – Removes remote voltage reduction commands for addressed control.

Remote Tap Control

■ **NOTE:** If the unit is equipped with the DC Power Backup option, then all automatic Raise or Lower operations are blocked when the input voltage decreases to less than 85.0 V dc. Remote initiated Raise or Lower operations will still be initiated if Motor Power is available.

Lower 1 Tap – Initiates remote Lower in 1 step increments. Limited by tap Block Lower setpoint and tap position limit settings.

▲ **CAUTION:** If an appropriate pulse width setting is not input, then a misoperation of the tapchanger may occur when a SCADA Manual Raise or Lower is initiated.

Raise 1 Tap – Initiates remote Raise in 1 step increments. Limited by tap Block Raise setpoint and tap position limit settings.

Block Auto Control via Communication

Block – Blocks automatic operation of the addressed control.

Unblock – Initiates automatic operation of the addressed control.

Save Comm. Block at Power Off – Allows the state of the "Block Auto Operation" communication command to be saved or not saved when power has been lost.

Exit – Returns to the TapTalk® main window. Exiting does not cancel blocking or voltage reduction. *Automatic operation of the control is disabled until the **Unblock** command is chosen.*

Broadcast Control

▲ **CAUTION:** This feature should be used with extreme caution.

The **Broadcast Control** feature enables the user to remotely apply voltage reduction and/or Block (Unblock) Automatic Control to one or more controls.

Remote Voltage Reduction

Step #1 – Initiates first step-voltage reduction command for all controls on the communication network.

Step #2 – Initiates second step-voltage reduction command for all controls on the communication network.

Step #3 – Initiates third step-voltage reduction command for all controls on the communication network.

Clear – Removes remote voltage reduction commands for all controls on the communication network.

Block Auto Control via Communication

Block – Blocks automatic operation of all controls on the communication network.

Unblock – Initiates automatic operation of all controls on the communication network.

Save Comm. Block at Power Off – Allows the state of the "Block Auto Operation" communication command to be saved or not saved when power has been lost.

Tap Calibrate

The Tap Calibrate feature enables the user to initialize the tap position for a transformer or regulator when the control is installed. Tap calibration is required for keeping accurate tap positions when using any KeepTrack™ method.

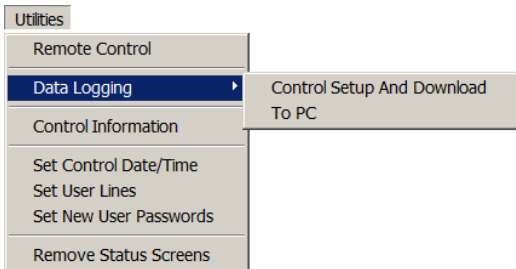
Tap Position – Sets actual tap position.

Raise/Lower – Sets actual tap direction.

Set – Writes the currently displayed tap position and direction to the addressed control.

Exit – Returns to the TapTalk main window. Exiting does not cancel blocking or voltage reduction. *Automatic operation of the control is disabled until the **Unblock** command is chosen.*

Utilities/Data Logging



The **Data Logging** toolbar item includes **Control Setup and Download** and **To PC** data logging features.

When connected to a M-2001C control the **Data Logging** feature provides the user with the ability to initiate data logging of selectable control parameters to either the selected control for downloading at a later time or directly to a PC.

This feature allows the user to configure the parameters that the control will use to log data, and to download the logged data to a comma separated value (CSV) file or a TapPlot® file. CSV files can be opened in a spreadsheet program such as Microsoft Excel™. TapPlot files can be viewed with TapPlot.

Data Logging/Control Setup and Download

This submenu item displays the **Data Logging Control Setup and Download** Dialog Screen.

The **Logging** section allows the user to select the parameters to be logged by the control. The number of parameters selected determines the **Max Time Available** duration that the control can store.

In the **Logging Timer** section, the **Sampling Period** allows the user to input the frequency in minutes at which the data will be logged. **Max Time Available** displays the amount of data that can be held in the circular memory block. This field will automatically update with any changes made in the **Sampling Period** or the **Data To Be Logged** section.

To erase the existing data and start logging new data, select "**Erase Existing Data and Start Logging Data to Control...**"

Once the **Data to be Logged** parameters are uploaded to the control by selecting **Erase Existing Data and Start Logging data to Control**, the control will log data to onboard memory. Logging will continue indefinitely until a new set of log parameters are uploaded, at which point all previously logged data will be cleared, and the control will begin logging data with the new parameters.

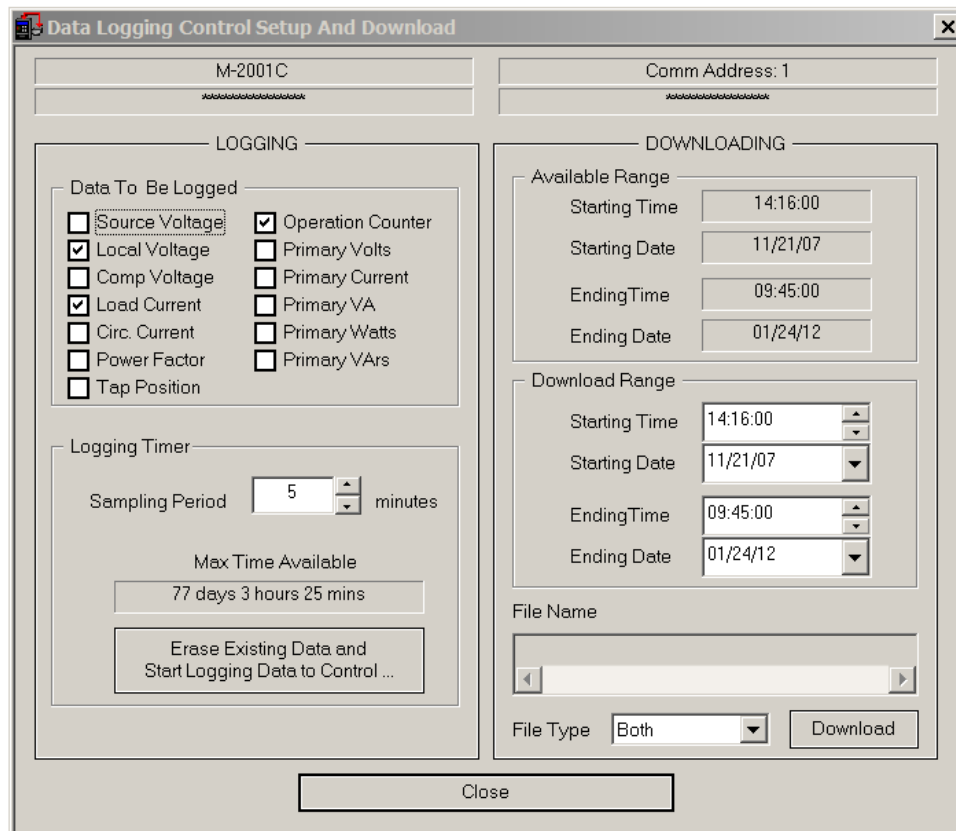


Figure 9-28 Data Logging Control Setup and Download Dialog Screen

In the **Downloading** portion of the screen, the **Available Range** section will display the oldest and latest dates of the logged data. These dates will also initially appear in the **Download Range** section edit boxes, which indicate the start and end points for the data to be downloaded.

The **File Name** text box contains the name of the file to which the data will be downloaded. The **File Type** box also contains the selection which can be ".CSV", ".TPF" or both. A ".CSV" file extension is required for these files so that they can be recognized and opened by Excel or Lotus123 compatible spreadsheet applications. A ".TPF" file extension allows the file to be read by TapPlot®. If an incorrect file extension or no extension is used, TapTalk® will prompt the user to have TapTalk apply a correct extension or cancel the operation. Files saved using duplicate file names will be overwritten without warning.

▲ CAUTION: Be sure to download your data before changing parameters. Once the **Start Logging to Control** button is selected, all previously logged data will be cleared (and will no longer be available for download), and the control will begin logging new data.

▲ CAUTION: Do not attempt to download logged data from Com1 and Com2 simultaneously, as this will corrupt the download.

When **Download** is selected, all data selected in the Download Range section will be downloaded to the file displayed in the **File's Name** section. If the range chosen includes a large amount of data, the download may take up to 45 minutes (300 Kb).

If necessary edit the Download Range, then select **Download** to download the data from the selected range.

Data Logging/To PC

The **To PC** submenu item displays the **Data Logging to PC** Dialog Screen (Figure 9-29). The **To PC** feature enables the user to store selected parameter data for review at a later time. One or more of the parameters listed in the **Data To Be Logged** section can be selected for logging. The time displayed in the **Sampling Period** in the **Logging Options** section determines how frequently data samples are acquired, ranging from 1 minute to a maximum of 9999 minutes. The duration of sampling is further regulated by the **Sampling Duration** which restricts data logging to a maximum of 9999 hours or 9999 days. Uninterrupted communication with the control is required while data is being logged.

Data logging is initiated by selecting **Start Data Logging to PC**. The **Start Data Logging to PC** is replaced by **Stop Data Logging to PC** dialog to indicate data logging is active. Logging can be canceled either by choosing the **Stop Data Logging to PC** command or by interrupting communication.

The **Set File Name** selection allows the user to name the file to which data is saved. If the Suggested File Name feature is disabled, then a file name will be required to be entered with a default file extension of *.CSV, (Comma Separated Values is the default for files with data logging information). If the Suggested File Name is enabled, then the file name will be determined by the settings from the Suggested File Name window with a filename extension of ".CSV". If the user saves a file using a duplicate filename, the previously saved file will be overwritten without warning. The size of the file must not exceed available disk space. The file format ".CSV" can be opened by most spreadsheet applications, allowing the user to analyze the collected data.

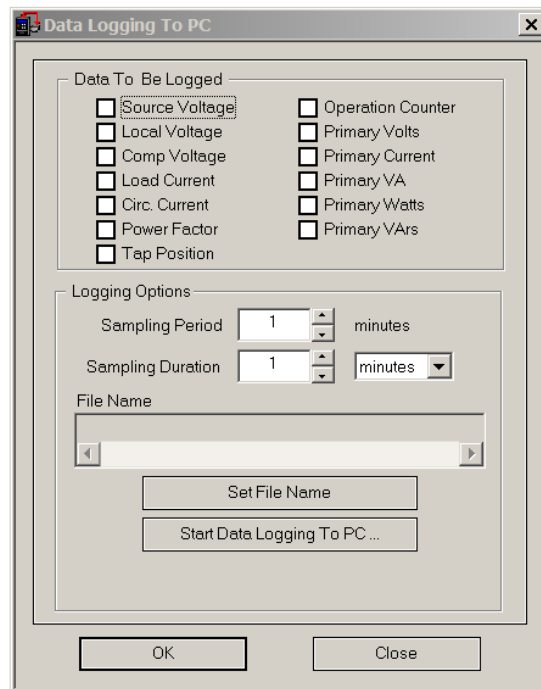


Figure 9-29 Data Logging To PC Dialog Screen

Utilities/Control Information

The **Control Information** submenu item displays the **Control Information** Screen (Figure 9-30). The **Control Information** screen provides specific information about the addressed control. The **Control Information** screen includes the following:

- Beckwith Electric identification (model) number
- The addressed control's serial number
- Control's firmware version
- Mod Number
- Model of M-2001C
- 12 V DC Power Backup, if enabled
- The text currently displayed in the User Text Lines 1 and 2
- Control Address
- The Communication Channel status which reflects whether the correct communication password has been identified, "unlocking" the communication channel and allowing access to the control.

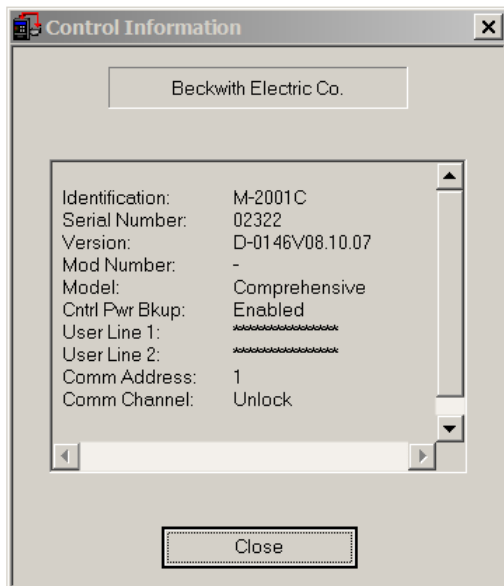


Figure 9-30 Control Information Screen

Utilities/Set Control Date and Time

The **Set Control Date and Time** submenu item enables the user to review the internal clocks for the host computer, the addressed control, or all controls in the broadcast mode, as well as the last power-up for the addressed control.

To set control(s) time/date perform the following:

1. Select either **To Current Address** or **Broadcast**
2. Input the desired time/date, then select **Set**

To set control(s) time/date to match host computer's current time/date perform the following:

1. Select either **To Current Address** or **Broadcast**
2. Select **Set Control time to PC's time**

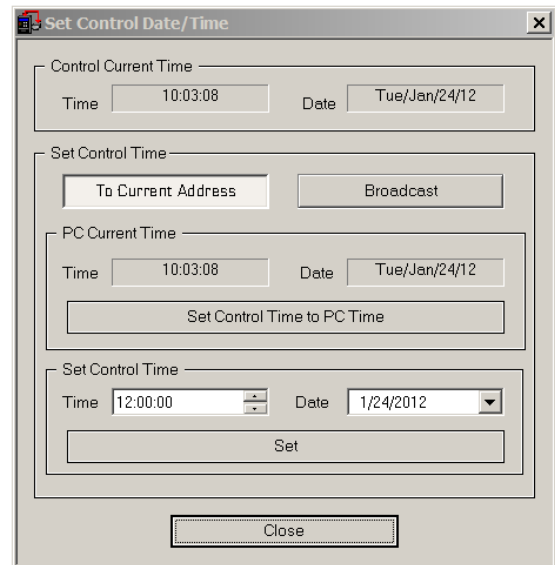


Figure 9-31 Set Control Date and Time Dialog Screen

When the time is set, a prompt will be displayed, asking if the user wants to reset Demand Metering, Energy Metering (if applicable), Drag Hands and Resettable OP Count.

Utilities/Set User Lines

The **Set User Lines** submenu item provides the user with the ability to review and change the user lines for the addressed control.

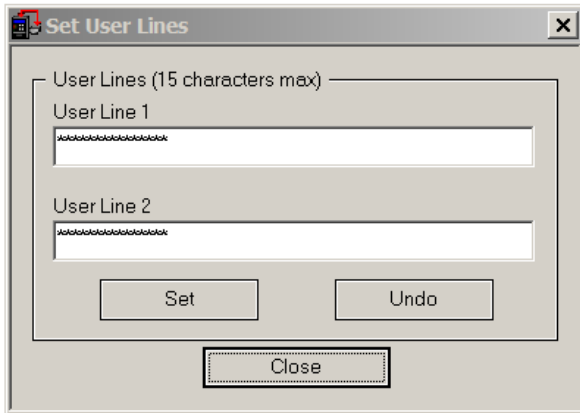


Figure 9-32 Set User Lines Dialog Screen

Utilities/Set New User Passwords

The **Set New Passwords** submenu item displays the **New Passwords Setup** Dialog Screen.

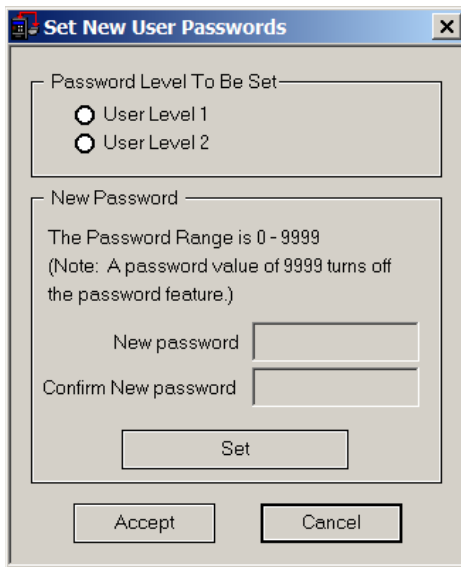


Figure 9-33 New Passwords Setup Dialog Screen

TapTalk® User Level 1 and User Level 2 passwords are unique to TapTalk only. Control User Level 1 and User Level 2 passwords protect access to the control from the front keypad.

When a communication password has been configured at the control, the communication password allows the user to bypass both the configuration and setpoint passwords otherwise required by a control.

NOTE: The communication password is identified as a string #. Therefore, the passwords "001" and "1" are not interchangeable.

Each control can be given a unique, 4-digit password ranging from 0 to 9999. If the password has been configured at the control as 0000, communication is not restricted a password does not need to be identified by TapTalk. The control is shipped with communication password disabled (set to 0000).

TapTalk password protection, when implemented, is as follows:

Default	View All
Level 1	Change Setpoints, Set Control Date/Time
Level 2	Change Setpoints, Configuration, DNP Configuration, Set New Passwords, Start Data Logging, Setup Data Logging, Remote Control, Set User Text Lines, Set Control Date/Time

To change **User Level** passwords perform the following:

1. Select **Control Setup/Set New Passwords** from the TapTalk toolbar, TapTalk will display the **Set New Passwords** dialog screen.
2. Select **User Level 1** or **User Level 2**.
3. Input a four digit password between 0 and 9999 in **New Password**.
4. Input the four digit password from Step 4, in **Confirm...**
5. Select **Setting**, then verify that TapTalk displays the **New User Level Password has been set** confirmation.

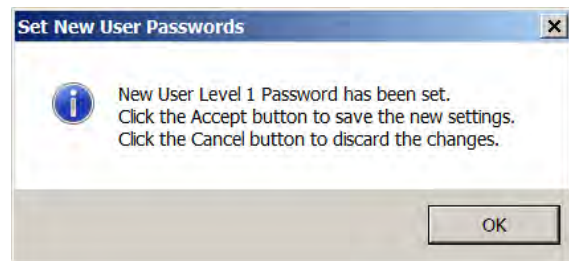


Figure 9-34 New User Level Password Confirmation Screen

Utilities/Remove Status Screens

The **Remove Status Screen** allows the user to hide or restore status screens on the M-2001C.

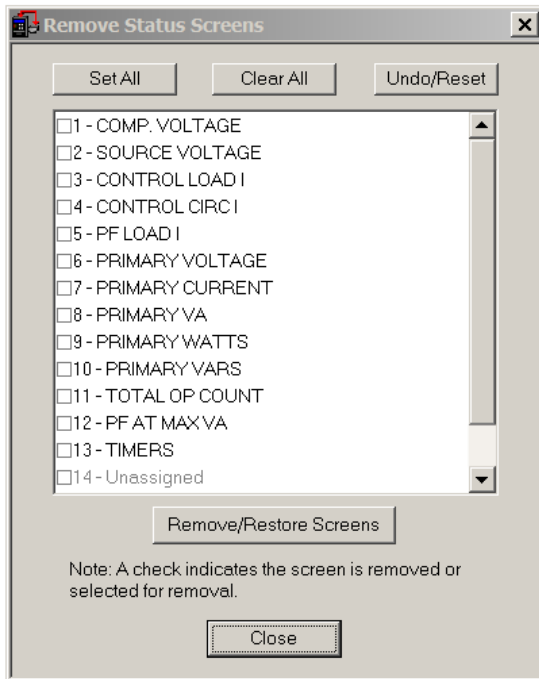
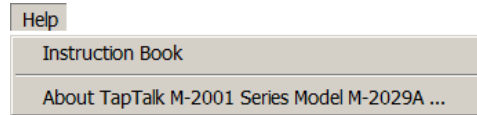


Figure 9-35 Remove Status Screens Selection Screen

Help



The **Help** toolbar item provides the user with information about the control and the software version that is installed in the unit.

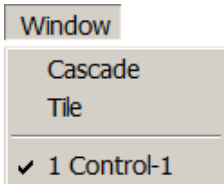
Help/Instruction Book

The Instruction Book menu topic has been indexed to its Table of Contents. By selecting the "Navigator pane" in Adobe Acrobat Reader, the user can directly access selected topics.

Help/About M-2029A

The **About** submenu item provides the TapTalk software version number and copyright information.

Window



The **Window** toolbar item provides the **Cascade** and **Tile** display options. The **Window** toolbar item also allows the user to select between open TapTalk® windows.

9.9 Communication Cables

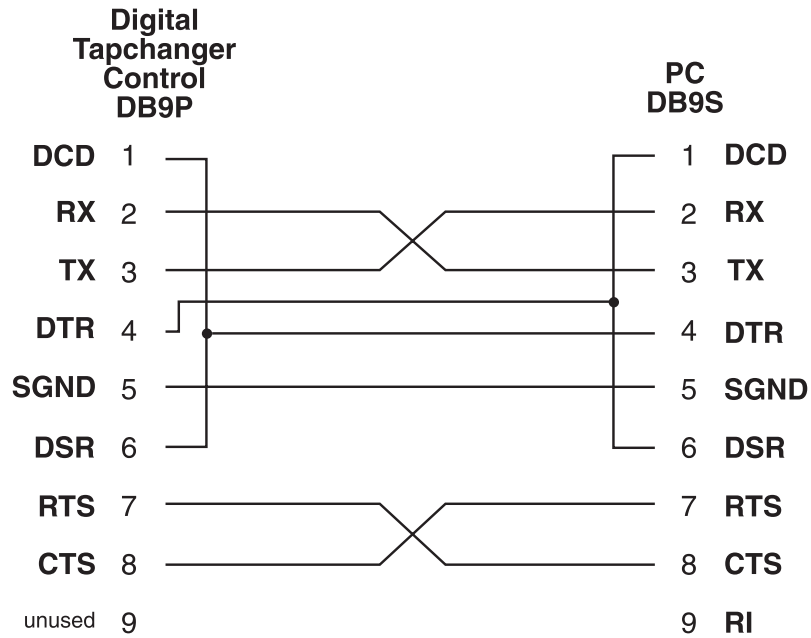


Figure 9-36 Null Modem Cable 9-Pin to 9-Pin

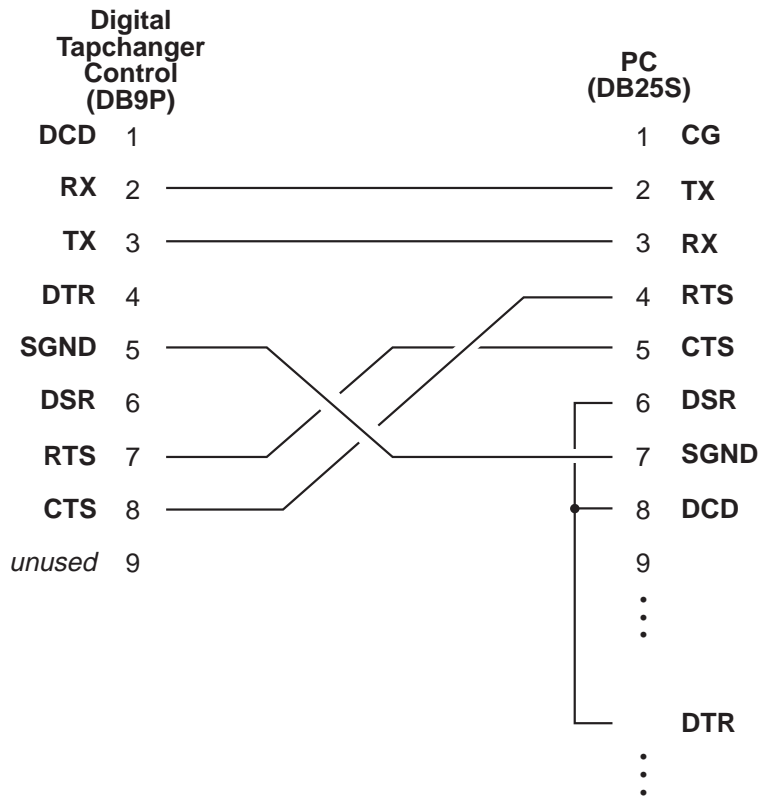


Figure 9-37 Null Modem Cable 9-Pin to 25-Pin

Digital Tapchanger Control (DB9P)			Modem (DB25S)	
DCD	1	_____		8
RX	2	_____		3
TX	3	_____		2
DTR	4	_____		20
SGND	5	_____		7
DSR	6	_____		6
RTS	7	_____		4
CTS	8	_____		5
<i>unused</i>	9			

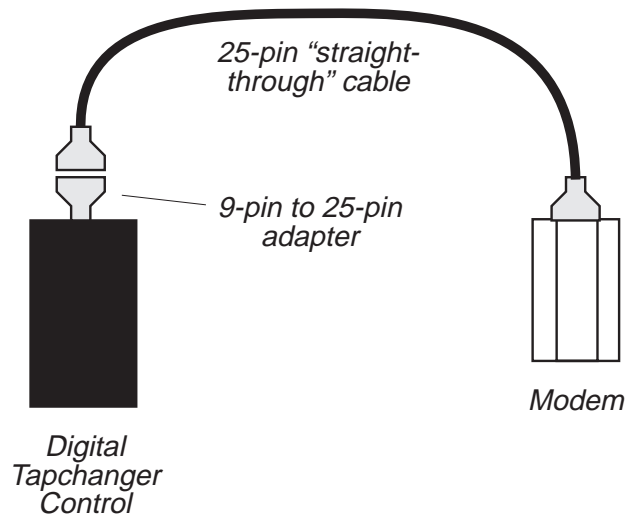


Figure 9-38 Modem Cable 9-Pin to 25-Pin

9.10 M-2829 TapPlot® Analysis Software

The M-2829 TapPlot Analysis Software operates in conjunction with all TapTalk® Communications Software on any Windows™ based computer. TapPlot allows the user to plot and print tap data retrieved from Beckwith Electric M-2001 series Digital Tapchanger Controls utilizing the Data Logging feature of TapTalk.

Installation

TapPlot runs with the Microsoft Windows 95, 98, NT 4.0, 2000, XP or Windows 7 operating system. Familiarity with Windows is important in using TapPlot, as the conventions defined in the Windows documentation are strictly followed therein.

TapPlot will be installed on the host computer's hard disk. While it does not require special installation procedures, an installation utility has been provided to make the process easier.

To install TapPlot:

1. Insert the TapPlot software into your CD-ROM drive.
2. Select **Run** from the **Start Menu**.
3. In the **Run** dialog box, initiate software installation by typing **D:\Setup.exe** (or other drive designator:\Setup.exe, depending on the letter designation for the CD-ROM drive).
4. The Installation Wizard will prompt the user through the installation process. After installation, the TapPlot program icon (located in the Becoware folder) can be placed on the desktop (Figure 9-39).



Figure 9-39 TapPlot Program-Item Icon

Creating TapPlot Data Files

To create data files for viewing in TapPlot proceed as follows:

1. From the "Start" menu select the M-2029A TapTalk program.
2. From the TapTalk Main Menu select **Utilities\Data Logging\Data Logging Control Setup And Download**. TapTalk will display the Control Setup And Download screen (Figure 9-28).
3. Select the File Type as "TapPlot" file or "Both".
4. Perform the Data Logging download.
5. Close TapTalk.

Starting TapPlot

1. Select the TapPlot program-item icon from the Becoware group in the Program Manager, or select TapPlot from the program list using the **Start Menu**. The TapPlot Window and Toolbar is displayed (Figure 9-40).
2. Select File->Open from the menu, and browse for the .tpf file.
3. Open the file. TapPlot should display the saved data, as shown in Figure 9-40.

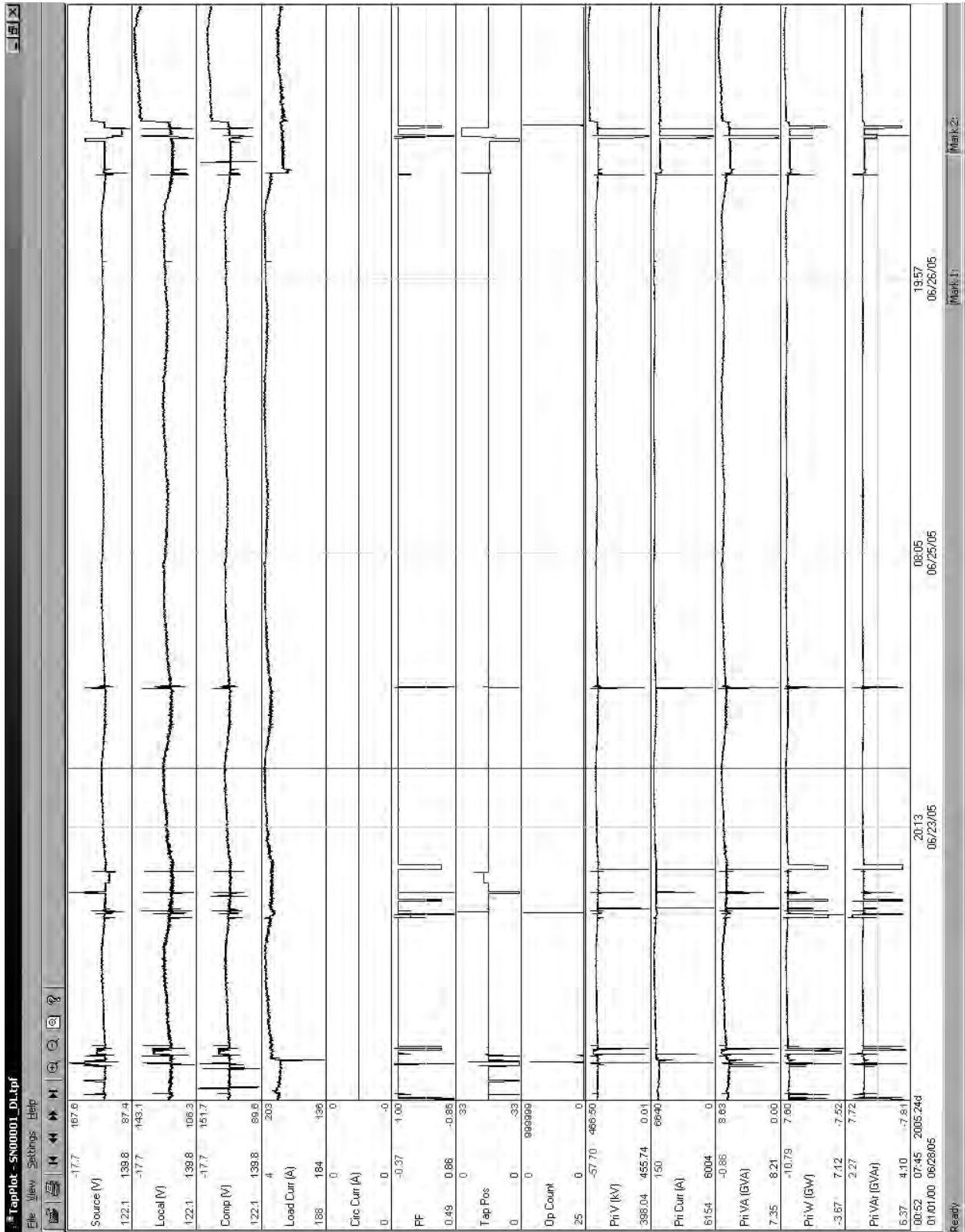


Figure 9-40 TapPlot® Window and Tap Data Example

Markers

TapPlot® includes two user selectable markers. The first is positioned by double clicking on the plotted wave form data. The second is positioned by pressing and holding the **SHIFT** key and then double clicking on the plotted wave form data.

The markers can be dragged by moving the cursor over the marker until the cursor changes to a double-headed arrow ↔, then holding down the Left mouse button and dragging the marker. The marker can also be moved an interval at a time by pressing the **UP** or **DOWN** arrow key. The last cursor selected is the one that is moved. To toggle the active cursor, press the **T** key.

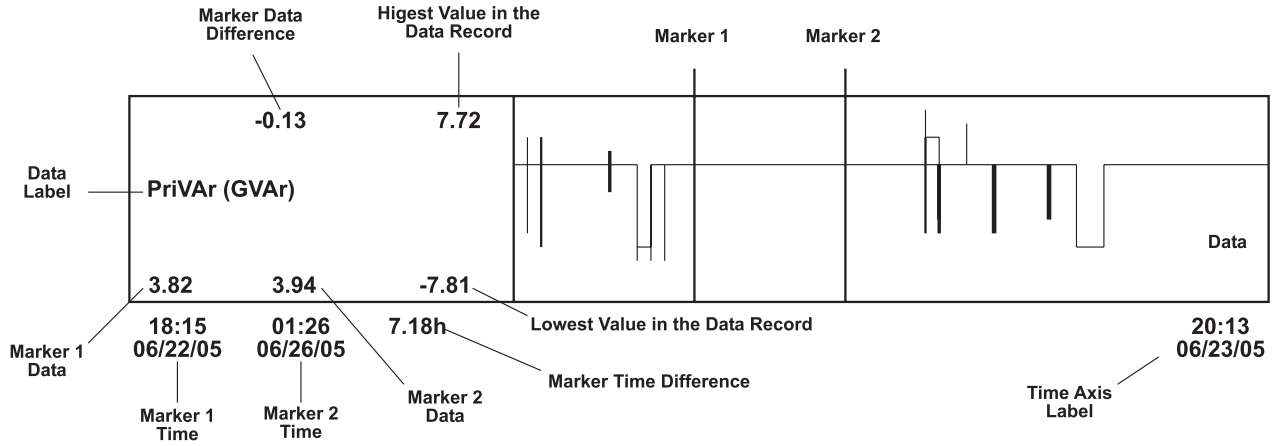


Figure 9-41 TapPlot Screen With Callouts

Overview

TapPlot® is a windows based program for viewing the data that has been retrieved using the Data Logging feature of TapTalk®.

When TapPlot is started, a menu and tool bar are displayed (see Figure 9-40). This section describes each TapPlot menu selection and explains each TapPlot command in the same order that they are displayed in the software program. Figure 9-42 presents the TapPlot Menu and Submenu Callouts.

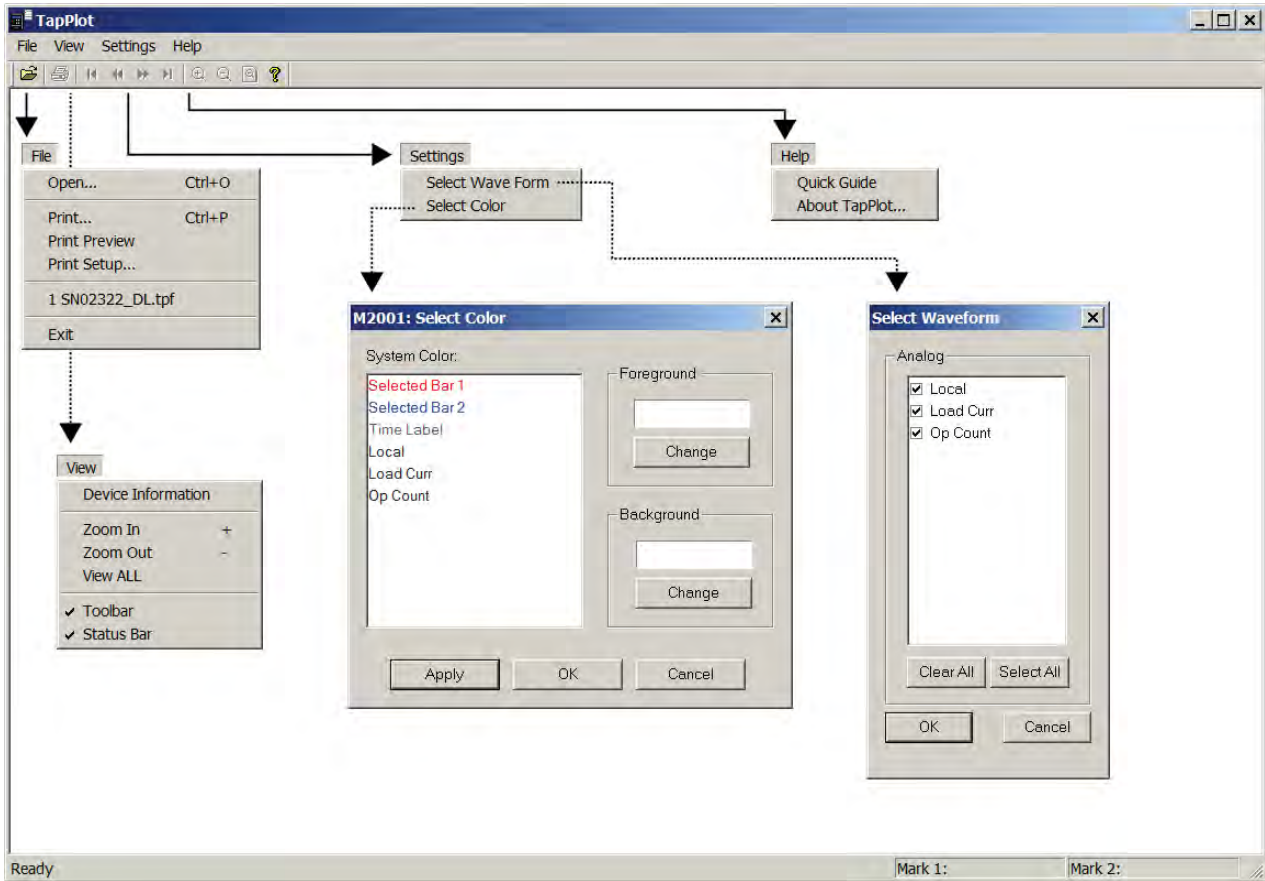
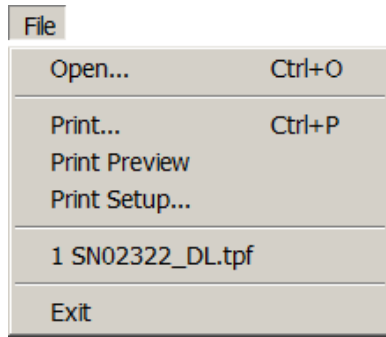


Figure 9-42 TapPlot Submenu Callouts

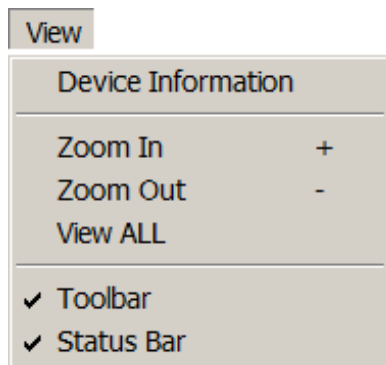
File Menu



The **File** menu allows the user to:

- Open a TapPlot® (.tpf) file previously downloaded by TapTalk®.
- Print the displayed TapPlot data.
- Print Preview the displayed TapPlot data.
- Select the printer and printer settings to be used.
- Select from previously viewed .tpf files (the last four files displayed).
- Exit the TapPlot program.

View Menu



The **View** menu allows the user to:

- Display the Device Information (Figure 9-43) for the corresponding TapPlot data file.
- Zoom In, increase the resolution of the tap data displayed on the screen.
- Zoom Out, decrease the resolution of the tap data displayed on the screen.
- View ALL, returns the display to include all data within the record.
- Select which Tool Bar (Toolbar/Status Bar) is available on the display window.

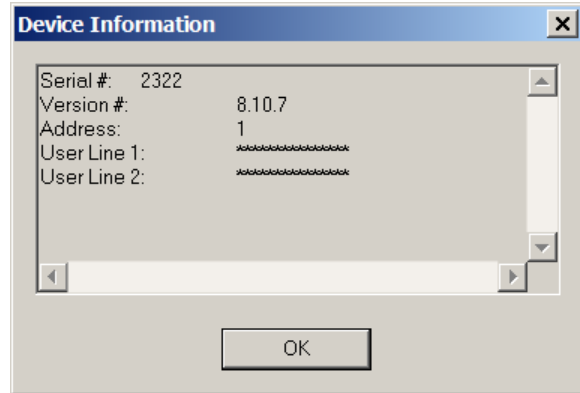
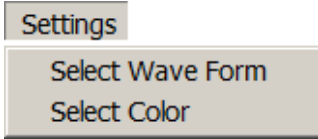


Figure 9-43 Device Information Screen

Settings Menu



The Settings menu allows the selection of the waveforms to be displayed and the format of display colors. **Select Waveform** allows the selection of any of the following Tap Parameters to be plotted or printed:

- Source Voltage (V)
- Local Voltage (V)
- Comp Voltage (V)
- Load Current (A)
- Circulating Current (A)
- Power Factor
- Tap Position
- Operation Counter
- Primary Voltage (kV)
- Primary Current (A)
- Primary VA (GVA)
- Primary Watts (GW)
- Primary VAr (GVAR)

The Waveform selections are made from the Select Waveform screen (Figure 9-44).



Figure 9-44 Select Waveform Dialog Screen

Select Color provides the user with the capability to change Foreground and Background display color of individual Waveform traces for customized plotting.

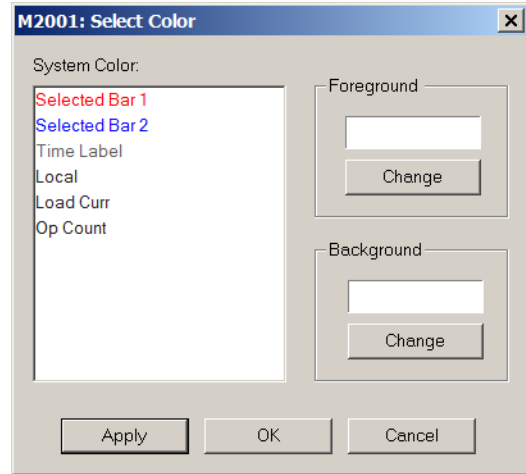
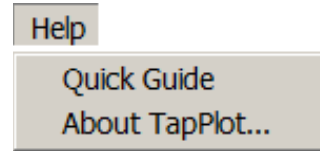


Figure 9-45 Select Color Dialog Screen

Help Menu



The **Help** menu provides access to the **Quick Guide** which provides basic information about TapPlot® menus and commands. The **About** command provides version information for TapPlot.

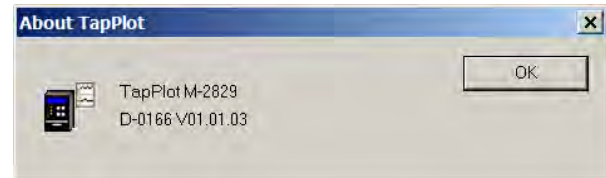


Figure 9-46 About TapPlot Screen

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A Appendix

A.0	Summary of Specifications.....	A-1
A.1	External Connections	A-1
A.2	Field Checkout Procedure.....	A-1
A.3	Screen Review	A-3
A.4	Setpoint and Configuration Worksheets	A-18

A.0 Summary of Specifications

The following is a brief summary of specifications that may be required for installation. Please refer to specification sheets for complete information.

Voltage withstand:

140 V continuous
 240 V for one second
 480 V for one cycle
 Voltage measurement linear to 140 V

Current withstand: (both inputs)

0.2 amps continuous
 0.4 amps for 2 hours
 4.0 amps for one second
 Output raise and lower circuits:
 6 amps AC

Alarm contacts:

Programmable Alarm
 3.0 amps AC, 125 V
 0.1 amps DC, 125 V
 Deadman/Selftest
 6.0 amps AC, 125 V
 0.2 amps DC, 125 V

Recommended external fusing:

Motor power input - 6 A
 Voltage input - 1 A


A.1 External Connections

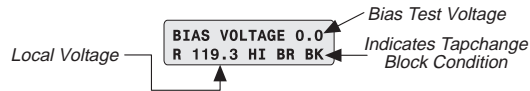
See the Application Guide for the adapter panel being used.

The control's operating frequency can be 50 Hz or 60 Hz. This option may *not* be selected in the field.

A.2 Field Checkout Procedure

■ **NOTE:** The following procedure assumes that the M-2001C (Comprehensive) Tapchanger Control is connected to an adapter panel. The M-2050 Surface Mounting Kit cannot be used with this procedure.

1. To wake unit from blank screen mode, press any pushbutton. Unit will display a series of power-up screens, then the Local Voltage screen.
2. Press the  pushbutton to go to the Bias Voltage-Test Mode screen.
3. Press **ENT** to reach the Bias Voltage input screen.



■ **NOTE:** If a Tapchange Block condition is indicated (see above), unit cannot be tested per this procedure. Therefore, make sure that you have placed the control in Automatic operation by using a communications protocol and resolving blocking condition.

4. Presuming that the unit is not in a Tapchange Block condition, set the **AUTO/OFF/MANUAL** switch to **MANUAL** and run the tapchanger control 3 or 4 steps in the Raise direction. Return the **AUTO/OFF/MANUAL** switch to Automatic.
5. Set the **AUTO/OFF/MANUAL** switch to **MANUAL** and run the tapchanger control 3 or 4 steps in the Lower direction. Return the **AUTO/OFF/MANUAL** switch to **AUTOMATIC**.
6. Press **ENT** to return to the **Bias Voltage Test Mode** screen. To exit from the unit's software, move through the screens using the **↑** and **↓** pushbuttons to one of the Exit screens. Press the **ENT** pushbutton. Unit will display a blank screen.

A.3 Screen Review

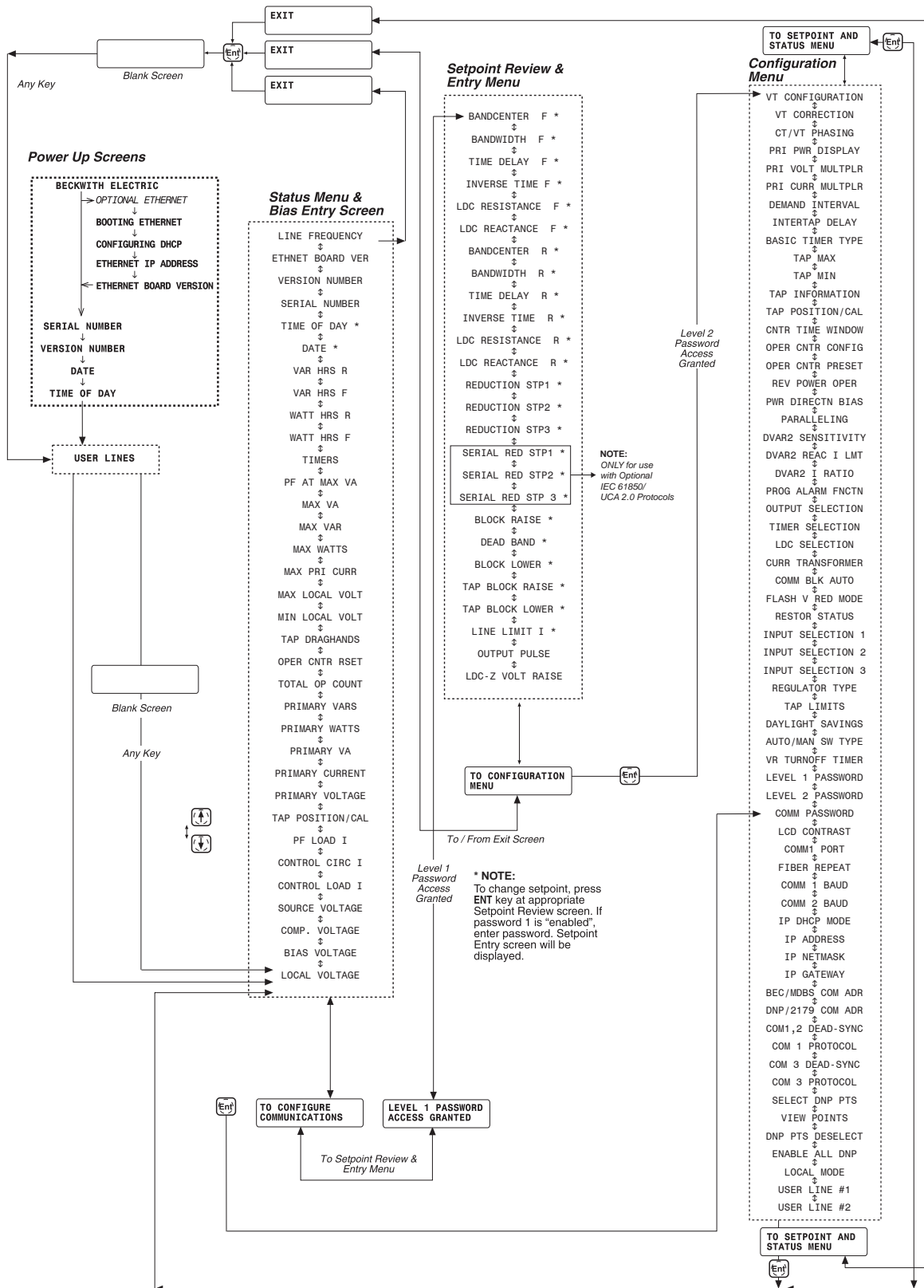


Figure A-1 Software Menu Flow

<p>LINE FREQUENCY 60.10 Hz</p>	<p>Displays the line frequency. (Section 5.4)</p>
<p>ETHNET BOARD VER D-0147V01.00.00</p>	<p>Displays the M-2001C Ethernet Board version number.</p>
<p>VERSION NUMBER D-0146V01.00.00</p>	<p>Displays the M-2001C's firmware version number, and any options present (Mods, ΔVAR®, Base Mode, and Backup Power.)</p>
<p>SERIAL NUMBER 00023</p>	<p>Displays the Beckwith Electric M-2001C serial number.</p>
<p>TIME OF DAY 08:15:00</p>	<p>Displays and allows resetting of the time of day. Press E to set time of day; change mode indicated by flashing C. Used in conjunction with memories where the date/time stamp will be recorded for each drag-hand quantity. (Section 5.3)</p>
<p>DATE 02/01/95</p>	<p>Displays and allows resetting of the date. Press E to set date; change mode indicated by flashing C. Used in conjunction with drag-hands memories where the date/time stamp will be recorded for each drag-hand quantity.</p>
<p>VAR HRS R 1/3 PH E 84.074 MVarHR</p>	<p>Displays total reverse VarHr in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/VarHr.</p>
<p>VAR HRS F 1/3 PH E 47.879 MVarHR</p>	<p>Displays total forward VarHr in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/VarHr.</p>
<p>WATT HRS R 1/3 PH E 234.687 MWHR</p>	<p>Displays total reverse WHr in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/WHR.</p>
<p>WATT HRS F 1/3 PH E 899.002 MWHR</p>	<p>Displays total forward WHr in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/WHR.</p>
<p>TIMERS R=0 L=0 IT=0</p>	<p>Displays the status of the raise, lower, and intertap timers; inverse or linear.</p>
<p>PF AT MAX VA 0.87 Lag/Lead</p>	<p>Displays power factor at time of maximum VA. Resets automatically when MAX VA screen, below, is reset.</p>

Figure A-2 Status Screens (page 1 of 3)

■NOTE: For detailed information on the above settings, see the referenced Instruction Book Sections.

MAX VA 1/3 PH E 2.12 MVA	Displays maximum VA in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/MVA.
MAX VAR 1/3 PH E 0.67 MVar	Displays maximum VAr in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/MVar.
MAX WATTS 1/3 PH E 1.98 MW	Displays maximum Watts in 1 or 3 phase determined by the PRI PWR DISPLAY configuration setting (Section 5.1). Bottom line toggles between date/time/MW.
MAX PRI CURR E 290 Amps	Displays maximum primary current. (Section 5.1) Bottom line toggles between date/time/Amps.
MAX LOCAL VOLT E 123.1 Volts	Displays maximum local voltage at the regulator or transformer. (Section 5.1) Bottom line toggles between date/time/Volts.
MIN LOCAL VOLT E 116.9 Volts	Displays minimum local voltage at the regulator or transformer. (Section 5.1) Bottom line toggles between date/time/Volts.
TAP DRAGHANDS E L= 2L R= 3R	Displays minimum and maximum values of tap position since reset. (Section 5.2)
OPER CNTR RSET E 0	Records the total number of raise and lower operations as does the total operations counter, discussed below. This counter is reset by pressing ENT at this screen. This counter can be used to monitor the number of tap changes since the last time it was checked. (Section 4.4)
TOTAL OP COUNT 1285	Records the total number of raise and lower operations. The operation counter will advance by one or two counts, as set by user, for each open-close-open contact operation. This counter is not resettable, but can be preset to any value between 0 and 999,999. (Section 4.4)
PRIMARY VARS 1/3 PH 1.44 MVar	Displays the calculated primary quantity based on the user-selected multipliers, VT configuration (line-to-line or line-to-ground), single-phase or three-phase and measured secondary voltage and current. (Section 5.1)
PRIMARY WATTS 1/3 PH 3.00 MW	
PRIMARY VA 1/3 PH 3.30 MVA	

Figure A-2 Status Screens (page 2 of 3)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

<p>PRIMARY CURRENT 133 Amps</p>	<p>Displays the calculated primary current based on the user-selected current multiplier and measured secondary current. (Section 5.1)</p>
<p>PRIMARY VOLTAGE 14.4 kV</p>	<p>Displays the calculated primary voltage based on the user-selected voltage multiplier and measured secondary voltage. (Section 5.1)</p>
<p>TAP POSITION/CAL 4 R</p>	<p>Displays the tap position of the tapchanger. Recognizes tapchanges commanded via manual, automatic or external (SCADA) means, if tap position not disabled. The tap position can be calibrated by selecting ENT, then setting the tap position using the \uparrow/\downarrow pushbuttons and then selecting ENT to confirm the new tap position.</p>
<p>PF LOAD I 0.90 Lag/Lead</p>	<p>Displays the real-time calculated value of power factor.</p>
<p>CONTROL CIRC I 1 mA Lead/Lag</p>	<p>In paralleling applications, displays the measured value of circulating current or reactive delta VAr current, at the circulating current input related to the scaling factor Current Transformer of 200 mA, 1 A or 5A. When using ΔVAR[®]2 "DISABLE" will be displayed when ΔVAR2 Disable Input is active.</p>
<p>CONTROL LOAD I 100 mA</p>	<p>Displays the real-time measured value of load current related to the scaling factor Current Transformer of 200 mA, 1 A or 5A.</p>
<p>SOURCE VOLTAGE 117.0 Volts</p>	<p>Displays the real-time calculated source voltage-only applicable in regulator control applications and includes any corrections made using the user-selected VT correction voltage.</p>
<p>COMP. VOLTAGE 120.0 Volts</p>	<p>Displays the calculated voltage at the "load center," based on load current and the LDC settings.</p>
<p>BIAS VOLTAGE STATUS/TST MODE</p>	<p>When ENT is pressed, the control status can be checked, and a bias test voltage can be entered to test the control's automatic operation. (Figure A-3)</p>
<p>LOCAL VOLTAGE 120.0 Volts</p>	<p>Displays the real-time measured value of voltage at the regulator or the transformer, including the voltage reduction if applicable and any corrections made using the user-selected VT correction voltage.</p>

Figure A-2 Status Screens (page 3 of 3)

■NOTE: For detailed information on the above settings, see the referenced Instruction Book Sections.

The six status screens shown above indicate "drag-hand values," that is, minimum or maximum values of a parameter that are retained in non-volatile memory until reset by the user. The three screens for each parameter cycle continuously and indicate, respectively, the value, date and time of each parameter. The "E" located on the right top line indicates that by pressing **ENT** while viewing any of the three pertinent screens, the values retained in drag-hand memory will be reset to the present value. The unit is equipped with a real-time clock to allow a date/time stamp to be recorded in conjunction with each drag-hand quantity.

Bias Voltage Function

When **ENT** is pressed from the Bias Voltage Test Mode screen, the bias test voltage can be entered to test the control's automatic operation. The figure below shows the status conditions indicated by this screen.

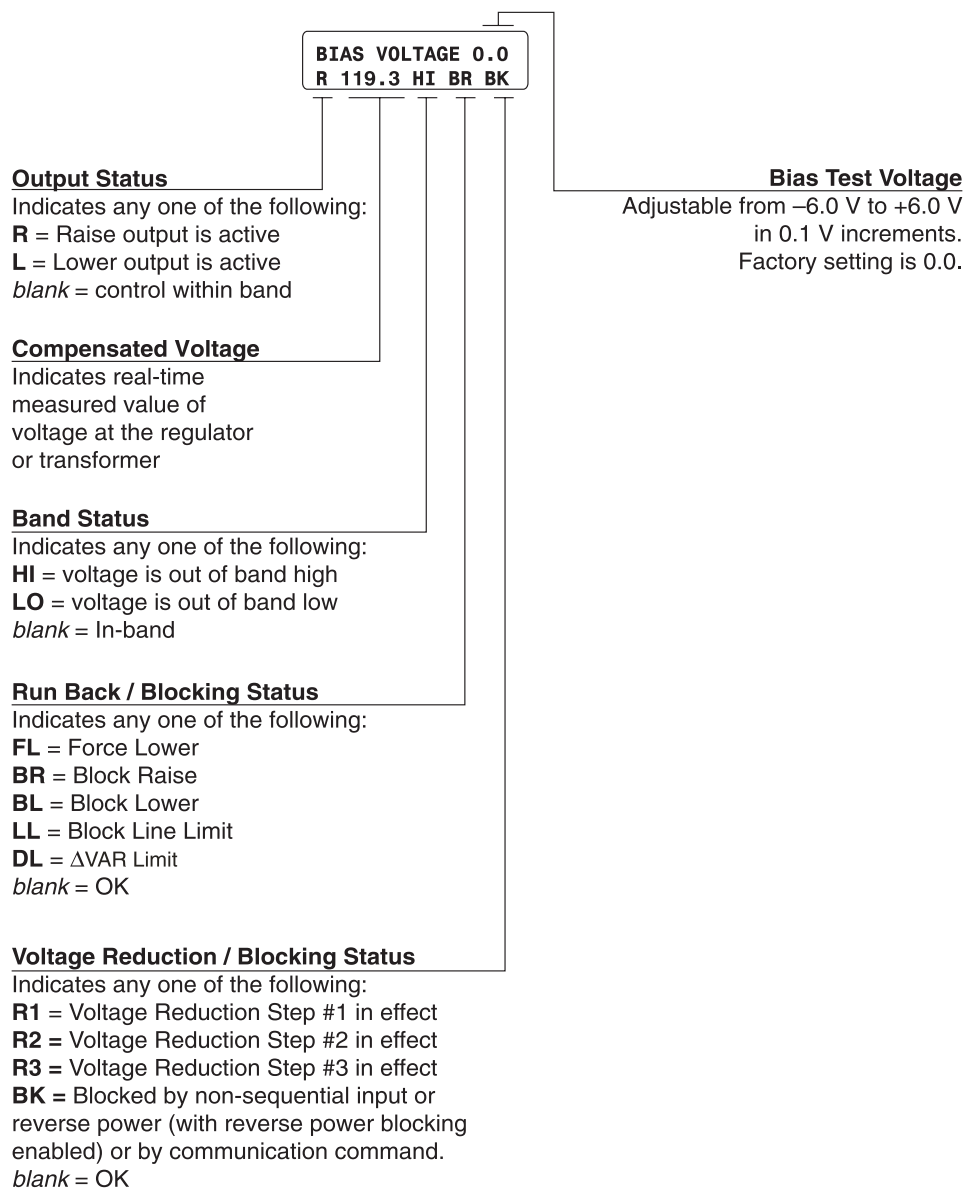


Figure A-3 Bias Test Voltage Screen

BANDCENTER F 120.0 Volts	Forward power bandcenter is adjustable from 100 V to 135 V in 0.1 V increments with a factory setting of 120 V. (Section 3.2)
BANDWIDTH F 2.0 Volts	Forward power bandwidth is adjustable from 1 V to 10 V in 0.1 V increments with a factory setting of 2.0 V. (Section 3.2)
TIME DELAY F 30 Sec	Forward power time delay for a tapchange is adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 sec. (Section 3.2)
INVERSE TIME F 30 Sec	Forward power inverse time delay for a tapchange is adjustable from 1 seconds to 120 seconds in 1 second increments, with a factory setting of 30 seconds. (Section 3.2)
LDC RESISTANCE F 0 Volts	Forward power Line Drop Compensation resistance is adjustable from -24 V to +24 V in 1 V increments with a factory setting of 0 V. (Section 3.2)
LDC REACTANCE F 0 Volts	Forward power Line Drop Compensation reactance is adjustable from -24 V to +24 V in 1 V increments with a factory setting of 0 V. (Section 3.2)
BANDCENTER R 120.0 Volts	Reverse power bandcenter is adjustable from 100 V to 135 V in 0.1 V increments with a factory setting of 120 V. (Section 3.2)
BANDWIDTH R 2.0 Volts	Reverse power bandwidth is adjustable from 1 V to 10 V in 0.1 V increments with a factory setting of 2.0 V. (Section 3.2)
TIME DELAY R 30 Sec	Reverse power time delay for a tapchange is adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 sec. (Section 3.2)
INVERSE TIME R 30 Sec	Reverse power inverse time delay for a tapchange is adjustable from 1 sec. to 120 sec. in 1 second increments with a factory setting of 30 sec. (Section 3.2).
LDC RESISTANCE R 0 Volts	Reverse power Line Drop Compensation reactance is adjustable from -24 V to +24 V in 1 V increments, with a factory setting of 0 V. (Section 3.2)
LDC REACTANCE R 0 Volts	Reverse power Line Drop Compensation reactance is adjustable from -24 V to +24 V in 1 V increments, with a factory setting of 0 V. (Section 3.2)

Figure A-4 Setpoint Screens (page 1 of 3)

■NOTE: For detailed information on the above settings, see the referenced Instruction Book Sections.

REDUCTION STP1 2.5 %	Used for all protocols. Controls using protocols other than UCA can achieve voltage reduction via contact or communication methods. Controls using UCA protocol can achieve voltage reduction via contact method. First of three independent steps of voltage reduction adjustable from 0% to 10% in 0.1% increments of the bandcenter setpoint. Factory setting is 2.5% (Section 3.3)
REDUCTION STP2 5.0 %	Used for all protocols. Controls using protocols other than UCA can achieve voltage reduction via contact or communication methods. Controls using UCA protocol can achieve voltage reduction via contact method. Factory setting is 5.0% (Section 3.3)
REDUCTION STP3 7.5 %	Used for all protocols. Controls using protocols other than UCA can achieve voltage reduction via contact or communication methods. Controls using UCA protocol can achieve voltage reduction via contact method. Third voltage reduction step. Factory setting is 7.5% (Section 3.3)
SERIAL RED STP1 2.5 %	THESE SCREENS ONLY AVAILABLE WITH OPTIONAL IEC 61850/ UCA 2.0 PROTOCOL: First of three independent steps of voltage reduction adjustable from 0% to 10% in 0.1% increments of the bandcenter setpoint. Factory setting is 2.5%
SERIAL RED STP2 5.0 %	THESE SCREENS ONLY AVAILABLE WITH OPTIONAL IEC 61850/ UCA 2.0 PROTOCOL: Second voltage reduction step. Factory setting is 5.0%
SERIAL RED STP3 7.5 %	THESE SCREENS ONLY AVAILABLE WITH OPTIONAL IEC 61850/ UCA 2.0 PROTOCOL: Third voltage reduction step. Factory setting is 7.5%
BLOCK RAISE 128.0 Volts	Overvoltage limit is adjustable form 95 V to 135 V in 0.1 V increments with a factory setting of 128 V. The Block Raise setpoint should always be set above the Block Lower setpoint and above the upper band limit (the bandcenter plus one-half of the bandwidth) for the control to operate. (Section 3.4) If the DC Power Backup Option is enabled, then all automatic Raise/Lower tap operations are blocked, when input voltage is less than 85.0 V dc.
DEAD BAND 2.0 Volts	Deadband is adjustable from 1 V to 4 V in 0.1 V increments with a factory setting of 2.0 V. (Section 3.4)
BLOCK LOWER 114.0 Volts	Undervoltage limit is adjustable from 95 V to 135 V in 0.1 V increments with a factory setting of 114 V. The Block Lower setpoint should always be set below the Block Raise setpoint and below the lower band limit (the bandcenter minus one-half of the bandwidth) for the control to operate. (Section 3.4) If the DC Power Backup Option is enabled, then all automatic Raise/Lower tap operations are blocked, when input voltage is less than 85.0 V dc.

Figure A-4 Setpoint Screens (page 2 of 3)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

TAP BLOCK RAISE 16 R	Adjustable based on Tap Max and Tap Min. Raise in 1 step increments with a factory setting of 16 Raise. When using the M-2025B(D) Current Loop Interface Module with the M-2001C, a one-second intertap time delay should be used due to the settling time of the M-2025B(D). (Section 3.4) NOTE: A change in the Tap Min (or Tap Max) will change this value to the Tap Min (or Tap Max) value.
TAP BLOCK LOWER 16 L	Adjustable based on Tap Max and Tap Min. Lower in 1 step increments with a factory setting of 16 Lower. When using the M-2025B(D) Current Loop Interface Module with the M-2001C, a one-second intertap time delay should be used due to the settling time of the M-2025B(D). (Section 3.4)
LINE LIMIT I 400 mA	Line limit is adjustable from 200 mA to 640 mA in 1 mA increments with a factory setting of 400 mA with hysteresis of 5 mA. If the value of the current exceeds the line limit setpoint, the unit will not permit automatic control. (Section 3.4)
OUTPUT PULSE 1.5 Sec	Adjustable from 0.2 to 12 seconds in 0.1 second increments. Factory set at 1.5 seconds. (Section 3.5)
LDC-Z VOLT RAISE 0 Volts	Adjustable from 0 to 24 volts in 1.0 volt increments. (Section 3.2)

Figure A-4 Setpoint Screens (page 3 of 3)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

VT CONFIGURATION LINE_TO_GROUND	VT configuration toggles between Line-to-Line and Line-to-Ground with a factory setting of Line-to-Ground.
VT CORRECTION 0.0 Volts	VT ratio correction is adjustable from -15 V to +15 V in 0.1 V increments with a factory setting of 0 V. (Section 4.5)
CT/VT PHASING 0 Deg	CT/VT phasing correction is adjustable from 0° to 330° in 30° increments with a factory setting of 0°. This setting will advance the current phasor by the indicated value. (Section 4.5)
PRI PWR DISPLAY SINGLE_PHASE	Toggles between two modes of operation: Single-Phase-based on measured inputs, and Three-Phase-based on measured inputs and presumed balanced system. Factory setting is single-phase.
PRI VOLT MULTPLR 60.0 X	Adjustable from 0.1 to 3260 in 0.1 increments with a factory setting of 60. User selection to include knowledge of VT ratio, sensing VT ratio correction and indication of either line-to-line or line-to-ground voltage. (Section 4.6)
PRI CURR MULTPLR 6000 X	Adjustable from 1 to 32600 in 1.0 increments with a factory setting of 6000. User selection to include knowledge of CT ratio, from primary rating to 0.2 A rating of control. (Section 4.6)
DEMAND INTERVAL 15 Min	Toggles between 15, 30 and 60 minute interval with a factory setting of 15 minutes. The time interval is the amount of time it takes for a thermal meter to indicate 90% of a change of load. (Section 5.1)
INTERTAP DELAY 0 Sec	Adjustable from 0 to 60 Seconds in 1.0 second increments with a factory setting of 0 seconds. (Section 3.6)
BASIC TIMER TYPE INTEGRATING	Toggles between integrating timer and instantaneous reset (INST_RESET) timer upon voltage return to in-band condition. (Section 4.12)
TAP MAX 16 R	Maximum allowed upper tap. May be set from 0 to 33 R. Tap Range must be less than 34. Factory default = 16R. (Section 4.7)
TAP MIN 16 L	Minimum allowed lower tap. May be set from 33L to 29R. Factory default = 16L. (Section 4.7) Note that Tap Max must be 4 taps greater than Tap Min (-33 to +29).
TAP INFORMATION DISABLE	Toggles between ten modes of operation: XFMR External #3, XFMR External #2, XFMR External #1, Reg External #3, Reg External #2, Reg External #1, Reg Internal, Contact KeepTrack™ 1R1L, Contact KeepTrack 1N and Disable. Factory setting is Disable. See Table 4.1. (Section 4.7)

Figure A-5 Configuration Screens (page 1 of 6)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

TAP POSITION/CAL 0 Neutral	Allows input of known tap position to calibrate the unit tap position. This function is disabled when Tap Information is disabled. (Section 4.7)
CNTR TIME WINDOW DISABLED	Allows the Counter Time Window to be set from 0.5 to 10.0 seconds. This screen is enabled when "Oper Cntr Config" is set to "count window", otherwise, it is disabled. (Section 4.4)
OPER CNTR CONFIG 1 X	Selects the contact operation sequence that will cause the software counter to increment by one. Open/close/open (1 X), open/close or close/open contact operation (2 X). The count window mode registers any activity as a valid input within the count window time setting. (Section 4.4)
OPER CNTR PRESET 000000	Presets a number in the Total Operations Counter. (Section 4.4)
REV POWER OPER BLOCK	Toggles between five modes of operation: Ignore—to continue unit action as though Forward Power Flow continued to exist, Block—to inhibit automatic tapchange operation, Regulate Rev—to detect a reverse power condition and regulate according to reverse power settings, Return to Neutral—to drive the tap position to Neutral, and Distributed Generation—allows alternate LDC R and X values to be applied to the control when reverse power is detected. Factory setting is Block. (Section 4.8)
PWR DIRECTN BIAS NONE	Allows one of three methods to be used for the control to switch between forward/reverse power operation. The three settings are None, Forward Bias, and Reverse Bias (Section 4.8).
PARALLELING DISABLE	Toggles between four modes of operation: Circulating Current, Δ VAR [®] 1, Δ VAR2, Δ VAR2 + KeepTrack™ and Disable. Factory setting is Disable. (Section 4.9)
DVAR2 SENSITIVTY 0.0	Provides a method to control how much the voltage bandcenter is shifted relative to the delta VARs present between the circulating current input and the load current input. The settings for this screen are -4.0 to +4.0 in 0.1 increments, which correspond to a sensitivity of 0.5 to 2 times as sensitive (i.e., -4.0 = .5, 2.0 = .75, 0 = 1.00, 2.0 = 1.50, 4.0 = 2.00). The default setting is 0.0, for a sensitivity of 1. (Section 4.9)
DVAR2 REAC I LMT 200 mA	Provides a method to set a reactive current (VARs) limit between the circulating current input and the load current input. If the reactive current reaches this setpoint, the operation of the M-2001C will be blocked, and the alarm output function will be activated, if enabled. The settings for this screen are 5 mA to 200 mA in 1 mA increments. The default setting is 200 mA. (Section 4.9)

Figure A-5 Configuration Screens (page 2 of 6)

■NOTE: For detailed information on the above settings, see the referenced Instruction Book Sections.

DVAR2 I RATIO 1.00 Par/Ld	Provides a method to adjust the sensitivity to the circulating current input versus the load current input. When the setting is 0.50, the control will be 0.50 times as sensitive to the VARs from the circulating current versus the load current input. At 1.00, the control will be equally sensitive both current inputs. At 2.00, the control will be 2.00 times as sensitive to the VARs from circulating current input versus the load current input. The settings for this screen are 0.50 to 2.00 in 0.01 increments. The default setting is 1.00 to obtain equally sensitive current inputs. (Section 4.9)
PROG ALARM FNCTN 00000000	Provides alarm for one or more of the following user-selected conditions: Communication Block, Block Raise Limit exceeded, Block Lower Limit exceeded, Voltage Reduction (any step) invoked, Reverse Power Flow condition detected, Line Limit Current exceeded, Tap Block Raise in effect, and Tap Block Lower in effect. Factory setting is all alarms are disabled. (Bottom line of display indicates eight zeroes.) See Figure A-8. (Section 4.3)
OUTPUT SELECTION CONTINUOUS	Allows choice of output at tapchanger Raise/Lower output pin. Choices are continuous or pulsed. For continuous, the control must wait to be in band or counter input valid for output to become disabled. For pulsed, an adjustable pulse width will be applied to the output triacs of 0.2 to 12 seconds. (Section 4.10)
TIMER SELECTION DEFINITE	Allows setting control timer for Definite or Inverse time. There are four setpoints associated with this selection: Time Delay F/R, and Inverse Time F/R. (Section 3.2)
LDC SELECTION RES- REAC	Allows Line Drop Compensation to be either Resistance/Reactance or Z-compensated. (Section 3.2)
CURR TRANSFORMER 200 mA	Selection of display current can be made to be either 200 mA, 1 A or 5 A. This screen allows load and circulating current displays to be viewed on 200 mA, 1A or 5A scales. Line Limit I settings also affected. (Section 4.14) ▲ CAUTION: The current input to the control is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for one second.
COMM BLK AUTO DONT SAVE	Allow the state of the "Block Auto Operation" communication command to be saved or not saved when power has been lost.
FLASH V RED MODE DISABLE	Allows the flashing voltage reduction status screen to be enabled/disabled (Section 5.5). ■ NOTE: Enabling this function may shorten the life of the screen.
TO RESTOR STATUS SCREENS PRESS E	Allows any of the status screens which may have been removed to be restored in the status menu (Section 5.6)

Figure A-5 Configuration Screens (page 3 of 6)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

INPUT SELECTION 1 SWITCH STATUS	Allows the seal-in input to be used as a seal-in input or a switch status input. When the Switch Status input mode is selected, all Seal-In input functions will be disabled (Section 6.1). The factory setting is Switch Status.
INPUT SELECTION 2 NONSEQ INPUT	Allows the non-sequential input to be used as the Non-Sequential Input or as a SCADA Cutout input. When SCADA Cutout is selected, all non-sequential functions are disabled. (Section 6.1) Factory setting is Non-Sequential.
INPUT SELECTION 3 VR2 INPUT	Allows VR2 Input to be used as an Aux Status Input that can be read via DNP, BECO 2200 or MODBUS.
REGULATOR TYPE TYPE A	Allows the regulator type to be selected as Type A or B for correct source voltage calculation. (Section 4.15) Factory setting is Type A.
TAP LIMITS ENABLE	Allows the tap position limits to be enabled/disabled (Section 3.4).
DAYLIGHT SAVINGS ENABLE	Allows automatic Daylight Savings time adjustment to be enabled or disabled.
AUTO/MAN SW TYPE TOGGLE SWITCH	Allows the Auto/Man switch type on the adapter panel to be set to toggle, SCAMP or NONE. NONE is used when no Auto/Manual switch exists.
VR TURNOFF TIMER 0 Min	Settable from 0 to 999 minutes. 0 = Disabled. When set from 1 to 999 it turns off any voltage reduction invoked (via comms only) after the set time expires.
LEVEL 1 PASSWORD 0000	Configures a four-digit numerical password for Level 1. Factory setting is 0000 (disabled). (Section 4.1)
LEVEL 2 PASSWORD 2222	Configures a four-digit numerical password for Level 2. Factory setting is 2222. (Section 4.1)
COMM PASSWORD 0000	Configures a four-digit numerical password for remote communications. Factory setting is 0000. (Section 4.1)
LCD CONTRAST 0	Allows contrast to be adjusted from +10 (lightest) to -10 (darkest). Factory setting is 0, which provides a neutral contrast.
COMM 1 PORT RS232	M-2001C COM1 can be selected for three different configurations: RS-232, RS-485, or Fiber Optics.

Figure A-5 Configuration Screens (page 4 of 6)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

FIBER REPEAT OFF	If Fiber Repeat is OFF, an optical fiber link can only be connected in a point to point configuration. If Fiber Repeat is ON, a fiber repeater loop may be accomplished with a number of controls. (Section 6.5)
COMM 1 BAUD 9600	Selects baud rate for COM1, located on the top of the control. (Section 6.5)
COMM 2 BAUD 9600	Selects baud rate for COM2, located in front of control. (Section 6.5)
IP DHCP MODE DISABLE	When enabled, the Ethernet port will search for any available IP address to use. The detected address will be displayed during the ethernet boot-up, shortly after the Control is powered up (and also in the DHCP IP ADDRESS screen). When this function is disabled, the ethernet port will use the address set in the IP ADDRESS configuration screen. Factory setting is Disabled. (Section 6.5) This screen is disabled unless the unit is provided with the Ethernet option, and COMM 1/3 is configured for Ethernet.
IP ADDRESS 192.168.1.43	This address is set to match the available LAN address used with the optional Ethernet port. (Section 6.5) When DHCP mode is enabled, this screen will display the DHCP IP ADDRESS. The DHCP IP ADDRESS cannot be changed, as it is determined at bootup. This screen is disabled unless the unit is provided with the Ethernet option, and COMM 1/3 is configured for Ethernet.
IP NETMASK 255.255.255.0	The Netmask is set to perform multicasting on a LAN system with optional Ethernet port. This screen is disabled unless the unit is provided with the Ethernet option, and COMM 1/3 is configured for Ethernet.
IP GATEWAY 0.255.255.255	Allows a Network Gateway address to be configured with the optional Ethernet Port. This screen is disabled unless the unit is provided with the Ethernet option, and COMM 1/3 is configured for Ethernet. The Gateway Address is only used when DHCP is disabled.
BEC/MDBS COM ADR 1	Configures a three-digit numerical address, from 1 to 200, for remote communications, using MODBUS, BECO 2179, and BECO 2200 protocols. The factory setting is 1. (Section 4.1)
DNP/2179 COM ADR 1	This menu item is for 2179, 2179A, GP2179 and DNP protocols, and will not work for any other protocol. Range is from 1 to 2046 for 2179 Versions and 1 to 65534 for DNP.
COM1,2 DEAD-SYNC 50 msec	This time delay improves robust operation when communication lines are intermittent. Communication dead-sync time is the time that the control will wait from the last received character and continue without attempting to resynchronize. Factory setting is 50 msec; range is 0-32000 msec.
COM 1 PROTOCOL BECO2200	Allows selection between standard protocols: BECO2200, 2179 (Cooper 2179), 2179A, GP 2719, DNP3.0, GP DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0, BECO 2179 or MODBUS, or optional IEC-61850/UCA 2.0 for COM3. Factory setting is BECO 2200. (Section 4.11)

Figure A-5 Configuration Screens (page 5 of 6)

■ **NOTE:** For detailed information on the above settings, see the referenced Instruction Book Sections.

COM 3 DEAD-SYNC
50 msec

This time delay improves robust operation when communication lines are intermittent. Communication dead-sync time is the time that the control will wait from the last received character and continue without attempting to resynchronize. Factory setting is 50 msec; range is 0-32000 msec.

COM 3 PROTOCOL
BECO 2200

Allows selection between standard protocols: BECO2200, 2179 (Cooper 2179), 2179A, GP 2719, DNP3.0, GP DNP3.0, AL PWR DNP3.0, MISS PWR DNP3.0, BECO 2179, MODBUS, or optional IEC 61850/UCA 2.0 for COM3. Factory setting is BECO 2200. (Section 4.11)

SELECT DNP PTS
0 disable

Allows DNP3.0 data points to be enabled. For more information, refer to the DNP3.0 communication profile, available from Beckwith Electric. **NOTE:** After enabling or disabling any DNP3.0 data points, power must be cycled off and on for selection to apply.

VIEW POINTS
0 disable

Allows viewing of enabled/disabled DNP3.0 data points to be enabled. **NOTE:** After enabling or disabling any DNP3.0 data points, power must be cycled off and on for selection to apply.

DNP PTS DESELECT
0 disable

Allows DNP3.0 data points to be deselected, or disabled. **NOTE:** After enabling or disabling any DNP3.0 data points, power must be cycled off and on for selection to apply.

ENABLE ALL DNP
DISABLE

Allows all DNP3.0 data points to be enabled or disabled. **NOTE:** After enabling or disabling any DNP3.0 data points, power must be cycled off and on for selection to apply.

LOCAL MODE
DISABLE

Allows control of reading/writing setpoints and configurations via communications. There are 4 settings associated: Disable, Read Only, Always Read Only, and No Read or Write. When set to Disable, read/write communication will be available at all times. When set to Read Only, read/write communication will be available only when the front panel of the control is inactive. If the front panel is active, only reads via communications will be allowed. When set to Always Read Only, only reads via communications will be allowed regardless of whether the front panel is active or not. When set to No Read or Write, read/write communication will be available only when the front panel of the control is inactive. If the front panel is active, no communications will be allowed.

USER LINE #1

Allows input of 15 ASCII characters to configure a unit locator or description. If not configured, a row of 15 asterisks will appear in top row of User Line #1 screen. (Section 4.2)

USER LINE #2

Allows input of 15 ASCII characters to configure a unit locator or description. If not configured, a row of 15 asterisks will appear in bottom row of User Line #2 screen. (Section 4.2)

Figure A-5 Configuration Screens (page 6 of 6)

NOTE: For detailed information on the above settings, see the referenced Instruction Book Sections.0

Programmable Alarm Function

The programmable alarm function can provide an alarm for one or more of eight conditions. Each condition corresponds to one of eight digits on the bottom line of the display: a "0" indicates that the alarm condition is disabled; a "1" indicates that the alarm condition is enabled. The figures below show how to program this function.

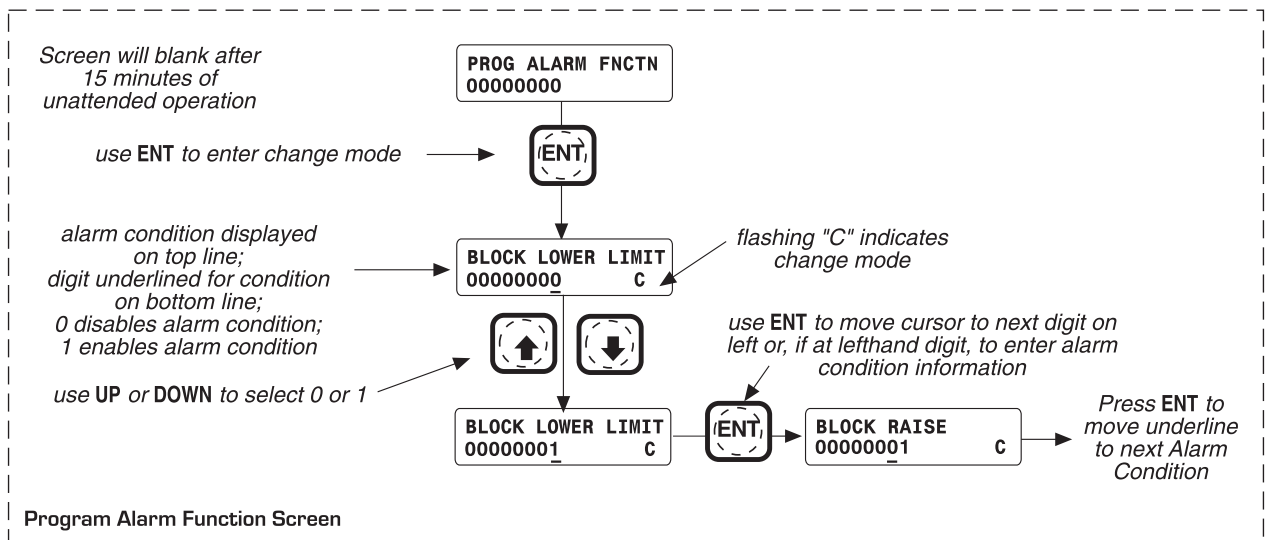
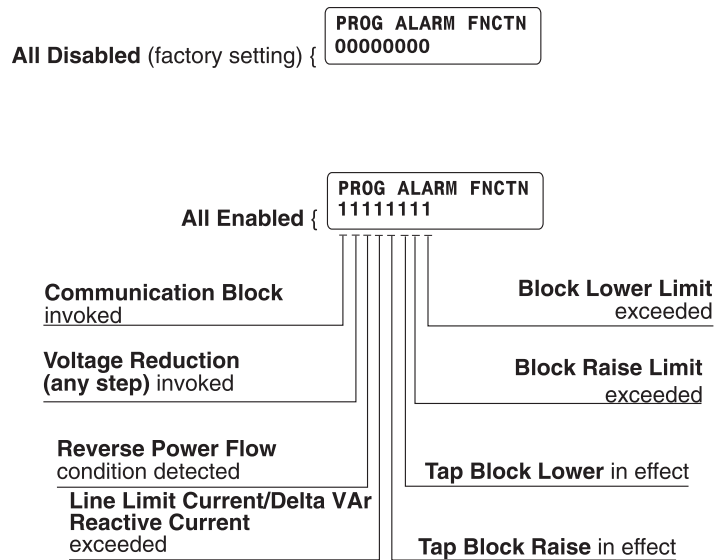


Figure A-6 Programmable Alarm Function Screen

A.4 Setpoint and Configuration Worksheets

Use these forms to record the M-2001C unit configuration. These forms can be given to a technician for configuring the M-2001C, or changing the setpoints, and kept on file for future reference.

BANDCENTER F _____ Volts	REDUCTION STP1 _____ %
BANDWIDTH F _____ Volts	REDUCTION STP2 _____ %
TIME DELAY F _____ Sec	REDUCTION STP3 _____ %
INVERSE TIME F _____ Sec	SERIAL RED STP1 _____ %
LDC RESISTANCE F _____ Volts	SERIAL RED STP2 _____ %
LDC REACTANCE F _____ Volts	SERIAL RED STP3 _____ %
BANDCENTER R _____ Volts	BLOCK RAISE _____ Volts
BANDWIDTH R _____ Volts	DEAD BAND _____ Volts
TIME DELAY R _____ Sec	BLOCK LOWER _____ Volts
INVERSE TIME R _____ Sec	TAP BLOCK RAISE _____ R
LDC RESISTANCE R _____ Volts	TAP BLOCK LOWER _____ L
LDC REACTANCE R _____ Volts	LINE LIMIT I _____ mA
	OUTPUT PULSE _____ Sec
	LDC-Z VOLT RAISE _____ Volts

Figure A-7 Setpoint Worksheet

V.T. CONFIGURATION LINE_TO_LINE LINE_TO_GND	TAP POSITION/CAL __ L Neutral __R
VT CORRECTION _____ Volts	CNTR TIME WINDOW _____ Sec
CT/VT PHASING _____ Deg	OPER CNTR CONFIG 1X 2X COUNT WINDOW
PRI PWR DISPLAY SINGLE_PHASE THREE_PHASE	OPER CNTR PRESET _____
PRI VOLT MULTPLR _____ X	REV POWER OPER REGULATE REV IGNORE BLOCK RETRN TO NEUTRL DIST GEN MODE
PRI CURR MULTPLR _____ X	PWR DIRECT BIAS REV BIAS FWD BIAS NONE
DEMAND INTERVAL 15 30 60 Minutes	PARALLELING CIRCULATING I DVAR1 DVAR2 DVAR2 + KPTR DISABLE
INTERTAP DELAY _____ Sec	DVAR2 SENSITIVITY _____
BASIC TIMER TYPE INTEGRATING INST_RESET	DVAR2 REAC I LMT _____ mA/Amps
TAP MAX _____ R	DVAR2 I RATIO _____
TAP MIN _____ L	PROG ALARM FNCTN BLK LOWER BLK RAISE TAPBLKLOWR TAPBLKRAISE LINE LIMIT I REV PWR FLOW VOLT RED COMM BLOCK
TAP INFORMATION DISABLE REG INTERNAL REG EXT #1 REG EXT #2 XFMR EXT #1 XFMR EXT#2 XFMR EXT #3 REG EXT#3 CONTACT KT 1R1L CONTACT KT 1N	

Figure A-8 Configuration Worksheet (page 1 of 3)

OUTPUT SELECTION CONTINUOUS PULSED	LEVEL 1 PASSWORD _____
TIMER SELECTION DEFINITE INVERSE	LEVEL 2 PASSWORD _____
LDC SELECTION RES_REAC Z-COMPENSATED	COMM PASSWORD _____
CURR TRANSFORMER 200mA 1A 5A	LCD CONTRAST _____
COMM BLK AUTO DONT SAVE SAVE AT PWR OFF	COMM 1 PORT RS232 RS485 FIBER
FLASH V RED MODE ENABLE DISABLE	FIBER REPEAT ON OFF
INPUT SELECTION 1 SEAL-IN SWITCH STATUS	COMM 1 BAUD 300 600 1200 2400 4800 9600 19200
INPUT SELECTION 2 NON SEQ SCADA CUTOUT	COMM 2 BAUD 300 600 1200 2400 4800 9600 19200
INPUT SELECTION 3 VR2 INPUT AUX INPUT	IP DHCP MODE ENABLE DISABLE
REGULATOR TYPE A B	IP ADDRESS _____
TAP LIMITS ENABLE DISABLE	IP NETMASK _____
DAYLIGHT SAVINGS ENABLE DISABLE	IP GATEWAY _____
AUTO/MAN SW TYPE TOGGLE SCAMP NONE	BEC/MDBS COM ADR _____
VR TURNOFF TIMER _____ Min	

Figure A-8 Configuration Worksheet (page 2 of 3)

DNP/2179 COM ADR _____	USER LINE #1 _____
COM1,2 DEAD-SYNC _____ msec	USER LINE #2 _____
COM 1 PROTOCOL BEC02200 2179 DNP3.0 BEC02179 MODBUS 2179A GP2179 GP DNP3.0 AL PWR DNP3.0 MISS PWR DNP3.0	
COM 3 DEAD-SYNC _____ msec	
COM 3 PROTOCOL BEC02200 2179 DNP3.0 BEC02179 MODBUS 2179A GP2179 GP DNP3.0 AL PWR DNP3.0 MISS PWR DNP3.0	
SELECT DNP PTS _____ DISABLE	
VIEW POINTS _____ DISABLE	
DNP PTS DESELECT _____ DISABLE	
ENABLE ALL DNP ENABLE DISABLE	
LOCAL MODE NO RD OR WRITE ALWAYS RD ONLY READ ONLY DISABLE	

Figure A-8 Configuration Worksheet (page 3 of 3)

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B **Appendix B – TapTalk® Data Output**

This Appendix contains illustrations of the print-ready screens provided by TapTalk's Data Output command.

M-2001C Instruction Book

Beckwith Electric Co. Inc.
TapTalk M-2029A Data Profile

CONTROL INFORMATION:

Identification:	M-2001C
Serial Number:	1
Version:	D-0146V09.01.21
Modification Number:	-
User Line 1:	xxxxxxxxxxxxxxxx
User Line 2:	xxxxxxxxxxxxxxxx
Comm Address:	2
Control Date:	Mon/Feb/16 / 04
Control Time:	15 :09 : 59

CONNECTION TYPE: Serial Com1

CONTROL COM:

Local Mode: Disable

BASIC SETPOINTS:

Forward Band Center:	120.00 V
Forward Band With:	2.00 V
Forward Time Delay:	4 sec
Forward Inverse Time Delay:	30 secs
Forward LDC Resistance:	0 V
Forward LDC Reactance:	0 V
Reverse Band Center:	120.00 V
Reverse Band With:	2.00 V
Reverse Time Delay:	30 secs
Reverse Inverse Time Delay:	30 secs
Reverse LDC Resistance:	0 V
Reverse LDC Reactance:	0 V
Voltage Reduction 1:	2.50 %
Voltage Reduction 2:	5.00 %
Voltage Reduction 3:	10.00 %
Block Raise (Voltage):	135.00 V
Block Lower (Voltage):	95.00 V
Dead Band:	2.00 V
Current Limit:	640.00 mA
Block Raise (Tap):	16 R
Block Lower (Tap):	16 L
Output Pulse Width:	1.50 sec
Line Drop Compensation - Z:	0 V

CONFIGURATION:

VT Configuration:	Line To GroundV
VT Correction:	0.00 Volts
CT/VT Phasing:	0 Degree
Primary Power Display:	Single Phase
Primary Voltage Multiplier:	60.00 x
Primary Current Multiplier:	6000.00 x
Demand Interval:	15 minutes
Intertap Delay:	0 sec
Tap Information:	Reg. Internal
Operation Counter Configuration:	X1
Reverse Power Operation:	Regular Reverse
Paralleling:	Disable
Basic Timer Type:	Integrating
Tap Max:	16 R
Tap Min:	16 L
Output Selection:	Continuous
Input Selection 1:	Switch Status
Time Delay Selection:	Definite
Current Transformer Selection:	200 mA
Line Drop Compensation:	X,R
Power Direction Bias:	None

Figure B-1 Data Output (Page 1 of 3)

Beckwith Electric Co. Inc.
 TapTalk M-2029A Data Profile

Flash Voltage Reduction Mode: Enable
 Input Selection 2: Non-Sequential
 Regulator Type: B
 Count Window: 2.0 sec

ALARM CONFIGURATION:

Block Lower (Volt): Enabled
 Block Raise (Volt): Enabled
 Block Lower (Tap): Enabled
 Block Lower (Tap): Enabled
 Current Limit: Enabled
 Reverse Power: Enabled
 Voltage Reduction: Enabled
 Block Comm: Enabled

STATUS:

Primary Volts: 17.17 kV
 Primary Current: 1.00 Amps
 Primary Watts: 0.00 MW
 Primary VAR: 0.00 MVA_r
 Primary VA: 0.00 MVA
 Frequency: 60.00 Hz
 Local Voltage: 119.60 Volts
 Source Voltage: 119.60 Volts
 Load Current (Secondary): 0.00 mA
 Comp. Voltage: 119.60 Volts
 Circ. Current (Secondary): 0.00 mA
 Power Factor: 0.67 Lag
 Raise Timer: 0 sec
 Lower Timer: 0 sec
 Intertap Timer: 0 sec
 Operation Counter: 793
 Tap Position: 0 Neutral
 Band Status: OK
 Power Direction: Forward
 Operation Direction: Forward
 Voltage Red. In Effect: OFF
 Voltage Red. Step: No Red.

DEMAND METERING:

Present:

Interval: 15 Minutes
 Local Voltage: 119.90 Volts
 Primary Current: 0.00 Amps
 Primary Watts: 0.00 MW
 Primary VAR: 0.00 MVA_r
 Primary VA: 0.00 MVA

HISTORY:

Local Voltage (Min): 112.50 Volts [14:43:52 Feb/12/04]
 Local Voltage (Max): 123.10 Volts [07:28:02 Feb/15/04]
 Primary Current (Max): 1.00 Amps [07:49:14 Feb/12/04]
 Primary Watts (Max): 0.00 MW [12:34:22 Feb/12/04]
 Primary VAR (Max): 0.00 MVA_r [07:49:14 Feb/12/04]
 Primary VA (Max): 0.00 MVA [20:43:32 Feb/13/04]
 Power Factor at Max VA: 0.58 Lag
 Raise Tap Draghand: 0
 Lower Tap Draghand: 0

Energy Metering:

Figure B-2 Data Output (Page 2 of 3)

M-2001C Instruction Book

Beckwith Electric Co. Inc.
TapTalk M-2029A Data Profile

Watt Hours (Forward):	184.52 MWHrs	[19:08:38 Dec/31/99]
Watt Hours (Reverse):	0.00 KWHrs	[19:08:37 Dec/31/99]
VAr Hours (Forward):	2.58 MVarHrs	[19:08:37 Dec/31/99]
VAr Hours (Reverse):	36.23 MVarHrs	[19:08:38 Dec/31/99]

Figure B-3 Data Output (Page 3 of 3)

Patent

The units described in this manual are covered by U.S. Patents, with other patents pending.

Buyer shall hold harmless and indemnify the Seller, its directors, officers, agents, and employees from any and all costs and expense, damage or loss, resulting from any alleged infringement of United States Letters Patent or rights accruing therefrom or trademarks, whether federal, state, or common law, arising from the Seller's compliance with Buyer's designs, specifications, or instructions.

Warranty

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used herein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of five years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to perform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided, however, that Buyers shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to replacement value of the equipment furnished under this contract.

Seller makes no warranties expressed or implied other than those set out above. Seller specifically excludes the implied warranties of merchantability and fitness for a particular purpose. There are no warranties which extend beyond the description contained herein. In no event shall Seller be liable for consequential, exemplary, or punitive damages of whatever nature.

Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

Indemnification

The Seller shall not be liable for any property damages whatsoever or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary, or consequential damages, including but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence, or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

It is agreed that when the equipment furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site, and all premises used for such operations.

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