NEUNDORFER
PRECIPITATOR
KNOWLEDGE

USER MANUAL

MVC III

MICRO VOLTAGE CONTROL III
USER MANUAL

Revised June 2007

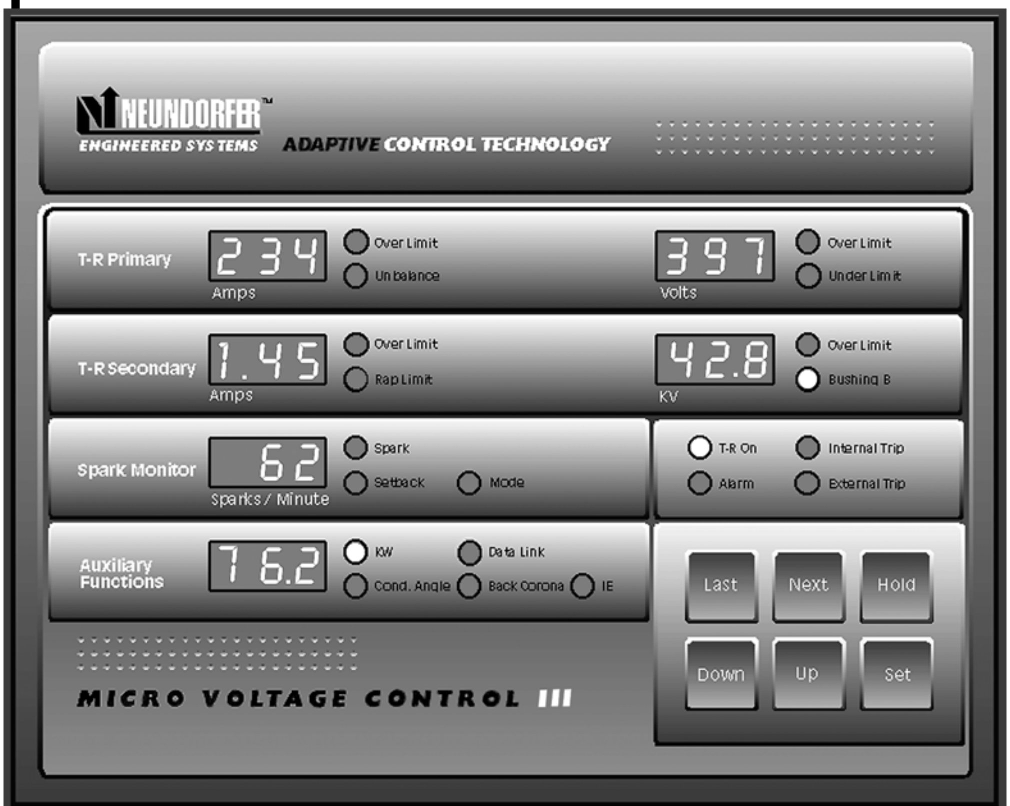

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TABLE OF CONTENTS

ADDENDUM vi

1.0 INTRODUCTION 1

- 1.1 About This Manual 1
- 1.2 Before Applying Power 2
- 1.3 Introducing The MVC III 3

2.0 THEORY OF OPERATION 5

3.0 SOFTWARE 7

- 3.1 Ownership 7
- 3.2 Upgrades 7
- 3.3 Installing A New Software Memory Chip 9
- 3.4 Software Identification 9

4.0 SPECIFICATIONS 10

- 4.1 PCB Assembly & Serial Number ID 10
- 4.2 Inputs (To Interface Circuit Board) 10
- 4.3 Outputs (From Interface Circuit Board) 13
- 4.4 SCR Ratings 13
- 4.5 Logic System Temperature Rating 13

5.0 INSTALLATION AND WIRING 14

- 5.1 General 14
- 5.2 Grounding 14
- 5.3 Secondary Current And KV Feedback Signal Wiring 15
- 5.4 Complete Cabinet Or Pre-Wired Back Panel Installation 15
- 5.5 Major Assembly Subsystems Retrofit Installation 16
- 5.6 Continuity Test 16

6.0 OPERATOR CONTROLS 17

- 6.1 MVC III Display Panel 17
- 6.2 Keypad 20
- 6.3 T-R On Switch 21
- 6.4 Local / Remote Switch 21
- 6.5 Reset Pushbutton Switch 21

7.0 MVC III MODES 22

8.0 SOFTWARE CONFIGURATION 23

8.1 Selecting Software Options 24
8.2 Setting T-R Primary Size 25
8.3 Setting T-R Secondary Size 25
8.4 Setting Spark Detection Sensitivity 26

9.0 ADJUSTING LIMITS AND SETPOINTS 26

9.1 Primary Current Limit 28
9.2 Primary Over voltage Limit 28
9.3 Under voltage Limit 29
9.4 Secondary Current Limit 29
9.5 Rap Limit 30
9.6 Secondary Over Voltage Limit 30
9.7 Baseline Spark Rate 31
9.8 Setback 31
9.9 Spark Response Mode 32
9.10 Kilowatts 32
9.11 Conduction Angle 33
9.12 Data Link Unit Number 33
9.13 Back Corona Software 34
9.14 IE Ratio Settings 34

10.0 ADDITIONAL FEATURES 36

10.1 Operation of Auto Restart 36
10.2 Display Hold Feature 37
10.3 Dual Bushing Kilovolt Metering 37
10.4 Auxiliary Functions Display Default Parameter 37
10.5 Auto Spark Quench Interval 37
10.6 RS-485 Communications 38
10.7 Data Link Start, Stop, and Reset Commands 39
10.8 External Restart, Stop, and Ack Alarm Signals 39
10.9 Alarm Relays 40
10.10 Rapper Outputs 40

11.0 START-UP PROCEDURE & CALIBRATION 41

11.1 Setting Circuit Board Jumpers 42
11.2 Initial Turn On and Adjustment 43
11.3 Calibration - General Information 44
11.4 Primary Current Calibration 44
11.5 Primary Voltage Calibration 45
11.6 Secondary Current Calibration 45
11.7 Secondary Voltage Calibration 47

11.0 START-UP PROCEDURE & CALIBRATION (*con't*)

11.8 Final Calibration and Set-Up 48
11.9 Suggested MVC III Setup 49
11.10 Normal Operation 51

12.0 CALIBRATION POTS, SWITCHES, LED's, TEST POINTS AND JUMPERS 52

12.1 Table 13 - Main Logic PCB 52
12.2 Table 14 - Interface PCB 53

13.0 TROUBLE SHOOTING 54

13.1 Diagnostic Error Codes 54
13.2 MVC III Trouble Shooting Guide 57
13.3 MVC III Setup Problems 62
13.4 Precipitator Trouble Shooting Guide 63
13.5 Identifying Causes of Trips 65

APPENDIX

A. ZEROING AND CALIBRATING A/D CONVERTER A-1

A.1 Zeroing the Analog Inputs A-1
A.2 Calibrating the A/D converter A-3

B. FIGURES .... (Pages B-1 to B-10)

Figure 1 MVC III Control Panel Item Identification B-1
Figure 2 MVC III Logic Board Component Identification B-2
Figure 3 MVC III Interface Board Component Identification B-3
Figure 4 MVC III Display Circuit Board (chip side) B-4
Figure 5 MVC III Display Circuit Board (display side) B-5
Figure 6 MVC III Data Link Jumper Configurations B-6
Figure 7 Spark Response Mode Waveforms B-7
Figure 8 Auto Spark Quench Interval Waveforms B-8
Figure 9 Primary Current Waveforms B-9
Figure 10 SCR Gate Firing Signal Waveform B-10

C. CURRENT MONITOR RELAY SPECIFICATIONS

D. RECOMMENDED SPARE PARTS LIST
(May be supplied under separate cover)

E. STANDARD DRAWINGS

8-01-0177 (Sheets 1-18)	Combined PCB Schematics
8-01-0178	Typical Data Link Network
8-01-0180 (Sheets 1 & 2)	Template, Interface PCB mounting
8-01-0180 (Sheets 3 & 4)	Template, flush mount door panel cutout & T-R On switch cutout
8-01-0180 (Sheets 5 & 6)	Template, Logic PCB mounting
8-01-0181	Interface PCB Customer Connection Drawing, Generic Configuration
8-01-0196 (Sheets 1 & 2)	System Schematic Diagram, Generic Configuration
8-01-0200	Connection Diagram, Generic MVC III Retrofit
8-01-0198	Cabinet Layout, MVC-3 Standard
82200-016	Outline, KV Signal Feedback & Surge Suppression PCB
84700-250A (Sheet 1 of 2)	Schematic Diagram, Voltage Divider, Type 2
84700-250A (Sheet 2 of 2)	Field Assembly / Shipping BOM Voltage Divider, Type 2

F. CUSTOM AS BUILT AND INSTALLED DRAWINGS

(Some may be supplied under separate cover)

Equipment Layout (for cabinets) or
Scope of Supply (for retrofits)
System Schematic, As Built
System Wiring Diagram, As Built

INDEX .... **End of Binder**

ADDENDUM

Changes in operation with V3.0a and derivative firmware

V3.0a firmware addresses a customer request for a new spark sensing mode and longer **IE OFF** times. Current versions of POS will not properly report the IE ratio in the data log.

Spark Sensing Mode 4 - A new spark sensing mode, available as selection number 4, provides a setback of the conduction angle without a quench for the first occurrence of a spark. If there is another spark on the next half cycle of **SCR ON** time, there will then be a quench and ensuing fast ramp without an additional setback. Only the spark causing the setback is counted in the digital SPM display.

Intermittent Energization settings - Available Intermittent Energization setting have been changed to allow selection of up to 62 half cycles of **OFF** time with one through three half cycles of **ON** time. Settings with four half cycles of **ON** time are no longer provided.

As before, spark rate and IE settings are interlocked to prevent operating IE with spark rate selections above 60 SPM. New to version 3.0a firmware is a mechanism to automatically reduce the spark rate for long **IE OFF** times to ensure a few stable **IE** cycles at the slow ramp rate before the next spark.

Also, to accommodate the long **IE OFF** periods, a new adaptive digital display averaging program provides optimum smoothing and response for the digital readouts at all **IE** duty cycles.

Operational notes - When Intermittent Energization is configured for two half cycles of **ON** time, it may produce a net DC current in the T-R primary due to high recharge current in the first of the two half cycles of **ON** time. Select one half cycle of **ON** time to prevent **Unbalance** trips.

Changes in operation with V3.0c and derivative firmware

V3.0c firmware adds KV based spark sensing, provides adjustments to traditional spark sensing means, provides a new method of back corona detection and reaction, and provides a flashing display for tripped controls. Current versions of POS will not properly display the blanked display.

Secondary Current based spark sensing - Algorithm has been enhanced to improve spark sensing for installations with low spark current transients or unusually low conduction angle at current limit.

Primary Current based spark sensing - Parameter changes have been made to improve primary derived spark sensing for installations with inadequate primary circuit inductance.

KV based spark sensing - A new algorithm has been added to sense sparking by analysis of enabled KV bushings. For this feature to function the low pass filter jumpers, JMPR1 and JMPR2, on the logic board must be removed.

KV based Back Corona sensing - A new algorithm has been added to sense back corona by analysis of enabled KV bushings. For this feature to function the low pass filter jumpers, JMPR1 and JMPR2, on the logic board must be removed.

The new algorithm senses back corona based on changes in KV waveform, and responds by initiating a four half cycle quench and a setback. The effect is to limit TR operation to a point just below the onset of back corona. The new algorithm is active for back corona setting number 1. The former settings 1 - 4 have been reassigned to settings 2 - 5.

1.0 INTRODUCTION

1.1 About This Manual

This manual covers installation, operation, and troubleshooting procedures which can be performed by customer personnel who operate and maintain the control.

It is recommended that the personnel installing the MVC III read and understand the contents of *sections 4* and *5* as well as the system drawings and schematics before starting installation.

Sections 6 through *11* should be thoroughly understood by personnel operating the MVC III to ensure personal safety and equipment protection.

Sections 11 through *13* provide technical information for the personnel responsible for calibration and maintenance of the MVC III.

The technical staff at Neundorfer Inc. always invites commentary on our manuals in an effort to improve or clarify their contents. Please feel free to contact us at:

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1.2 Before Applying Power

! WARNING !

Voltages and currents capable of causing death are present in the T-R control cabinet and at the T-R set!

No one should attempt to operate this equipment who does not have a through knowledge of all required safety procedures.

Improper operation of this equipment could result in damage to the MVC III, T-R set or precipitator. Before applying power to the MVC III system for the first time:

- Verify continuity and correctness of all connections.
- Verify all connections are tight and properly insulated.
- Verify proper grounding of T-R set and MVC III logic system. *See section 5.2.*
- Verify proper configuration of all circuit board jumpers. *See section 11.1.*
- Open the **T-R On** switch.
- Power up the MVC III logic in the Software Configuration Mode with the **T-R On** switch in the open position. *See section 8.0.*
- Set the Software Options Code, T-R Primary Size Code and T-R Secondary Size Code as indicated in *sections 8.1 - 8.3.*
- Referring to *sections 9.1 to 9.14*, set the MVC III limits as follows:

Primary Current Limit ---------50% of T-R rating
Primary Over Voltage ----------T-R nameplate
Primary Under Voltage---------100 Volts
Secondary Current Limit ------50% of T-R rating
Rap Limit --------------------------0.0 Amps
Secondary Voltage Limit-------T-R rating - 10 KV
Baseline Spark Rate -------------15 SPM
Setback -----------------------------5%
Spark Response Mode ----------1
Conduction Angle----------------30 degrees
Data Link Unit Number --------sequential
Back Corona Adjust-------------0
IE Ratio ----------------------------0.00

- Be sure to set the Conduction Angle Limit to 30^{o}. *See section 9.11*.

  This setting is critical to protect the T-R set when it is initially energized.
- Remove power from the MVC III logic for about 10 seconds, then reapply power and verify that all software configuration codes and setpoint limits have been retained.
- You are now ready to follow the startup procedure outlined in *section 11*.

1.3 Introducing The MVC III

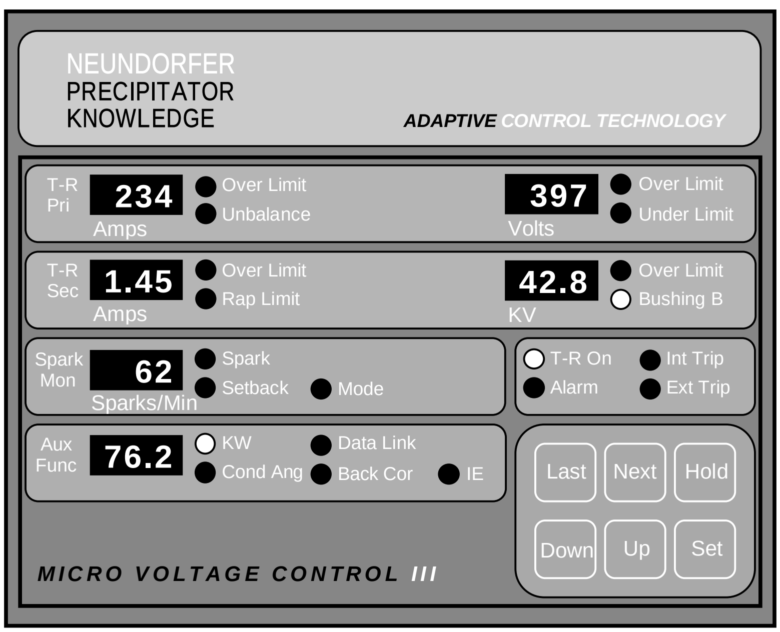
The **MICRO VOLTAGE CONTROL III (MVC III)** is an advanced microprocessor T-R controller designed for easy installation and use. It features large dedicated LED digital readouts and other illuminated indicators to set and verify operating functions. It can communicate with the Neundorfer MicroRap rapper control and the Neundorfer PC based Precipitator Optimization System (POS) over an RS-485 data link network as part of a unified precipitator control system. The POS software provides remote control, plan view displays, data logging and energy management.

The MVC III is available as a complete stand alone factory wired cabinet, as a retrofit with a pre-wired backpanel using the customer's existing compatible equipment (requiring customer interface wiring) or as major assembly subsystems for customer installation and wiring.

The MVC III is a based on a Motorola MC68HC11 HCMOS single-chip microcontroller unit (MCU). This powerful MCU samples the primary current, primary voltage, secondary current, secondary voltage, and spark inputs every 521 microseconds. From these collected samples sophisticated waveform analysis is performed every half cycle of the line (8.33 msec) to determine adjustments in the SCR gate firing program for the next half cycle and in some cases for the present half cycle.

The speed of the MVC III enables the control to adjust quickly and accurately to changing conditions in the precipitator, and provides the user with precise information about T-R set operation. If a condition exists, such as a shorted electrical field due to a broken discharge electrode, that the MVC III cannot control or correct, it will shut itself off and freeze the **DISPLAY** panel. With the **DISPLAY** frozen, the operator can identify the condition that caused the control to shut down.

The MVC III Display Panel



1.3 Introducing The MVC III

(con't)

The MVC III employs advanced hardware designs and increased use of self adaptive software algorithms to improve the collection efficiency of electrostatic precipitators. This third generation controller builds on the vast knowledge gained from nearly 2000 MVC II systems in service to provide a more capable controller at a lower overall installed cost. Some significant enhancements are:

General Enhancements

- Lower cost, smaller size, and easier installation for reduced total installed cost.
- Three PC board system with plug connections to all boards for quick board swaps. Ribbon cable interconnect between boards.
- Standard calibration adjustments on **INTERFACE** board eliminates need to recalibrate when changing **LOGIC** board.
- No requirements for periodic re-calibration.
- Can be configured without **DISPLAY** panel. All operating setpoint adjustments are accessible from the POS terminal.
- Optional expansion I/O board can be used to operate tumbling hammer rappers.

Technical Enhancements

- Faster microprocessor supports more complex performance enhancing control algorithms.
- ***ADAPTIVE CONTROL TECHNOLOGY*** improves precipitator performance by eliminating need for retuning as process conditions change.
- Proprietary ***NON LINEAR RAMPING*** algorithm increases precipitator power levels under virtually all operating conditions.
- Self tuning spark rate eliminates constraints of operating at a fixed pre selected spark rate. As precipitator conditions become less stable, ***ADAPTIVE CONTROL TECHNOLOGY*** automatically increases spark rate to maintain optimum collection efficiency.
- 19,200 baud data link speed improves communications with POS or DCS and provides RPR/POR link to MicroRap.
- Supports POS managed IE ratio optimization.
- High speed 200 Volt common mode input differential amplifiers enhance capability to extract accurate T-R feedback signals from the background electrical noise for improved waveform analysis.
- Proportional current limit algorithm provides faster response to precipitator transients reducing possibility of SCR fuse clearing or SCR damage on retrofits with marginal rated SCR's.
- Tunable Back Corona Control software.
- Separate primary and secondary T-R current range selection optimizes use of A/D converter.

2.0 THEORY OF OPERATION

The Neundorfer MVC III is designed to maintain the highest possible precipitator collection efficiency by maximizing the instantaneous high voltage applied to the bus section and minimizing response and recovery time to sparking. The MVC III prevents development of arcing, which can reduce collection efficiency and damage the precipitator. Since conditions in a precipitator continually change, the applied voltage must be adjusted continuously to achieve maximum efficiency.

The voltage that can be applied to a precipitator is determined by the spark over voltage between the discharge electrodes and the collecting plates. When the voltage applied to a precipitator approaches the point at which the flue gas filled space between the wires and plates breaks down, sparking occurs. The term “spit spark” refers to a momentary breakdown from which the precipitator recovers rapidly with little effect on precipitator operation. In most cases a spit spark will self extinguish. However, when the momentary breakdown produces a channel of ionized gas between the precipitator electrodes of sufficiently low impedance to permit large currents to flow, the result is called a “spark”. A sustained spark lasting for more than a few half cycles of the line is called an “arc”.

The Neundorfer MVC III maintains the optimum voltage by continuously monitoring the T-R feedback signals for indication of an impending arc. If an arc is imminent, the power is removed from the T-R set primary before a damaging arc can develop. After a brief quench interval, the MVC III then rapidly increases the T-R primary current and voltage to re-apply power to the bus section.

Figure 7 shows typical control response to sparking. After a spark, there is a brief quench interval during which power is removed from the T-R set primary. Then power is rapidly ramped up to the Post Spark Setback level, which is in the range of 1% to 20% below the level at which the spark occurred. The control then enters the slow ramp phase until the next spark occurs or an operating limit is reached. The MVC III’s self adaptive software dynamically adjusts the shape and duration of each of the response intervals as needed for maximum precipitator collection efficiency.

To achieve maximum precipitator efficiency, the MVC III performs three major functions: T-R set electrical feedback sensing, processing, and controlling.

T-R Set Electrical Feedback Sensing

The MVC III rapidly samples analog input signals from the T-R set primary and secondary current and voltage feedback signals to calculate instantaneous operating levels and determine occurrences of sparking. Primary voltage and current are calculated as RMS values while the secondary values are calculated as average DC to agree with T-R nameplate labeling convention.

Secondary voltage feedback is only necessary for operation of the Back Corona Control feature and for KV limiting. If these features are not needed, the MVC III can be operated without secondary voltage dividers. The MVC III has the capability to monitor both bushings of a dual bushing T-R set.

Primary current and voltage feedback and Zero Cross timing signals are provided by electrically isolated transducers while secondary feedback is via special operational amplifiers capable of withstanding up to 200 volts of common mode input signal. The secondary feedback circuits provide transient noise filtering and suppression for noise or offset voltages up to 50 volts.

2.0 THEORY OF OPERATION *(con't)*

Processing

The microcontroller continually processes the T-R feedback signals using circuitry, operator setpoint adjustments, and the software program to generate optimally timed SCR gate firing signals. The MVC III SCR gate circuitry converts the SCR turn on signal from the microcontroller into trigger pulses which fire the SCR's supplying power to the primary side of the T-R set.

After each full line cycle of ***actual SCR conduction***, the Microcontroller calculates the primary RMS current and voltage and the average DC secondary current and voltage for that period. The values are checked against the setpoint limits to modify T-R set power input (SCR gate firing signal) as need to correct any out of limit conditions.

This process automatically ensures correct T-R set operating limit control under all operating conditions, including Intermittent Energization. The line cycle values are time averaged and displayed on the front panel. Transient conditions trigger front panel status indicators.

Controlling

Controlling the precipitator secondary voltage and current is accomplished by controlling the conduction angle of the primary power applied to the T-R set. After receiving the trigger pulses from the firing circuit, the SCR's act as switches that conduct only for that portion of each half cycle necessary to produce the desired precipitator voltage and current within the setpoint nameplate limits.

The principle method of spark sensing is based on a feedback signal derived from the T-R set secondary current signal. Sparking usually causes a fast rise high current transient in the secondary current which is interpreted as a spark. There are some arc conditions that slowly develop without the expected transient. These occurrences are detected using a primary voltage analysis algorithm. Spark sensing does not require operator adjustments or calibration.

When a spark is detected, it is quenched by momentarily interrupting power flow to the T-R set. Then the operating voltage is rapidly increased to the Setback level followed by a slow ramp up to the next spark or operating limit. The exact spark response pattern is determined by the Spark Response Mode, Baseline Spark Rate, Setback, and self adaptive software algorithms.

The MVC III includes Intermittent Energization (IE) and Back Corona Control software. Intermittent Energization can improve precipitator performance and significantly reduce energy consumption in many applications. Back Corona Control software maintains the maximum operating level possible below the onset of back corona. Back corona is an undesirable operating condition that can reduce collection efficiency and increase power consumption.

3.0 SOFTWARE

3.1 Software Ownership

The MVC III controller contains a computer program "software," which is a copyrighted product of Neundorfer, Inc. Neundorfer, Inc. retains ownership of the computer program. The owner of the MVC III is granted a license to operate the computer program in the MVC III controller in which it was originally supplied by Neundorfer, Inc. Duplication or alteration, in part or in whole, of the program or reverse engineering the program is prohibited by United States copyright law.

3.2 Software Upgrades

Neundorfer, Inc. may make future changes in the MVC III computer program to enhance operation or add features. While Neundorfer, Inc. is under no obligation to modify or upgrade customers' controllers with such new programs, it is company policy to provide memory chips containing updated software free of charge upon request for the life of the equipment. The customer is responsible for all shipping charges, installation, and return of removed chips. New programs may be provided in file format for the customer to program into the memory chips. In that case the customer will be granted the right to duplicate the supplied file format program to provide one copy for each owned MVC III.

3.2.1 Upgrading Software From V1.3 To V1.4

When upgrading from any version 1.3 software (memory chip label NVC3x1.3xx) to version 1.4 or higher (NVC3x1.4xx and higher), the control ***must be re-calibrated after the software change***.

Versions 1.4 and later incorporate software calibration for trimming the **LOGIC** board analog inputs to a calibration standard and feature rescaled KV inputs to increase the useable KV range.

To upgrade software across the V1.4 boundary follow the directions in *section 3.3*. The new software will detect the upgrade from V1.3 and will automatically set the internal software analog calibrations and offsets to the nominal values. All customer limits and setup codes will be retained.

To gain maximum benefit from V1.4 and later, all calibrations should be done on the **INTERFACE** PCB and the calibration pots on the **LOGIC** board (if any) should be set fully clockwise. This will allow replacing **LOGIC** boards with no need for recalibration. If at this time the calibration method is being changed, recalibrate MVC III controller using the procedure outlined in *sections 11.4 - 11.8*.

If the calibration method is remaining unchanged, the following procedure will quickly restore control calibration to within 2% of previous accuracy.

- If T-R KV inputs are used, temporarily increase the KV Limit by 50% to accommodate the rescaled KV input software. *See section 9.6.*
- Restart the MVC III and stabilized it below sparking and below all T-R limits using the Conduction Angle Limit. *See section 9.11.*
- Note the **T-R Secondary KV** bushing "A" and bushing "B" readings, then use the respective adjustment pot to reduce each reading by 30%.
- Restore the KV Limit to its original setting.
- Use the Conduction Angle Limit adjustment to set stable control operation 10% below all limits and below the onset of sparking.
- Note the **T-R Primary Amps**, **T-R Primary Volts** and **T-R Secondary Amps** readings.
- Use the respective adjustment pots to adjust each of the displays upward 6%.
- Restore Conduction Angle Limit to its original setting.

3.2.2 Major Software Upgrade Features

V1.3b 10/20/95 – First program shipped.

V1.3c 1/30/96 – Corrected operational problem in Back Corona Control software algorithm. Improved SCR firing algorithm.

V1.3f 3/25/96 – Added processing for external STOP, ACK ALARM and RESTART opto inputs. Modified POS remote control (keyboard) operation.

V1.4d 10/3/96 – Provide auto choice of KW or Conduction angle for **Auxiliary Functions** display. Added automatic KV under limit calculation and trip feature. Provide capability for software A/D calibration. Rescaled KV inputs for increased range. Corrected Back Coronal Control software problem.

V1.4e 12/19/96 – First release of 14.456 mHz. Program. Added delay to Primary Current Limit trip.

V1.4g 1/21/98 – Extensively modified data link programming to provide quicker response to POS and to eliminate responses with stale data. Corrected status indication sent to POS when display was frozen.

V1.4h 5/13/98 – Revised operation of External Stop Input override all Start commands while asserted.

V1.5a 6/18/98 – Added programming to operate K3 Open Circuit Breaker relay. Modified system response to loss of Zero Cross input signal to maintain communications with POS. Made provisions for hot plugging display panel.

V2.5b. 10/14/99 – Provides data collection and data link messages for Digital Storage Scope function in POS. Requires 14.7456 mHz. Crystal and 4 mHz. Processor.

V2.7b. 2/06/01 – Added status information to message $13 so POS will know MVC limiting condition or cause of trip.

Added non-linear ramping feature.

V2.7c 6/27/02 – Changed data link time out time from 4.5 minutes to 1.0 minute.

V2.8a 1/20/03 – Added programming to support POS Start Up / Shut Down module.

Corrected sporadic occurrences of data link lockup when logic was initially powered up or processor came out of reset.

V2.9a 4/15/04 – Enable POS to start a control that had been stopped by the EXTERNAL STOP input if that input is no longer asserted.

V3.0a 12/10/04 - Added spark sensing mode 4 to provide setback without quench on first spark, and only quench if restrike on next on half cycle. Extended available IE OFF times to 62 half cycles and eliminated 4 half cycle ON time selection.

3.3 Installing A New Software Memory Chip

The MVC III microcomputer maintains error check data in its non volatile memory to verify program integrity. Any time the software program is changed (a new memory chip is installed), the new program will be detected as defective. The MVC III will halt with an error code of 1.3.1. in the **Auxiliary Functions** display. The microcomputer must be instructed to accept the new memory chip contents as valid by entering the Software Configuration Mode, pressing the **Set** key and exiting the configuration mode. *See section 8.0 steps 1-5 and 9-11*.

3.4 Software Identification

The MVC III software program is in the EPROM in socket U10 *(figure 2, item 37)* on the main **LOGIC** board. A white label on the EPROM identifies the particular version of the MVC III software installed. ***Please have the software version number available when calling Neundorfer for assistance.*** The EPROM labels are marked as follows:

`NVC 3 X 1.5 A 1`

- Program name (Neundorfer Voltage Control) — NVC
- Control generation (MVC-III) — 3
- C = communications, S = non communications — X
- Program number — 1
- Major revision number — 5
- Minor revision letter — A
- Application code: 1 = 9.8304 MHz., 19,200 baud — 1
  - 2 = 14.7456 MHz., 19,200 baud
  - 3 = 14.7456 MHz., 38,400 baud

4.0 SPECIFICATIONS

4.1 PCB Assembly & Serial Number ID

Each of the printed circuit boards in the MVC III system has an etched part number and an individually applied assembly number and serial number. Refer to *figures 2* through *5* for placement of the ID numbers on the various MVC III printed circuit boards.

Please have the main **LOGIC** ***board assembly number, serial number and software version number available when calling Neundorfer for assistance or spare parts***.

4.2 Inputs (To Interface Circuit Board)

4.2.1 Analog Input Signals Required For Operation

Grounding: ------------------------------A properly bonded earth ground is required for reliable operation of the MVC III logic system and data link network.

Logic power: ----------------------------120V AC, 10%, single phase, 60 Hz., 3/10 amp. ***If the system does not have a main line contactor and uses K3 to trip the T-R supply breaker for a run away condition, then the logic power should be from a source that will be maintained when the T-R supply breaker is opened.***

Zero Cross (ZC): -----------------------480 - 600 VAC to **INTERFACE** PCB Zero Cross circuit must be from same mains supplying the T-R set.

T-R Power source ----------------------480 - 600 VAC, 59.5 to 60.5 Hz.

Primary Voltage (PV):-----------------0 - 600 VAC RMS direct from T-R set primary connections.

Primary Current (PI): ------------------0.75 - 2.5 Amps RMS at maximum primary current. Usually supplied by an XXX : 5 current transformer where XXX is 2 to 4 times T-R primary current rating to ensure good signal fidelity. The **INTERFACE** PCB provides the C.T. burden resistor and can accommodate signals up to 5.0 Amps at maximum T-R set nameplate current. See *table 1*. **Both current transformer leads must be isolated from ground.**

! CAUTION !
Primary Current input signal above 5.0 AAC may cause failure of INTERFACE board components.

4.2.1 Analog Input Signals Required For Operation *(con't)*

Primary Current for CMR: -----------------Direct input from CMR C.T. recommended in *table 1*.
(optional) The CMR is an optional over current relay that operates independently from the MVC III logic. It is not required for operation.

T-R Pri Current Nameplate	Recommended Pri Current C.T.	C.T. Burden Resistor	Interface PCB JMPR1	C.T. for Optional CMR
0 - 75	250:5	1.0 ohm	out	250:5
76 - 150	500:5	1.0 ohm	out	250:5
151 - 188	500:5	0.5 ohm	in	250:5
189 - 225	500:5	0.5 ohm	in	500:5
189 - 225	1000:5	1.0 ohm	out	500:5
226 - 300	1000:5	1.0 ohm	out	500:5
301 - 375	1000:5	0.5 ohm	in	500:5
376 - 450	1000:5	0.5 ohm	in	1000:5
451 - 600	1200:5	0.5 ohm	in	1000:5

Table 1 - C.T.'s and burden resistors

Secondary Voltage (KV): -------------Jumper selectable KV circuit configurations can
(Optional input)
(*Requires optional circuitry*)
accommodate balanced or unbalanced feedback signals from 40 to 200 meg voltage dividers for single or dual bushing T-R sets. Although not required for operation, the KV feedback signal protects the T-R set from damage caused by secondary over voltage, and it is required to use the Back Corona Control software feature.

Secondary Current (SI): ---------------3.2 - 7.2 VDC at maximum secondary current for the selected T-R size range using the recommended secondary current sensing resistor from *table 2* in the ground leg of the T-R bridge. Maximum permitted input is 7.5 VDC.

! CAUTION !
Secondary Current input signal above 7.5 VDC may cause failure of INTERFACE board components.

4.2.1 Analog Input Signals Required For Operation *(con't)*

Max mA.	SI Sense Resistor (ohms/W)
0 - 420	20 / 25
421 - 850	10 / 25
851 - 1270	5 / 55
1271 - 1700	5 / 55
1701 - 2550	3 / 95
2251 - 3400	2 / 95

Table 2 - Secondary current sensing resistors

4.2.2 Digital Input Signals Required For Operation

Run Request: --------------------------------120 VAC or DC

External Interlock:---------------------------120 VAC or DC

Contactor closed status: --------------------120 VAC or DC

4.2.3 Optional Digital Input Signals (*requires optional circuitry*)

Reduced Power Rapping: (1) --------------120 VAC or DC

External Acknowledge Alarm: (1) --------120 VAC or DC

External Trip: --------------------------------120 VAC or DC

External Stop: -------------------------------120 VAC or DC

External Restart: ----------------------------120 VAC or DC

Data Link Network: -------------------------Half duplex RS-485 multi-drop communications network using 20 AWG or larger twisted pair shielded cable.

Note 1: Can be optionally configured to force control into remote mode

4.3 Outputs (From Interface Circuit Board)

4.3.1 Outputs Required For Operation

SCR Gate Firing: ----------------------------Dual 2 Amp pulsed DC, 8 kHz outputs, transformer isolated.

Run Enable (contactor coil power): ------120 VAC, 3 Amp rated solid state relay

4.3.2 Optional Output Signals (*requires optional circuitry*)

General Alarm (K1): ------------------------120 VAC, 10 Amp DPDT relay
(optional 3 Amp, 150 VDC)

Trip Alarm (K2): ----------------------------120 VAC, 10 Amp DPDT relay
(optional 3 Amp, 150 VDC)

Open Circuit Breaker (K3): ---------------120 VAC, 10 Amp DPDT relay
(optional 3 Amp, 150 VDC)

4.4 Table 3 - SCR Ratings

Size Code	Amps RMS @ 70° C	Amps RMS @ 40° C	1200 VAC P/N	1800 VAC P/N
4	120	160	84800-009	84800-809
4+	185	250	84800-008	84800-808
5	260	350	84800-010	84800-810
5+	320	450	84800-011	84800-811
6	440	700	84800-038	84800-838
7	735	1140	84800-020	84800-820

4.5 Logic System Temperature Rating

Storage temperature: ---------------------- -55° C to + 85° C.

Operating temperature: ------------------- -40° C to + 85° C.

5.0 INSTALLATION AND WIRING

5.1 General

The MVC III is available as:

- a complete stand alone factory wired cabinet
- a retrofit with a pre-wired backpanel to interface with the customer's existing compatible equipment
- major assembly subsystems for customer installation and wiring.

In each case, sound mechanical installation and proper grounding are essential for a successful installation.

Each component must be securely anchored to avoid any possibility of movement or damage to wiring. Cabinets, unless weatherproof design, should be protected from ingress of water, oil, dust, or any other contaminants that may be present. Placement of the MVC III in a non sealed cabinet inside an electrical control center room is acceptable if there are no airborne corrosives and dust infiltration is minimal.

To install the MVC III, refer to the following sections for the applicable type of installation. Ensure that all safety precautions are observed. Lock out all power feeds, and ground all applicable bus sections. Neundorfer, Inc. can provide complete installation services or, for customers who wish to install their own controls, we can provide any level of technical direction desired.

5.2 Grounding

5.2.1 Logic System Ground

Each control cabinet must have a ground terminal bonded to earth ground. Ground connections for the system should tie directly to this single point. It is poor practice to rely on sub panel mounting studs and other bolted structural parts for ground connections. The ground connection for the MVC III system at **INTERFACE** board connector *J8-terminal 3* must be connected directly to the cabinet grounding terminal.

5.2.2 T-R Set Ground

For proper control operation and to prevent damage to the **INTERFACE** PCB, the ground leg of the T-R bridge must be grounded through the appropriate size **SI SENSE RESISTOR** paralleled with a surge arrestor. *See section 4.2.1* for the proper resistor value.

It is preferable to place this resistor in the T-R set low voltage junction box. Some installations, however, may require placing the grounding resistor in the AVC cabinet to maintain operation of analog meters. Before installing the **SI SENSE RESISTOR**, take a precise reading of its resistance to 0.05 ohm accuracy and make a permanent record of it in the MVC III cabinet for secondary current calibration.

5.2.3 Current Sensing Transformer

It is common for the primary current sensing transformer in existing installations to be ground referenced. One of the terminals is often grounded either directly or through a connected device such as a meter. **Both terminals of the primary current sensing transformer must be isolated from ground for the MVC III to function properly.**

5.3 Secondary Current And KV Feedback Signal Wiring

The ideal installation uses a shielded twisted pair cable for each of the T-R set feedback signals to provide the cleanest possible signals. This is particularly desirable for the KV feedback signals since they originate from a high impedance source.

The generic system drawings depict the ideal wiring configuration with balanced KV feedback wiring. The balanced configuration may be necessary for waveform analysis and POS Digital Storage Oscilloscope software and may improve performance of the Back Corona Detection and Control software.

Unbalanced KV feedback wiring often requires filtering the signal at the **LOGIC** board to remove electrical noise. The loss of fidelity still allows accurate average DC KV readings, but removes signal waveform information.

We realize that in some installations it may not be practical to provide the ideal wiring. *Drawing 8-01-0196* shows four acceptable wiring methods for the KV feedback signals and tables of required **INTERFACE** and **LOGIC** board jumper settings.

Neundorfer KV Signal Feedback And Surge Suppression circuit boards (assembly number 82200-016 are supplied with each MVC III, one for each specified high voltage bushing. The circuit board is to be used in place of the standard surge suppressor or “lightning arrestor” normally located in the existing voltage divider or T-R set low voltage junction box. It mounts on the existing surge suppressor mounting block, and provides surge suppression and components to implement any of the 4 KV feedback circuits by cutting the required jumpers.

Drawing 82200-016 in section E of this manual shows the board layout and jumper configurations for the four possible feedback wiring configurations. The PCB is silk screened with Neundorfer part number 81700-220.

Part number 82200-016 boards are not required with Neundorfer voltage dividers (assembly number 84700-250) as the voltage dividers include the KV Signal Feedback And Surge Suppression circuitry. See the voltage divider documentation drawing number 84700-250A sheet 2 in section E of this manual for jumper configurations.

5.4 Complete Cabinet Or Pre-Wired Back Panel Installation

The complete cabinet and pre-wired back panel final assemblies are fully tested at the factory. For these, the user needs only to connect the main power feed, T-R power, T-R feedback signals and any additional alarm or **External Interlock** and control wiring desired. Neundorfer supplies as built system schematics, wiring diagrams, and equipment layout drawings with MVC III complete cabinet and pre-wired back panel configurations.

Drawing 8-01-0197 is a basic connection diagram identifying all connections needed for a typical installation. For detailed information on optional connections, see the **INTERFACE** board connection *drawing 8-01-0181*, generic system schematic *drawing 8-01-0196*, and connection diagram *drawing 8-01-0197*. In some cases custom as installed drawings are also supplied. Refer to the drawing lists in appendix F.

5.5 Major Assembly Subsystems Retrofit Installation

The MVC III can be purchased as major assembly subsystems for customer retrofit installation. The subsystems are:

- the **FACE PANEL** and **DISPLAY** board assembly (optional)
- the main **LOGIC** board, and
- the customer **INTERFACE** board.

All connections between the three assemblies are via Neundorfer supplied ribbon cables, greatly simplifying installation. Each ribbon cable has a different size connector to eliminate any possibility of mis-connection. Note that the **DISPLAY** ribbon cable plugs into *J3* which is the 26 pin connector nearer the edge of the **LOGIC** board.

Installation choices permit the main **LOGIC** board to be stacked on the door mounted **DISPLAY** panel or stacked on the **INTERFACE** board. The **DISPLAY** panel can be flush mounted on the cabinet door or surface mounted. In some cases, controls may be supplied without a **DISPLAY** panel.

These choices should have been made at order placement time as they affect the installation kit supplied. Contact Neundorfer if you do not have the correct *installation kit.*

Since every control is custom engineered to the particular installation, additional major components, such as SCR stack or contactor, may be supplied as part of a retrofit control.

Remove all equipment not being reused from the control cabinet. Select the mounting style and site for all supplied subsystems and using the supplied templates, *drawing 8-01-0180* prepare the required mounting holes and cutouts.

The Face Panel and Display Board

Mount the **FACE PANEL** and **DISPLAY** board assembly, if purchased, to the cabinet door in the desired location using the provided hardware. Use the provided template to make the required door cutouts according to the type of installation.

The Interface Board

Mount the **INTERFACE** board in a position central to the existing wiring and within a two foot wire run to the SCR stack. Mount all other supplied equipment except the main **LOGIC** board. Make all customer connections to the **INTERFACE** board and to any other supplied equipment.

Drawing 8-01-0197 is a basic connection diagram identifying all connections needed for a typical installation. For detailed information on optional connections, see the **INTERFACE** board connection *drawing 8-01-0181* and generic system schematic and connection diagram *drawings 8-01-0196 and 8-01-0197*. In some cases custom as built and installed drawings are supplied. Refer to the drawing list for appendix F.

The Logic Board

Finally, mount the main **LOGIC** board in the desired location and connect it to the **INTERFACE** board and **DISPLAY** board using the supplied ribbon cables. Dress and secure all cabling so that it will not be damaged by hot components or door movement.

5.6 Continuity Test

Before applying power to the completed installation, use a volt-ohmmeter to verify continuity of all connections.

6.0 OPERATOR CONTROLS

6.1 MVC III Display Panel *(figure 1)*

The MVC III **DISPLAY** panel has both dedicated and multi-function digital readouts along with 20 status indicators. The digital readouts show setpoint data when the T-R set is off and normally show real time operating values when the T-R set is energized. The status indicators blink slowly when an operating limit has been reached or remain on when exceeded or to indicate the cause of a trip. A rapidly flashing status indicator means that the corresponding digital readout is showing the setpoint limit and the limit can be adjusted using the **Up**, **Down** and **Set** keys unless locked out by the **Local / Remote** switch.

See section 9 for how to change setpoints.

The following digital readouts and status indicators are located on the MVC III **DISPLAY** panel. Refer to *figure 1* for item number identification.

Item	Description
1	**T-R Primary Amps** digital readout Displays primary T-R set operating current (or current limit) in RMS amps.
2	**T-R Primary Amps - Over Limit** Blinks slowly when Primary Current Limit has been reached or remains lit if exceeded.
3	**T-R Primary Amps - Unbalance** Lights when primary current flowing through the T-R is not equal on opposing half cycles of the line.
4	**T-R Primary Volts** digital readout Displays primary T-R set operating voltage (or voltage limits) in RMS Volts.
5	**T-R Primary Volts - Over Limit** Blinks slowly when Primary Voltage Limit has been reached or remains lit if exceeded.
6	**T-R Primary Volts - Under Limit** Lights when T-R primary or secondary voltage has dropped below the preset limit.
7	**T-R Secondary Amps** digital readout Displays secondary T-R set operating current (or current limit or reduced power rapping limit) in average DC amps.
8	**T-R Secondary Amps - Over Limit** Blinks slowly when Secondary Current Limit has been reached or remains lit if exceeded.
9	**T-R Secondary Amps - Rap Limit** Blinks slowly when Reduced Power Rapping (RPR) Secondary Current Limit has been reached or remains lit during Power Off Rapping (POR).
10	**T-R Secondary KV** digital readout Displays secondary T-R set operating voltage (or voltage limit) in average DC kilovolts.
11	**T-R Secondary KV - Over Limit** Blinks slowly when Secondary Over Voltage Limit has been reached or remains lit if voltage limit has been exceeded.

6.1 MVC III Display Panel *(figure 1) (con't)*

Item	Description

12 T-R Secondary KV - Bushing B

Illuminates when display is reading Bushing "B" or H2 kilovolts.

13 Spark Monitor digital readout

When T-R is energized, displays number of precipitator sparks occurring during the last 60 seconds. Also shows Baseline Spark Rate, Setback factor, or Spark Response Mode when these parameters are being adjusted. *See sections 9.7-9.9*.

14 Spark Monitor - Spark

Blinks when a spark has been detected. Flashes rapidly when digital readout (item 13) is showing Baseline Spark Rate setpoint.

15 Spark Monitor - Setback

Flashes when maximum Setback is reached (SCR Conduction Angle is at minimum). Blinks rapidly when digital readout (item 13) is displaying Post Spark Setback factor setpoint.

16 Spark Monitor - Mode

Blinks rapidly when digital readout (item 13) is displaying Spark Response Mode.

17 Auxiliary Functions digital readout

Displays the parameter indicated by items 18-22.

Item	Description

18 Auxiliary Functions - KW

Lights when digital readout (item 17) is displaying T-R Primary Kilowatts.

19 Auxiliary Functions - Cond. Angle

Lights steady when digital readout (item 17) is displaying SCR Conduction Angle. Blinks slowly when SCR Conduction Angle is at the setpoint limit. Blinks rapidly when digital readout (item 17) is displaying the SCR Conduction Angle setpoint limit.

20 Auxiliary Functions - Data Link

Blinks rapidly when digital readout (item 17) is displaying the unit number or address of this controller. Lights when the control is in the remote control mode and blinks briefly off to acknowledge receipt of a data link message. Indicator is off but blinks briefly on when the controller is not in the remote control mode to acknowledge receipt of a message.

21 Auxiliary Functions - Back Corona

Flashes rapidly when digital readout (item 17) is displaying the Back Corona Setup Code. A code of zero disables the Back Corona Control program, while settings of 1-4 make it progressively more sensitive. Illuminates when Back Corona software is active. Blinks slowly when the Back Corona program is limiting T-R operation below back corona onset.

6.1 MVC III Display Panel *(figure 1) (con't)*

Item **Description**

22 **Auxiliary Functions - IE**

Blinks rapidly when digital readout (item 17) is displaying the IE ratio. A setting of 0.00 disables IE while settings of X.YY enables IE with X half cycles of on time and YY half cycles of off time. To prevent T-R damage, the control will not allow setting odd number of off half cycles.

23 **T-R On**

Indicates the T-R set is energized.

24 **Alarm**

Indicates the T-R set is not energized.

25 **Internal Trip**

Indicates the T-R set has been de-energized by an internally detected uncorrectable error condition such as under voltage. The other **DISPLAY** panel status indicators will indicate the cause of the trip.

26 **External Trip**

Indicates the T-R set has been de-energized by an external trip condition. Possible causes are the **External Trip** input (*requires optional circuitry*) has been activated, loss of the **External Interlock** signal, or the optional CMR has detected an over current condition.

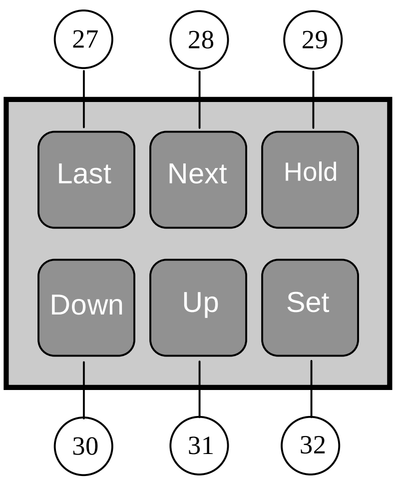
6.2 Keypad *(figure 1)*

The MVC III **DISPLAY** panel has a six position keypad to access and adjust all setpoint parameters.

The **Last** and **Next** keys act as cursor motion control keys to move through the MVC III parameters. A parameter selected for adjustment is indicated by a fast blinking indicator light and can be adjusted **Up** or **Down** with the respective key.

To lock a new setting into memory press the **Set** key. *See sections 6.4 and 9.0* for exceptions.

The Conduction Angle Limit is a special case that requires first pressing the **Set** key to change the display from the operating value to the setpoint value then pressing the **Set** key again after adjustment to lock in the new value.



Partial figure 1.
See Appendix B for complete figure 1.

Item	Description
27	**Last Key** - Permits reverse sequential selection of the parameter for display and adjustment in the various digital readouts.
28	**Next Key** - Permits forward sequential selection of the parameter for display and adjustment in the various digital readouts.
29	**Hold Key** - Updates then freezes the digital readouts and indicators but does not affect the control's operation. Press the **Hold** key again to unfreeze the **DISPLAY**.
30	**Down Key** - Decreases selected setpoint adjustment.
31	**Up Key** - Increases selected setpoint adjustment.
32	**Set Key** - Locks in the new setpoint or limit value. When the **Set** key is pressed, if the selected parameter has changed, the cursor will move to the next position to confirm entry of the new setpoint into memory.

6.3 T-R On Switch

The **T-R On** switch, shown schematically in *drawing 8-01*-0196 and 8-*01-0197*, is usually provided with the MVC III, but may be a reused customer device. It is a two position single pole switch combined with a 120 VAC pilot light. The switch contacts are wired into the contactor coil circuit to provide fail safe shut off. Closing the switch provides a Run Request to the logic system, which will energize the T-R set if all other run requirements are met. The pilot light is illuminated when the T-R set is energized. Opening the **T-R On** switch overrides the data link commands and **External Restart** commands, shutting down the T-R set.

6.4 Local / Remote Switch

Item 8 in figure 2 is the **Local / Remote** toggle switch. Placing the switch in the Local position enables the local keypad to access and change operating setpoints, but prevents a host computer from making any changes to the control's operation via the data link.

In the Remote position, the keypad is disabled, and the host computer is granted control of the MVC III setpoints and **Start / Stop / Reset** control. Opening the **T-R On** switch will override the data link commands and shut down the T-R set.

Placing the switch in the middle position allows both keypad and data link to examine the setpoints and operating data.

Optional external inputs can be configured to override the **Local / Remote** switch and force the MVC III into the remote mode. *See section 8.1*.

6.5 Reset Pushbutton Switch

Item 7 in figure 2 is the **Reset** pushbutton switch. Pressing this button initiates a power up restart sequence for the microcomputer. The T-R set will be shut off if it is energized. This switch is normally used only to enter The Software Configuration Mode. *See sections 7 and 8*.

7.0 MVC III MODES

With logic power applied the MVC III can be in one of four possible modes or conditions:

- **SOFTWARE CONFIGURATION**
- **STANDBY**
- **TRIPPED**
- **OPERATING**

Software Configuration Mode is a special mode that can be entered only by operator intervention when power is first applied or when releasing the **Reset** pushbutton on the MVC III **LOGIC** board. It is used to select certain software options, configure several inputs to the system and adjust T-R size and Spark Detection Sensitivity. *See section 8.0* for software configuration information.

Standby Mode is the normal mode when the T-R set is not energized and the control is not tripped. The indicator light in the **T-R On** switch will be off, the **T-R On** front panel indicator will be off, and the **Alarm** front panel indicator will be on.

Tripped condition results from an out of limit condition that the MVC III cannot correct or from external inputs. When a trip occurs, the entire **DISPLAY** is frozen at the moment of the trip, the **T-R On** front panel indicator turns off, the **Alarm** front panel indicator turns on and the appropriate **Internal** or **External Trip** LED is illuminated.

The **DISPLAY** can be unfrozen by pressing the **Hold** key. Opening the **T-R On** switch will change the control mode back to Standby Mode. This can also be done using the optional **External Restart**, **Stop**, or **ACK Alarm** contact inputs (*requires optional circuitry*) or via data link commands (*requires optional circuitry and software*).

With the MVC III in the Operating or Run modes the T-R set is energized and the MVC III is monitoring and controlling power delivery to the T-R set and the bus section. The front panel **T-R On** switch must be closed and the **External Interlock** input closed to enter the Run Mode. Once in the Run Mode, the MVC III can be stopped, reset from trips and started using the **External Restart**, **Stop**, or **ACK Alarm** contact inputs or via data link commands. Opening the front panel **T-R On** switch or opening the **Interlock** input will always override the **External Restart** contact input and data link commands.

8.0 SOFTWARE CONFIGURATION

The MVC III feature user configurable software options to customize the MVC III to the particular installation. These settings are made at the time of installation and are not usually changed again. They have been made less accessible than the operator set point adjustments. When possible, the controls are shipped with these parameters pre-configured. The configurable parameters are: T-R size, Spark Detection Sensitivity, and Software Options Code, which includes several configurable inputs to the logic system. When logic power is applied to the MVC III, the **DISPLAY** panel is cleared, and then the configuration codes are presented in the four readouts listed in *table 4* before the display test. The other two readouts will be blank.

Readout	Parameter	Values
T-R Pri. Amps	T-R Pri. Size	0 - 5
T-R Sec. Amps	T-R Sec. Size	0 - 5
Spark Monitor	Spark Sensitivity	0 - 100
Aux. Functions	Software Options	0 - 255

Table 4 - Configuration mode parameters

Changing any of these values requires entering the Software Configuration Mode with the control off line, which can only be done when logic power is applied to the MVC III or when releasing the **Reset** pushbutton on the MVC III **LOGIC** board.

To change the software configuration or options:

1. Stop the MVC III by opening the front panel **T-R On** switch.
2. Set the **Local / Remote** toggle switch on the **LOGIC** board to the Local position.
3. Remove 120 VAC logic power (or press and hold the **Reset** pushbutton on the MVC III **LOGIC** board).
4. Press and hold the **Set** and **Up** keys while reapplying logic power (or releasing the **Reset** pushbutton). Continue holding the **Set** and **Up** keys for 2 seconds until the **DISPLAY** clears.
5. Release the **Set** and **Up** keys.
6. The Software Options Code will appear in the **Auxiliary Functions** display and all other displays will be blanked.
7. Use the **Next** and **Last** keys to select the desired parameter which will appear in its assigned display.
8. Use the **Up** or **Down** keys to change the selected parameter to the desired value.
9. When settings are satisfactory, enter new configuration codes into memory by pressing the **Set** key which saves all four parameters.
10. Cycle logic power to control or press and release the **Reset** pushbutton. The new configuration settings will be presented in the **DISPLAY** at the start of the Power On Display Test.
11. Return the **Local / Remote** toggle switch to its original position.

8.1 Selecting Software Options

Enter the Software Configuration Mode with the control off line as explained in *section 8.0*. Use the **Next** and **Last** keys to display the Software Options Code in the **Auxiliary Functions** digital readout. Use the **Up** or **Down** keys to change the Software Options Code to the desired value. Press the **Set** key to save the new code.

The Software Options Code is the sum of the values for each of the enabled software options.

Note that the communications software is factory installed and cannot be user enabled or disabled. The displayed configuration code will, however, reflect the absence or presence of the communications software.

For some of the software options, the zero value may select an alternate option designated as the "else" option.

Some of the software options require optional circuitry. The software options are encoded as follows:

VALUE	SOFTWARE OPTION
128 =	Communications software installed.
64 =	Enable AUTO RESTART after power failure with control on. *See section 10.1.*
32 =	Signal on **External Trip** input trips control & lights **External Trip** LED, else
0 =	No signal on **External Trip** input trips control & lights **External Trip** LED.
16 =	**External ACK Alarm** input clears alarm indicators and resets TRIP ALARM RELAY else
0 =	**External ACK Alarm** input overrides **Local / Remote** toggle switch and forces remote operation.
8 =	**RPR** input invokes Reduced Power Rapping limit, else
0 =	**RPR** input overrides **Local / Remote** toggle switch and forces remote operation.
4 =	Deactivating **External Stop** input turns off control
0 =	Activating **External Stop** input turns off control
2 =	Bushing "B" input enabled (Will cause under voltage trip if enabled without KV-b feedback signal)
1 =	Bushing "A" input enabled (Will cause under voltage trip if enabled without KV-a feedback signal)

Table 5 - Software Options coding

8.2 Setting T-R Primary Size

Enter the Software Configuration Mode with the control off line as explained in *section 8.0*.

Use the **Next** or **Last** keys to display the T-R Primary Size Code in the **T-R PRIMARY AMPS** digital readout.

Use the **Up** or **Down** keys to change the T-R Primary Size Code to the desired value.

Press the **Set** key to save the new value. Use the lowest setting from *table 6* that includes the nameplate Primary Current Limit of the T-R set.

! CAUTION !

Changing this setting affects control calibration and Primary Current Limit setting.

Always reset the Primary Current Limit and re-calibrate the primary current digital readout after any change to this setting.

T-R Nameplate Primary Current	Primary Size Setting
0 - 75 Amps	0
76 - 150 Amps	1
151 - 225 Amps	2
226 - 300 Amps	3
301 - 450 Amps	4
451 - 600 Amps	5

Table 6 - T-R Primary Size coding

8.3 Setting T-R Secondary Size

Enter the Software Configuration Mode with the control off line as explained in *section 8.0*.

Use the **Next** or **Last** keys to display the T-R Secondary Size Code in the **T-R Secondary Amps** digital readout.

Use the **Up** or **Down** keys to change the T-R Secondary Size Code to the desired value.

Press the **Set** key to save the new value. Use the lowest setting from *table 7* that includes the nameplate Secondary Current Limit of the T-R set.

! CAUTION !

Changing this setting affects control calibration and Secondary Current and RPR Limit settings.

Always reset the Secondary Current Limit, RPR Limit and re-calibrate the secondary current digital readout after any change to this setting.

T-R Nameplate Secondary Current	Secondary Size Setting
0 - 420 mA	0
421 - 850 mA	1
851 - 1270 mA	2
1271 - 1700 mA	3
1701 - 2550 mA	4
2551 - 3400 mA	5

Table 7 - T-R Secondary Size coding

8.4 Setting Spark Detection Sensitivity

Enter the Software Configuration Mode with the control off line as explained in *section 8.0*.

Use the **Next** or **Last** keys to display the Spark Detection Sensitivity code in the **Spark Monitor** digital readout.

Use the **Up** or **Down** keys to change the Spark Detection Sensitivity code to the desired value.

Press the **Set** key to save the new value.

The Spark Detection Sensitivity adjusts the secondary current based spark sensing only. It has no effect on the spark sensing derived from the T-R primary feedback signals. It has a range of 0 to 100. A setting of 0 disables secondary current spark sensing, while 100 is the most sensitive setting. The spark sensing algorithm is self adaptive to changing precipitator conditions.

The Spark Sensitivity is factory set to 50 and should never be changed. It is provided only as a trouble shooting tool for service personnel.

9.0 ADJUSTING LIMITS AND SETPOINTS

BEFORE setting any limits, the proper Primary and Secondary T-R Size Codes must be set. If these settings are not correct, the primary and secondary current readings may be incorrect and cannot be properly calibrated. *See sections 8.2 and 8.3* for the correct settings and procedure.

When the MVC III is in the Standby Mode *(see section 7)* the principle adjustable limits and setpoints are displayed: Primary Current, Primary Under Voltage, Secondary Current, Secondary Voltage and Baseline Spark Rate. The auxiliary setpoints and limits can be accessed using the keypad. All limits and setpoints may be adjusted while in the Standby Mode or Operating Mode.

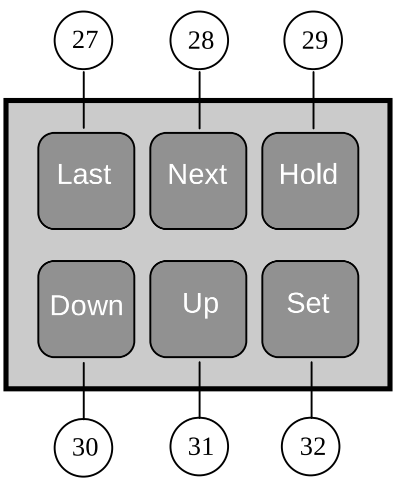
Access to the setpoint adjustments is controlled by the **Local / Remote** toggle switch S2 *(figure 2, item 8)* on the back of the LOGIC PCB. When the switch is in the Remote position, the limits and operating setpoints for the MVC III are accessible only via data link commands. The local keypad is inoperative.

When the selector switch is in the middle position, all setpoint values can be accessed and certain ones can be temporarily changed from the front panel keypad. No new values can be written into nonvolatile memory and any temporary values will automatically revert back to their normal settings after ***five minutes*** without keypad activity.

9.0 ADJUSTING LIMITS AND SETPOINTS *(con't)*

With the selector switch in the Local position, the limits and operating setpoints for the MVC III are entered and set using the front panel keypad at the bottom right area of the facepanel.

The six keys control the travel of a cursor around the facepanel and the adjustment of the operating limits and setpoints. They are the **Last** key, the **Next** key, the **Hold** key, the **Down** key, the **Up** key, and the **Set** key *(figure 1, items 27 - 32).*



Partial figure 1. See Appendix B for complete figure 1.

The **Last** and **Next** keys move the cursor *(readout parameter indicator)* sequentially through the displayable parameters and setpoints associated with each digital readout. The top five digital readouts each display one real time monitored parameter and provide setting of one or more operational limits or setpoints. A rapidly blinking LED indicates that the displayed number is the setpoint, not the real time monitored value and the setpoint can be adjusted using the **Down** or **Up** keys.

After adjusting the value, enter it into non volatile memory by pushing the **Set** key. If the value has changed, the cursor will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

Moving into or out of the **Auxiliary Functions** readout without saving a changed parameter will revert back to the original value.

The **Auxiliary Functions** readout can display two real time operating values; T-R Primary KW consumption and SCR Conduction Angle. The **Last** and **Next** keys will select the desired parameter for the readout. KW has no associated setpoint, but the SCR Conduction Angle does. To display the SCR Conduction Angle Limit setpoint, first select the SCR Conduction Angle display using the **Last** or **Next** keys, then press the **Set** key. This will change the display to the Conduction Angle Limit setpoint.

Remember that a new limit may only be entered if a fast flashing LED is present in the indicator for the limit to be set. See the following sections for details of setting the various parameters.

A limit or parameter can be changed to a temporary setting during normal operation. Select and change the parameter as desired, but do not push the **Set** key after using the **Up** or **Down** keys. Do not use the **Next** or **Last** keys or the temporary setting will revert back to the original value. Temporary settings not locked in with the **Set** key will time out in *five minutes* and revert to the original limits.

The following sections are listed in the automatic access order resulting from using the **Next** key to access Primary Current Limit.

9.1 Primary Current Limit

Push the **Next** or **Last** key until the **T-R Primary Amps Over Limit** indicator *(figure 1, item 2)* flashes rapidly. This indicates that the displayed value is the setpoint limit and the limit may be adjusted.

Using the **Up** or **Down** keys, set the displayed limit to the T-R nameplate primary current rating for the connected T-R primary tap. When the correct value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

NOTE: Set Primary Current Limit to 50% of T-R nameplate for initial calibration.

If the current reaches the T-R Primary Current Limit during operation, the **T-R Primary Amps Over Limit** indicator will flash about once per second indicating that the current limit has been reached but not exceeded. If the limit is exceeded and cannot be corrected by the MVC III, the control will trip off and the **T-R Primary Amps Over Limit** indicator will remain on.

9.2 Primary Over Voltage Limit

Push the **Next** or **Last** key until the **T-R Primary Volts Over Limit** indicator *(figure 1, item 5)* flashes rapidly indicating that the displayed value is the setpoint limit and it may be adjusted. Using the **Up** or **Down** keys, set the displayed limit to the T-R nameplate primary voltage rating for the connected T-R primary tap. When the correct value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

If the primary voltage reaches the Over Voltage Limit during operation, the **Over Limit** indicator will flash about once per second indicating that the limit has been reached but not exceeded. If the limit is exceeded and cannot be corrected, the control will trip off and the **T-R Primary Volts Over Limit** indicator will remain on.

9.3 Under Voltage Limit

During an arcing or a shorted condition in the precipitator, the current rises and the voltage decreases in both the T-R set primary and the precipitator. A timed under voltage trip function prevents a shorted condition from causing T-R set or precipitator damage. Anytime the voltage falls below the primary or secondary setpoint values during operation, the **Under Limit** indicator will light. If any of the monitored voltages remain at or below the setpoint level for more than 30 seconds, the control will trip off and the **T-R Primary Volts Under Limit** indicator will remain on.

To adjust the T-R under voltage limits, push the **Next** or **Last** key until the **T-R Primary Volts Under Limit** indicator *(figure 1, item 6)* flashes rapidly indicating that the displayed value is the setpoint limit and that it may be adjusted. Using the **Up** or **Down** keys, set the displayed limit to the desired under voltage trip point, usually in the range of 80 Volts to 120 Volts. When the desired value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

Adjusting the **T-R Primary Volts Under Limit** automatically calculates and sets the equivalent Secondary Under Voltage Limit based on the entered T-R set nameplate data. The Secondary Under Voltage Limit will be approximately 100 times the Primary Under Voltage Limit for a typical T-R set. The Secondary Under Voltage Limit will be applied only to the T-R bushings enabled for KV monitoring. *See section 8.1*.

The formula for calculated **T-R KV Under Voltage Limit** is:

$$KV\ Under\ Limit = \frac{PV\ Under\ Limit}{PV\ Over\ Limit} \times KV\ Over\ Limit$$

9.4 Secondary Current Limit

Push the **Next** or **Last** key until the **T-R Secondary Amps Over Limit** indicator *(figure 1, item 8)* flashes rapidly, indicating that the displayed value is the setpoint limit and the limit may be adjusted. Using the **Up** or **Down** keys, set the displayed limit to the T-R nameplate secondary current rating. For T-R sets with secondary current ratings that vary with the connected T-R primary tap, use the highest listed secondary current. If the nameplate value is given in milliamps (mA.), divide by 1000 to convert to Amps. When the correct value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

NOTE: Set Secondary Current Limit to 50% of T-R nameplate for initial calibration.

If the secondary current reaches the setpoint value during operation, the **Secondary Amps Over Limit** indicator will flash indicating that the maximum limit has been reached but not exceeded. If the limit is exceeded for *7-1/2 seconds*, the control will trip off and the **Over Limit** indicator will remain on.

9.5 Rap Limit

In some cases reducing or turning off precipitator power enhances rapping efficiency. The RAP LIMIT is an auxiliary T-R Secondary Current Limit used to implement Reduced Power Rapping or Power Off Rapping (RPR / POR). The RAP LIMIT can be activated by a 120V AC or DC input or contact closure (*requires optional input circuitry*) from a rapper control or via data link commands from a Neundorfer MicroRap rapper control or POS. When the MVC III receives an RPR command, it will reduce the secondary current to the RAP LIMIT setpoint. If the RAP LIMIT is set to zero, primary power will be removed from the T-R set during the POR interval. Low T-R voltage during an RPR interval will not cause an under voltage trip.

To adjust the RAP LIMIT, push the **Next** or **Last** key until the **T-R Secondary Amps Rap Limit** indicator *(figure 1, item 9)* flashes rapidly indicating that the displayed value is the setpoint and that it may be adjusted. Using the **Up** or **Down** keys, set the displayed limit to the desired RPR value. When the desired value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

If the secondary current reaches the RAP LIMIT setpoint value during RPR operation, the **Secondary Amps Rap Limit** indicator will flash indicating that the RPR setpoint is limiting T-R set secondary current. During POR, the indicator remains on.

9.6 Secondary Over Voltage Limit

Push the **Next** or **Last** key until the **T-R Secondary KV Over Limit** indicator *(figure 1, item 11)* flashes rapidly, indicating that the displayed value is the setpoint limit and it may be adjusted. Using the **Up** or **Down** keys, set the displayed limit to the T-R nameplate secondary kilovolt rating. For T-R sets with secondary kilovolt ratings that vary with the connected T-R primary tap, use the highest listed secondary kilovolts. If the nameplate value is given in volts, divide by 1000 to convert to kilovolts (KV). When the correct value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will move to the next parameter to acknowledge the new value has been saved. The entered limit is used for both bushings of a dual bushing T-R set.

If the secondary voltage reaches the setpoint value during operation, the **T-R Secondary KV Over Limit** indicator will flash about *once per second* indicating that the limit has been reached but not exceeded. If the limit is exceeded and cannot be corrected by the MVC III, the control will trip off and the **T-R Secondary KV Over Limit** indicator will remain on.

9.7 Baseline Spark Rate

The MVC III uses the Baseline Spark Rate as the value it will strive to maintain during stable precipitator conditions. A higher or lower spark rate may occur, however, depending on precipitator operating conditions. If a T-R nameplate limit, Conduction Angle Limit, Back Corona Control limit, or RPR is reached below the spark threshold of the precipitator, the spark rate will fall below the setpoint. When the MVC III detects unstable precipitator conditions, the proprietary adaptive control algorithms will increase the spark rate to maintain optimum precipitator power input.

Push the **Next** or **Last** key until the **Spark Monitor Spark** indicator *(figure 1, item 14)* flashes rapidly, indicating that the displayed value is the sparks per minute baseline rate and that it may be adjusted. Using the **Up** or **Down** keys, set the displayed setpoint to the desired value. When the desired value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

Pressing the **Set** key without changing the Spark Rate generates a spark simulation, causing the MVC III to execute its normal spark response algorithm.

NOTE: If Intermittent Energization (IE) is enabled, the Baseline Spark Rate cannot be set above 60 sparks per minute. To set higher Spark Rates, set the IE ratio to 0.00. See section 9.14.

9.8 Setback

After a spark the T-R primary power is briefly interrupted to quench the spark and prevent arcing. Then the power is fast ramped back to a level reduced by the Setback factor below the power level at which the spark occurred.

The Setback factor is a self adaptive control parameter. Our experience has shown that to achieve stable operation free from restrikes, a larger setback percentage is required at lower power levels than at higher power levels. The Setback factor entered is a target percentage value to be used as the T-R set approaches Primary Current Limit. The MVC III will automatically increase the setback percentage according to its algorithm at lower power levels.

Push the **Next** or **Last** key until the **Spark Monitor Setback** indicator *(figure 1, item 15)* flashes rapidly, indicating that the displayed value is the Post Spark Setback factor and that it may be adjusted. Using the **Up** or **Down** keys, set the displayed setpoint to the desired value. When the correct value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter to acknowledge the new value has been saved.

The available Setback settings are 1%, 2%, 5%, 10%, 15%, and 20%. Inlet fields and fields that spark excessively need a higher Setback to maintain stable operation, typically 10% to 20%. Outlet fields and fields with stable spark over voltage typically use a lower Setback in the 1% to 5% range.

9.9 Spark Response Mode

The MVC III provides a choice of three different Spark Response Modes. *Figure 7* shows typical response patterns for each mode.

MODE 1 - The MVC III quenches every spark, counts one spark; fast ramps to the Setback level, and slow ramps back to the next spark.

MODE 2 - The control ignores the first spark. If a second spark occurs during the next one-half cycle of **SCR conduction**, the MVC III quenches the spark, counts one spark, fast ramps to the Setback level, and slow ramps back to the next spark.

! CAUTION !
Do not use Mode 2 with a dual bushing T-R set operating in double half wave.

MODE 3 - The control only takes corrective action if sparks occur on three consecutive half cycles of **SCR conduction**. Then the MVC III quenches the spark, counts one spark, fast ramps to the Setback level, and slow ramps back to the next spark.

! CAUTION !
Do not use Mode 3 with a dual bushing T-R set operating in double half wave.

Mode 1 is used on precipitators which produce high intensity sparks. **Mode 2** would be used if spit sparking was occurring with some high intensity sparks. **Mode 3** is used in the case of very low intensity sparking. A storage oscilloscope should be connected to secondary current to monitor the intensity of the sparks and determine which mode should be used.

Push the **Next** or **Last** key until the **Spark Monitor Mode** indicator *(figure 1, item 16)* flashes rapidly, indicating that the displayed value is the Spark Response Mode and that it may be adjusted. Using the **Up** or **Down** keys, select the desired mode. When the desired value is displayed, press the **Set** key to save the new value in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

9.10 Kilowatts

Push the **Next** or **Last** key until the **KW** indicator *(figure 1, item 18)* is illuminated indicating that the displayed value in the **Auxiliary Functions** digital readout is the T-R set primary kilowatt power consumption. The displayed value excludes power losses in the CLR, SCR stack and peripheral circuitry. It is a read only value and has no associated setpoint.

The indicated value is true Kilowatts calculated from the T-R set feedback signals, not simply the KVA product. For any AC load, other than a purely resistive load, there is a phase angle difference between the current and voltage in the circuit. As a result, the power in the load (Watts) will always be less then the Volt-Ampere product for the load.

For a load energized by a sine wave power source:

$$KW = \frac{Volts \times Amps}{1000} \times \cos \varnothing$$

$$\text{Power Factor} = \frac{Watts}{Volts \times Amps} = \cos \varnothing$$

Where: ∅ = the phase angle in degrees between the voltage and current.

9.11 Conduction Angle

This feature allows monitoring the SCR Conduction Angle and setting an upper limit for the Conduction Angle. It may be used as a manual control during control setup and calibration and for taking V-I curve data. In installations where T-R sets and CLR's are not ideally matched, the Conduction Angle Limit is used to prevent saturation of the magnetic components.

Push the **Next** or **Last** key until the **Cond. Angle** indicator *(figure 1, item 19)* is illuminated indicating that the displayed value in the **Auxiliary Functions** digital readout is the SCR Conduction Angle. When the T-R is energized, a reading from 20 to 170, representing minimum to full power, will be displayed. To adjust the upper limit setpoint or place the MVC III in manual control, push the **Set** key. The **Cond. Angle** LED will flash rapidly, indicating that the displayed value is the Conduction Angle setpoint and that it may be adjusted. Using the **Up** or **Down** keys, select the desired Conduction Angle. If the new value is to be saved in non volatile memory as an operating limit, again press the **Set** key. If the value has changed, the flashing LED will move to the next parameter in the direction last moved, acknowledging the new value has been saved.

The Conduction Angle Limit is an upper limit only. It cannot be used to force MVC III operation above the other limits or the sparking level. The **Cond. Angle** indicator will flash about *once per second* when the conduction angle reaches the setpoint.

9.12 Data Link Unit Number

The Data Link Unit Number assigns a *unique* address or unit number to each MVC III in a data communications network. A computer system such as the Neundorfer POS or a DCS uses the Data Link Unit Number to access each controller on a party line communications network. Unit numbers must be assigned sequentially starting with number one, and there can be no missing numbers. The order of assignment must be coordinated with the POS or DCS definitions of unit assignments for proper communications and display results. The unit number assignment is also used to stagger the automatic restart of MVC III's after a power failure. *See section 11.1*.

To adjust the Data Link Unit Number, push the **Next** or **Last** key until the **Auxiliary Functions Data Link** indicator *(figure 1, item 20)* flashes rapidly indicating that the displayed value is the Data Link Unit Number and that it may be adjusted. Using the **Up** or **Down** keys, select the desired unit number. When the desired number is displayed, press the **Set** key to save the new number in non volatile memory. If the value has changed, the flashing LED will automatically move to the next parameter in the direction last moved to acknowledge the new value has been saved.

The **Data Link** indicator also indicates activity on the data link and the Local / Remote status of the MVC III. When the **Local / Remote** switch *(figure 2, item 8)* is in either the center or Local positions, the **Data Link** indicator is normally off. When the MVC III responds to a data link message directed to its own unit number, it briefly blinks the **Data Link** indicator on as an indication of having received a message. When the **Local / Remote** switch is in the Remote position, the operation of the indicator is reversed. It will be steady on to indicate remote mode, and will blink off briefly when sending a message.

9.13 Back Corona Software

Preventing back corona can improve precipitator collection efficiency. The MVC III has a user adjustable Back Corona Detection and Control algorithm. When enabled, the algorithm will periodically check the bus section for the presence of back corona, and if found will limit secondary current just below the onset of back corona. The Back Corona software can only be enabled when Intermittent Energization is disabled. *See the following section.*

NOTE: The MVC III must have secondary KV feedback for operation of the Back Corona software. Enabling the Back Corona software without KV feedback will have no effect on system operation.

When the Back Corona software is enabled, the **Back Corona** indicator *(figure 1, item 21)* is illuminated. At periodic intervals, the program reduces T-R set operating level until there is a 25% drop in secondary current and a 3 KV drop in secondary voltage. Then, while power is slowly ramped back up, voltage and current data are collected and analyzed for the presence of back corona. If back corona is found, secondary current is limited to the knee of the V-I curve and the **Back Corona** indicator light blinks slowly to indicate Back Corona limited operation. If back corona is not detected, the status indicator remains on steady to indicate that the Back Corona software is enabled. In either case, the software periodically makes a brief power level reduction and does a new V-I curve segment to retest for back corona.

The sensitivity of the Back Corona detection program can be adjusted by setting a value of 1 to 4 for the Back Corona Adjustment Factor. This determines how steep the V-I curve must be to detect back corona. Each step in the adjustment doubles the sensitivity of the program, that is reduces the required steepness of the curve at which back corona is determined to be present.

Setting the Back Corona Adjustment Factor to zero disables the Back Corona program.

To enable, disable or adjust the Back Corona software, push the **Next** or **Last** key until the **Auxiliary Functions Back Corona** indicator *(figure 1, item 21)* flashes rapidly indicating that the displayed value is the Back Corona Control Code and that it may be adjusted. If the **Auxiliary Functions** readout shows "- - -", IE is enabled, locking out the Back Corona program. *Refer to section 9.14* to resolve.

Using the **Up** or **Down** keys, select the desired Back Corona software control setting and press the **Set** key to save the new number in non volatile memory. If the value has changed, the flashing LED will move to the next parameter to acknowledge the new value has been saved.

9.14 IE Ratio Settings

IE refers to **Intermittent Energization**, a T-R energization process that rapidly cycles power on and off to the T-R set. IE can reduce power consumption and may prevent back corona which will increase collection efficiency. The IE program controls power flow to the T-R set in half cycle of the line increments, repeating the selected ON and OFF periods.

Power can be applied in 1, 2, 3, or 4 half cycles of the line increments. The power OFF time can only be selected as 2, 4, 6, 8, 10, 12, or 14 half cycles of the line to prevent net DC in the T-R set primary. For an example setting of 2.06, the digit to the left of the decimal (2) refers to the number of ON half cycles. The two digits to the right of the decimal point (06) represent the number of OFF half cycles.

9.14 IE Ratio Settings *(con't)*

Operating experience will help achieve the optimum setting. Setting the IE ratio to 0.00 disables the IE feature. To activate IE, the Spark Rate must be at or below 60 SPM and the Back Corona software must be disabled. *See sections 9.7 and 9.13*.

To enable, disable or adjust the IE software, push the **Next** or **Last** key until the **Auxiliary Functions IE** indicator *(figure 1, item 22)* flashes rapidly indicating that the displayed value is the Intermittent Energization control code and that it may be adjusted. If the **Auxiliary Functions** readout shows "- - -", either the Baseline Spark Rate is above 60 SPM or the Back Corona software is enabled, locking out the IE feature. *Refer to section 9.7 and 9.13* to resolve.

Using the **Up** or **Down** keys, select the desired IE ratio. When the desired setting is displayed, press the **Set** key to save the new number in non volatile memory. If the value has changed, the flashing LED will move to the next parameter to acknowledge the new value has been saved.

9.14.1 T-R Operating Limits With IE

The safe operating limits established by the T-R set nameplate are determined by temperature rise, safe rectifier current and voltage, and magnetic saturation limits. When IE is in operation, the MVC III will strictly adhere to these limits during ***any actual conduction period***. There is no need to make any other adjustments to accommodate IE. Because the front panel displays represent a time averaged value, it is normal to see status indicators showing operation at a limit while the readout value is significantly below the limit.

! CAUTION !
Do not re-adjust the limits to achieve rated nameplate operating values during IE operation. **Do not attempt to calibrate the MVC III with IE operating.**

10.0 ADDITIONAL FEATURES

10.1 Operation of Auto Restart

The MVC III has a user configurable option *(see section 8.1)* that, when enabled, provides automatic restart of the MVC III upon power restoration if the control was running when power failed and if the **T-R On** switch is closed when power is restored. The auto restart features an abbreviated display test and rapid ramp rate to quickly restore precipitator power. Startup of controls is staggered by unit number, so it is important to set the MVC III unit numbers sequentially.

The following table shows results at power on assuming all external permissives are present.

Control status at power down	Status of T-R On switch when power is restored	AUTO RESTART option	Control status after diagnostic self test concludes
STOPPED	OFF Position	Disabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby mode & ready to run.
RUNNING	OFF Position	Disabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby mode & ready to run.
STOPPED	ON Position	Disabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby. **T-R On** switch must be cycled off then on to start control.
RUNNING	ON Position	Disabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby. **T-R On** switch must be cycled off then on to start control.
STOPPED	OFF Position	Enabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby & ready to run.
RUNNING	OFF Position	Enabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby & ready to run.
STOPPED	ON Position	Enabled	**Trip** LED's and relay are off, **T-R On** LED is off, **Alarm** LED is on and ALARM RELAY is set. Control in standby. **T-R On** switch must be cycled off then on to start control.
RUNNING	ON Position	Enabled	**Trip** LED's and relay are off, **Alarm** LED and relay are clear, **T-R On** LED is on. Control automatically resumes operation.

Table 8 - Auto Restart operation

10.2 Display Hold Feature

During normal operation the MVC III facepanel displays the real time T-R operating values. If the MVC III trips off because it is unable to regulate to a limit or due to an **External Trip** input signal, the **DISPLAY** will freeze to show the values present at the time of the trip. One or more status LED indicators will be illuminated showing the reason for the trip. After noting the cause of the trip, the system can be reset by opening the **T-R On** switch, by activating the optional **External Stop** or **ACK Alarm** inputs (*requires optional circuitry*), or via data link commands (*requires optional circuitry and software*). Resetting the MVC III changes the **DISPLAY** back to the static display of the setpoint values. The **DISPLAY** will not freeze if the control trips off due to power interruption.

While the control is running, it may be difficult to take accurate readings from the digital readouts. Pressing the **Hold** key will freeze the displays at their current values. This will have no effect on control operation. Pressing the **Hold** key again will unfreeze the **DISPLAY**.

10.3 Dual Bushing Kilovolt Metering

For MVC III controls specified for dual bushing KV operation, the keypad **Up** and **Down** keys are used to select the desired bushing for display in the **T-R Secondary KV** readout. With the control running and no status indicators fast blinking, that is, no limits are available for adjustment, pressing the **Up** key selects bushing “B” and pressing the **Down** key selects bushing “A”. The **Bushing B** indicator illuminates when bushing “B” KV is displayed. Regardless of which bushing is displayed, operation of the T-R is regulated to keep both bushings within the set KV upper limit, and both are monitored for under voltage.

10.4 Auxiliary Functions Display Default Parameter

The **Auxiliary Functions** readout can display two real time operating values, KW and Conduction Angle. If either one of these parameters is displayed in the **Auxiliary Functions** digital readout when the MVC III is stopped, that parameter will become the new display default parameter. The default is used on startup or any time the keypad times out. The new default will be used until changed again.

10.5 Auto Spark Quench Interval

The MVC III automatically adjusts the quench time needed to extinguish sparking and prevent restrikes. It normally maintains a minimum quench time of two half cycles (16.7 msec). This maximizes power levels, improving collection efficiency. When restrikes are detected the MVC III will extend the quench time to 4, 6 or 8 half-cycles as needed. When normal sparking occurs without restrikes it will reduce the quench time back toward the two half cycle minimum.

10.6 RS-485 Communications

The MVC III's can communicate via an RS-485 multi-drop, serial communications network with a POS computer, DCS or other host computer system. Up to 238 voltage controls can be connected together in a network, using RS-485 repeaters.

Each RS-485 repeater can power the data line for at least 32 individual voltage controls. The computer RS-485 port card or converter box can also power at least 32 devices. Any combination can be used as long as the total number of voltage controls does not exceed 238 and no RS-485 device is directly connected to more than 32 devices.

For example: if there are two precipitators with 24 voltage controls on Unit #1 and 12 voltage controls on Unit #2 two repeaters would typically be used. The first repeater would have the 24 controls from Unit #1 wired to it with a twisted pair shielded cable. The second repeater would have the 12 controls from Unit #2 wired to it with another twisted pair shielded cable. A third twisted pair shielded cable would connect the two repeaters together and connect directly to the host computer RS-485 port card or converter box. *Drawing 8-01-0178* shows a typical data link network.

The physical ends of each data link cable must be terminated for reliable data link operation. Refer to the Neundorfer or other equipment user manual for the devices at the physical ends of the data link cable for the termination method. *Section 11.1* and *figure 6* of this manual provides information for setting the MVC III data link termination jumpers.

If the terminating device is powered down, its active termination circuitry will be inoperative. A powered down terminating device should be removed from the data link. To ensure reliable data link communications, the data link cable should be terminated by the last powered device at the physical ends of the data link cable.

10.7 Data Link Start / Stop / Reset (ACK Alarm) (*requires optional circuitry and software)*

Once running, the MVC III can be stopped, reset from trips (alarm acknowledge) and started via data link commands. Opening the front panel **T-R On** switch or opening the **External Interlock** input will always override the data link commands and stop the MVC III. These commands are standard functions of the Neundorfer POS or can be issued by a properly programmed host computer. To use the data link commands, the **Local / Remote** switch *(section 6.4)* must be in the Remote position and the MVC III **T-R On** switch *(section 6.3)* must be closed.

Following is the result of each command:

Command	MVC III condition	Result
Start	On Off Tripped	----- Start -----
Stop	On Off Tripped	Stop ----- Reset
Reset	On Off Tripped	----- ----- Reset

Table 9 - Data link control operation

10.8 External Restart, Stop, ACK Alarm (*requires optional circuitry*)

Once running, the MVC III can be stopped, reset from trips (alarm acknowledge) and started using the optional **External Restart**, **Stop**, or **ACK Alarm** contact inputs. The action takes place on the transition of the input, so these inputs may be operated with momentary or maintained contacts. The **Restart** and **ACK Alarm** functions take place on the off to on (open to close) transition of the inputs, while the **External Stop** input can be configured to operate on either the closing or opening transition. Refer to *section 8.1* for configuring the **External Stop** input.

Refer to *drawing 8-01-0181* for connection to these inputs. Opening the front panel **T-R On** switch, opening the **External Interlock** input, or asserting the **External Stop** input will always override all other inputs and stop the MVC III. To use the **External inputs**, the **T-R On** switch *(section 6.3)* must be closed.

With these inputs, controls can be started or stopped in groups using a single momentary or maintained switch for each function. The **Restart** input combines the function of RESET and START into one input.

Following is the result of asserting each input:

Input	MVC III condition	Result
Restart	On Off Tripped	----- Start Reset then Start
Stop	On Off Tripped	Stop ----- Reset
Ack Alarm	On Off Tripped	----- ----- Reset

Table 10 - External control input operation

10.9 Alarm Relays

There are three possible Alarm Relays available for the MVC III, each with a different function and purpose.

The controls are normally shipped with only K2 installed. Move the relay to the specific socket for the desired alarm function. It may also be necessary to move relay driver chips U25, U26, and U27 to appropriate sockets when relocating relays.

Optionally, additional alarm relays may be provided. *See drawing 8-01-0177, sheet 12.*

The General Alarm Relay K1

is essentially slaved to the main contactor. It is energized only when the T-R set is energized. Any time the T-R set is off, whether caused by a manual stop, trip, or loss of power, K1's normally closed contacts will provide an uncancelable alarm.

Trip Alarm Relay K2

is energized when an internally or externally generated control trip occurs including loss of **External Interlock** and CMR trips. Opening the **T-R On** switch, activating the **External Restart**, **Stop**, or **ACK Alarm** contact inputs, or sending a data link STOP or RESET command will clear the alarm.

Open Breaker Relay K3

is for systems without a main contactor.
It provides contacts to open shunt trip or motorized T-R supply breakers when the MVC III detects a T-R run away condition. K3 requires MVC III software version 1.5 or later to function. The K3 relay provides a form C contact and a normally open contact on the **INTERFACE** PCB connector J6.

After any MVC III trip condition, the microprocessor continues to monitor T-R set primary current and primary voltage signals for non zero values indicating a run away condition. This could happen in an installation that does not have a contactor and relies on the SCR's alone to stop power flow to the T-R set. Without a contactor, a shorted SCR would make it impossible for the MVC III to stop power flow to the T-R set.

If a run away condition is detected, the microprocessor will activate K3 to open the T-R supply breaker.

Since a run away condition is considered a catastrophic failure requiring repair, once K3 has been activated, it will remain activated until the MVC III cabinet power is removed. All operator inputs and POS control will be disabled until cabinet power is removed and restored. The **Auxiliary Functions** display will show the code HLP and a status code will be sent to POS indicating the MVC III has shut down due to a run away condition. The MVC III displays and the status indicators (except the **Auxiliary Functions** display) will show the conditions at the time of the original trip before the run away was detected.

If K3 activation causes loss of the Zero Cross signal, the MVC III will continue to communicate with POS as long as logic power is maintained

If K3 is used, the logic power should be provided from a different source than the breaker that will be tripped by K3.

10.10 Rapper Outputs

This is a future planned feature for the MVC III and is not yet implemented.

11.0 START-UP PROCEDURE

! WARNING !

Voltages capable of causing death are present in the T-R control cabinet and at the T-R set!

! CAUTION !

To prevent damage to the equipment, ensure that the continuity test has been performed and that continuity exists in all connections shown in the schematic diagram, before turning on main power to the T-R control cabinet.

Verify that the proper T-R set grounding resistor and surge suppresser has been installed in the ground leg of the T-R set high voltage bridge. ***See section 4.2.1 and drawings 8-01-0196 and 8-01-0197.***

After the continuity test has been completed, perform the initial turn on and calibration procedures.

The following equipment is required to perform the startup and calibration procedure:

1. Isolated input storage oscilloscope such as Tektronix model 224 or TEKSCOPE models THS710 or THS720 with inputs rated for 600 VAC. Each scope channel **must be isolated from all other channels and from earth ground**.

! DANGER !

Do not use a floated scope. A floated scope is potentially lethal!

2. TRUE RMS digital volt-ohmmeter rated for 600 VAC input
3. TRUE RMS clamp-on ammeter
4. Small screwdriver or alignment tool
5. Calculator

11.1 Setting Circuit Board Jumpers

The **INTERFACE** board and main **LOGIC** board have micro jumpers to configure the circuitry for the particular installation. This section identifies all jumper options and may direct the user to other sections of the manual for more detailed information.

11.1.1 Primary Current Burden Resistor

The primary current burden resistor on the **INTERFACE** board can be set to 0.5 ohm or 1.0 ohm using jumper JMPR1, *item 21 in figure 3*. If the primary current sensing transformer provides more than 2.0 Amps output at T-R set nameplate current, JMPR1 ***must be installed to protect the* INTERFACE *board components against possible damage***.

11.1.2 KV Feedback Circuit.

Four possible KV feedback configurations can be used with the MVC III. *See section 5.3* for more details. There are 5 jumpers on the **INTERFACE** PCB and one on the **LOGIC** PCB for ***each*** KV signal that must be configured according to the selected KV feedback wiring circuit. *Drawing 8-01-0196* shows the four acceptable wiring methods for KV feedback signals along with tables of required **INTERFACE** and **LOGIC** board jumper settings.

Tables on *Drawings 82200-016 and 84700-250A* show how to configure jumpers on the Neundorfer KV Signal Feedback And Surge Suppression circuit board and Neundorfer Type 2 Voltage divider for the desired feedback wiring circuit.

11.1.3 Data Link Jumpers

Also see section 10.6.

Figure 6 shows the data link jumper configurations for the MVC III. The data link jumpers can be set to one of three configurations:

IN LINE - places the MVC III in the data link as any device not at the physical end of the cable.

BYPASS - Removes the MVC III from the data link and passes the signal through to the next control. The bypass takes place at the **INTERFACE** PCB. The MVC III **LOGIC** board can then be disconnected or removed without disrupting communications.

END LINE - Breaks the data link and terminates it at this controller. All controllers farther down the line will be disconnected. This setting is used for the controller at the physical end of a data link cable. It is also useful as a temporary setting for locating faults on the data link.

11.1.4 EPROM Memory Jumper

Some versions of the MVC III have micro jumpers labeled JMPR3 and JMPR4 next to U10 *(figure 2, item 37)* to select the size EPROM memory chip installed. These MVC III boards can utilize a 16K or a 32K EPROM memory IC. **LOGIC** boards are being shipped with the 32K chip and JMPR3 installed. If the memory chip has been changed on the **LOGIC** board and it has micro jumper pins installed, make sure that the jumper is in the correct position. For memory chips with part numbers of the form 27C128-- the jumper is placed in the 8K-16K position. For 27C256-- memory chips, the jumper is placed in the 32K position.

11.2 Initial Turn On And Adjustment

Put the **Local / Remote** toggle switch S2 *(figure 2, item 8)* on the **LOGIC** board in the Local position. Turn the main circuit breaker on to apply 120V AC to the MVC III **LOGIC** board. The control will take about 8 seconds to complete its self test and display test. If the self test does not conclude successfully *refer to section 13* for trouble shooting guides.

After the self test has successfully completed, place the MVC III into the Software Configuration Mode and verify correct setting of all four configuration parameters. *Refer to section 8.0 through 8.4 for complete instructions*.

Press and release the **Reset** pushbutton to put the MVC III back into Standby Mode. Referring to *section 9.0 through 9.14* adjust all setpoints to the settings shown in *table 11*:

! CAUTION !

The primary current limit should be set at 50% or less of the T-R nameplate primary current rating until the calibration procedure is completed.

Item	Setpoint Value	Manual Section
Primary Current Limit	50% of T-R nameplate	9.1
Primary Over Voltage Limit	T-R nameplate	9.2
Primary Under Voltage Limit	100 Volts	9.3
Secondary Current Limit	50% of T-R nameplate	9.4
Rap Limit	0.0 Amps	9.5
Secondary Over Voltage Limit	T-R nameplate - 10 KV	9.6
Baseline Spark Rate	15 SPM	9.7
Setback	5%	9.8
Spark Response Mode	1	9.9
Kilowatts	no setting	9.10
Conduction Angle	30 degrees	9.11
Data Link Unit Number	as needed	9.12
Back Corona Software	0	9.13
IE Ratio Setting	0.00	9.14

Table 11 - Initial startup setpoint values

11.3 Calibration - General Information

! CAUTION !

Before the MVC III can be put into service, the Primary Current, Primary Voltage, Secondary Current, and Secondary Voltage readouts must be calibrated to accurately display T-R operating values.

The MVC III can be configured with calibration adjustments on the main **LOGIC** board, on the **INTERFACE** board, or on both. Refer to *figures 2 and 3* for location of the adjustment pots.

Starting with MVC III software release 1.4a, the analog to digital converter inputs are zeroed and calibrated at the factory. After any repairs involving the **LOGIC** board analog circuitry or microcomputer chip, this procedure must be repeated. *See appendix A.* If the converter has not been zeroed, an error code in the range of 1.5.1. to 1.5.8. will be displayed at power up.

Software versions 1.4a and later also provide software calibration of the A/D converter, rather than relying on manual adjustments, to set each **LOGIC** board to a standard calibration. If the converter has not been calibrated, codes in the range of 1.6.1. to 1.6.9. will be displayed on power up. Controls with software versions lower than 1.4a should be updated to the latest version.

If the control has both sets of calibration adjustments, then those on the main **LOGIC** board have been set fully clockwise at the factory. All field adjustments should be done on the **INTERFACE** board. This makes it possible to swap a main **LOGIC** board without having to recalibrate the control.

If you have systems with both sets of adjustments and would rather calibrate at the main **LOGIC** board, then set the respective calibration pots on the **INTERFACE** board fully clockwise and proceed with calibration at the **LOGIC** board.

Select the calibration site, main **LOGIC** PCB or **INTERFACE** PCB. Turn the primary current, primary voltage, secondary current and secondary voltage trimpots *(figure 2 or 3, items 1 through 5)* counterclockwise until a faint click is heard. Then turn the five pots clockwise 5 turns to midpoint.

As you make each of the following calibration adjustments, make sure the parameter being calibrated is not limiting T-R set operation as the operating point will change when the parameter is adjusted.

11.4 Primary Current Calibration

Place a TRUE RMS clamp-on ammeter around the T-R input power feed cable. Apply power to the T-R set by closing the **T-R On** switch. Use the Conduction Angle adjustment *(see section 9.11)* to manually raise the power level until the clamp on ammeter reads about 40% of the primary current rating of the T-R set. If sparking occurs set the Conduction Angle low enough to prevent sparking. Now, turn the primary current trimpot *(figure 2 or 3, item 1)* until the value displayed in the **T-R Primary Amps** digital readout agrees with the value shown on the TRUE RMS clamp on meter. Turning the trimpot clockwise will increase the value shown in the readout.

11.5 Primary Voltage Calibration

Connect the TRUE RMS voltmeter across the primary side of the T-R set, excluding the current limiting reactor (CLR).

! WARNING 600 VOLTS !

This reading can be taken in the cabinet at the input to the **INTERFACE** board at *J2* across terminals *1* to *2 (refer to drawing 8-01-0181, or 8-01-0197).* Use the Conduction Angle Limit *(see section 9.11)* to stabilize T-R operation below the spark threshold. Adjust the primary voltage trimpot *(figure 2 or 3, item 2)* until the value displayed in the **T-R Primary Volts** digital readout agrees with the value shown on the TRUE RMS meter. Turning the trimpot clockwise will increase the value shown in the readout.

11.6 Secondary Current Calibration

There are three possible ways to calibrate the secondary current. The simplest method can be used with no more than 5% error if the feedback signal wiring is AWG 16 or larger and the wire run distance from the T-R set to the MVC III is less than 100 feet. This method is also used if the secondary current sensing resistor is in the MVC III cabinet instead of the T-R set low voltage junction box. Open the **T-R On** switch and turn off the main circuit breaker. Using the volt-ohmmeter, read the resistance value at the MVC III **INTERFACE** board between terminals *J7-13 and J7-14.* Re-apply power to the MVC III and close the **T-R On** switch. Use the Conduction Angle adjustment to stabilize the control below the spark threshold.

Read the DC voltage across the **INTERFACE** board between terminals *J7-13 and J7-14*. Divide the DC voltage reading by the resistance reading. The quotient equals the secondary current. Adjust the secondary current trimpot *(figure 2 or 3, item 3)* until this value is displayed in the **T-R Secondary Amps** digital readout. Turning the trimpot clockwise will increase the displayed value.

Using this method, the results will always be low due to the resistance of the interconnecting wiring. In many cases the amount of error is minimal and can be ignored for the ease of working at the AVC cabinet. ***In some situations, however, the error can be so significant as to lower the secondary current readout by 50%, effectively eliminating any secondary over current protection.*** If in doubt, use one of the following methods for accurate secondary current calibration.

Open the **T-R On** switch and turn off the main circuit breaker. Using the volt-ohmmeter, read the resistance value directly across the secondary current sensing resistor with the feedback wiring connected to the MVC III **INTERFACE** PCB. This resistor is usually located in the T-R set low voltage junction box, but in some cases is in the MVC III cabinet. *Refer to drawings 8-01-0181, and 8-01-0197*.

Re-apply power to the MVC III and close the **T-R On** switch. After the control stabilizes below the spark threshold, read the DC voltage directly across the secondary current sensing resistor. Divide the DC voltage reading by the resistance reading. The quotient equals the secondary current. Adjust the secondary current trimpot *(figure 2 or 3, item 3)* until this value is displayed in the **T-R Secondary Amps** digital readout. Turning the trimpot clockwise will increase the value shown in the readout.

11.6 Secondary Current Calibration

(con't)

The third calibration method can be used at the MVC III cabinet if the value of the secondary current sensing resistor is accurately known. Open the **T-R On** switch and turn off the main circuit breaker. Determine the value of the secondary current sensing resistor R_S to at least 0.05 ohm accuracy. It should have been measured before it was installed. If not, it must be measured with all wiring disconnected from one end.

Then reconnect the wiring to the secondary current sensing resistor. Disconnect the pair of wires at terminals *J7-13 and J7-14* on the MVC III **INTERFACE** board and measure the resistance R_F across the pair of wires. With the wires still disconnected, measure the resistance R_{IN} across terminals *J7-13 and J7-14* on the **INTERFACE** board. Reconnect all wiring and restart the MVC III. After the control stabilizes below the spark threshold, read the DC voltage V_{IN} across the **INTERFACE** board between terminals *J7-13 and J7-14*. The secondary current is given by:

$$SI = \frac{R_F + R_{IN}}{R_S \times R_{IN}} \times V_{IN}$$

Where: SI = secondary current in Amps
V_{IN} is in volts
All resistances are in ohms

11.7 Secondary Voltage Calibration

The calibration procedure applies to controls with the optional single or dual bushing KV metering circuitry. *Refer to section 10.3* for dual bushing display operation. For dual bushing controls sequentially calibrate bushing "A" then "B".

11.7.1 Direct KV Calibration

The most accurate (and most dangerous) way to calibrate the KV readouts is to connect a direct reading high voltage meter to the bus section and adjust the MVC III displays to match the meter.

! WARNING !
Do not attempt this type of measurement unless you have the proper equipment and safety training.

Turn off the MVC III and open the main circuit breaker. Ground the T-R set high voltage bushings. Connect the high voltage meter to the T-R set high voltage bushing. Unground the high voltage bushings and turn on the main circuit breaker.

Restart the MVC III. For bushing "B" calibration, press the **Up** key to select bushing "B" in the KV readout.

Use the Conduction Angle adjustment *(see section 9.11)* to manually set stable operation just below the spark threshold. Adjust the secondary voltage trimpot, bushing "A" *(figure 2 or 3, item 4)* or bushing "B" *(figure 2 or 3, item 5)*, until the **T-R Secondary KV** digital readout agrees with the high voltage meter. Shut off the T-R set and open the main breaker. Ground the T-R set high voltage bushings, remove the KV meter, remove the high voltage bushing grounds and reassemble all safety access covers before restarting the T-R set.

11.7.2 Calculated KV Calibration

The KV can be calculated and calibrated using measurements taken at the **INTERFACE** board if the high voltage divider resistance R_{DIV} is known.

Calculated KV Calibration measurements require an ohm meter such as a Fluke 87 that will not forward bias a diode when measuring resistance. If in doubt about your meter's capabilities, measure the forward and reverse resistance of a common diode such as a 1N4007 with the meter, and ensure that the meter reads at least 500K ohms in both directions.

Turn off the MVC III and open the main circuit breaker.

For type 1 balanced and types 3 and 4 unbalanced KV feedback circuits, measure the input resistance R_{IN} across **INTERFACE** board terminals *J4-2 to J4-3* for bushing "A" and *J4-7 to J4-8* for bushing "B". Reverse the ohm meter leads and measure the resistance again. Use the **average** of the two values. ***Do not use old values of R_{IN} as the value changes after every adjustment and must be remeasured.*** If there is a significant difference between the two readings, then electrical noise or a signal due to operating fields is being injected into the circuit, and calibration should be verified during an outage when all fields are off.

For type 2 balanced circuit measure the resistance across terminals *J4-2 to J4-5* for bushing "A" and *J4-7 to J4-10* for bushing "B". Reverse the ohm meter leads and measure the resistance again. Use the **average** of the two values. ***Do not use old values of R_{IN} as the value changes after every adjustment and must be remeasured.*** If there is a significant difference between the two readings, then electrical noise or a signal due to operating fields is being injected into the circuit, and calibration should be verified during an outage when all fields are off.

11.7.2 Calculated KV Calibration
(con't)

Re-apply power to the MVC III. For bushing "B" calibration, press the **Up** key to select bushing "B". Use the Conduction Angle adjustment *(see section 9.11)* to set stable operation just below the spark threshold. Measure the DC voltage V_{IN} ***across the same terminals called out for the resistance measurement***.

Find the KV feedback circuit on *drawing 8-01-0196* that matches the installation.

For type 1 and 2 balanced circuits KV is:

$$KV = \frac{2000 \times R_{DIV}}{R_{IN}} \times V_{IN}$$

For type 3 or type 4 unbalanced circuit KV is:

$$KV = \frac{1000 \times R_{DIV}}{R_{IN}} \times V_{IN}$$

where: KV is secondary voltage in kilovolts
R_{DIV} is the KV divider in megohms
R_{IN} is input resistance in ohms
V_{IN} is input voltage in volts

Following is an example for type 3 unbalanced circuit.

Assume:
R_{DIV} =160 megohms
R_{IN} = 1023 ohms
V_{IN} = 0.28 volts

Then:
KV = (1000 x 160 x 0.28)/1023 = 43.8 KV

Adjust the secondary voltage trimpot, bushing "A" *(figure 2 or 3, item 4)* or bushing "B" *(figure 2 or 3, item 5)*, until the **T-R Secondary KV** digital readout agrees with the calculated value.

11.8 Final Calibration And Setup

After initial calibration set the Primary and Secondary Current Limits to the T-R set's maximum rating. Some T-R sets have more than one primary circuit connection tap. Be sure to follow the primary nameplate rating for the tap in use.

! WARNING !

If any primary circuit element; SCR, CLR, contactor, fuses, or wiring has a lower current rating than the T-R set, the lowest current rated element in the primary circuit must be used for the Primary Current Limit setting.

Set the Secondary KV Limit to the T-R set average KV nameplate rating. Use the Conduction Angle control to increase the power levels as high as possible without sparking and recheck primary and secondary current and voltage calibrations. Once the calibration is completed the MVC III control does not require periodic recalibration. Set the Conduction Angle Limit to 170 degrees for fully automatic operation.

Set Rap Limit, Spark Rate, Setback, Spark Response Mode, Back Corona and IE settings as desired and the MVC III is ready for final checkout. Connect a storage oscilloscope to the secondary current test points on the **INTERFACE** PCB at test points *TP-5 & TP-6* and verify proper spark detection and quenching as shown in *figure 7*.

Connect the oscilloscope to the primary current test points on the **INTERFACE** PCB at test points *TP-3 & TP-4*. With the MVC III running at full conduction angle, verify that the primary current waveform conduction periods are sinusoidal without appreciable distortion as shown in *figure 9*. If necessary reduce the Conduction Angle Limit setpoint to achieve an undistorted waveform with a 0.5 msec. minimum Off time between half cycles.

11.9 Suggested MVC III Setup

Table 12 lists the adjustable MVC III parameters along with the applicable section in the manual that covers each one.

Items 1 through 4 provide operational limits for the MVC III to prevent over stressing the T-R set and primary circuit elements. They should have been set following the guidelines in *section 11.8*.

If the nameplate shows different KV ratings for the different primary taps, it is safe to set the Secondary Over Voltage Limit to the highest rated tap even if that is not the tap in use. Some T-R sets have a peak KV rating that is significantly higher than the average KV rating. In that case, use the lower average DC KV rating as the KV Limit.

Item No.	Item	Manual Section
1	Primary Current Limit	9.1
2	Primary Over Voltage Limit	9.2
3	Secondary Current Limit	9.4
4	Secondary Over Voltage Limit	9.6
5	Primary Under Voltage Limit	9.3
6	Rap Limit	9.5
7	Conduction Angle Limit	9.11
8	Data Link Unit Number	9.12
9	Baseline Spark Rate	9.7
10	Setback	9.8
11	Spark Response Mode	9.9
12	Back Corona Software	9.13
13	IE Ratio Settings	9.14

Table 12 - MVC III adjustable parameters

The under voltage limits are used to detect a short in the precipitator bus section, which usually causes T-R set operation at current limit and low primary and secondary voltage. In this case, the MVC III will trip off due to low primary or secondary voltage. An under voltage trip is usually caused by a broken discharge wire or defective insulators. A typical setting for the Primary Under Voltage Limit is 100 Volts. The Secondary Under Voltage Limit is automatically calculated from the Primary Under Voltage Limit and T-R set nameplate data.

The Rap Limit need only be adjusted if the Reduced Power Rapping feature is being used in this installation. Reduced Power Rapping (RPR) or Power Off Rapping (POR) is sometimes useful to help dislodge collected dust from the plates. The RPR function is invoked via an opto coupler input or data link command to set the T-R secondary current down to the Rap Limit value. Setting the Rap Limit to zero provides POR. In some cases setting a low RPR value such as 10% of normal operating current will enhance rapping while still providing enough residual electric field to prevent unacceptable opacity spiking. The ideal setting is site specific and can only be determined by experimentation.

The Conduction Angle Limit is normally set to 170 degrees for automatic operation. There are some cases where poorly matched T-R set and CLR makes a lower setting necessary. *See section 11.8*.

The Data Link Unit Number must be set to agree with the site specific documentation for the POS installation. If there is no POS, set the Data Link Unit Numbers sequentially. On automatic recovery from power failure, control startup is slightly staggered based on Data Link Unit Number to reduce power bus inrush load.

11.9 Suggested MVC III Setup *(con't)*

Items 9 through 13 are site specific, but we can provide some basic guidelines. Baseline Spark Rate is process and field dependent. The general pattern is to set higher spark rates toward the inlet of the precipitator. For a power plant or other process producing a rather stable gas stream, typical inlet spark rates would be 60 - 80 SPM decreasing to 10 - 20 SPM at the outlet. Other unstable processes such as BOP/BOF, paper mills, cement plants, lime kilns, or waste burners may require much higher spark rates to track a rapidly changing spark over voltage. In some cases spark rates of several hundred SPM are required for maximum collection. In general, if raising the Spark Rate causes an increase in the KW of the ***following field*** T-R set, or a reduction in opacity, use the higher Spark Rate otherwise use a lower rate.
Post Spark Setback affects the controller's stability and ability to track changes in spark over voltage. A setting of 5% is a good starting point and works well in most situations. Like Spark Rates, higher settings may be beneficial toward the inlet of the precipitator while lower ones may be acceptable toward the outlet. If raising the Setback provides more uniform sparking without a loss in ***following field*** power or increase in opacity, use the higher rate. If a change in Setback increases the field's KW consumption, use that setting.

To maintain stability, greater setback percentage is usually required at lower power levels than at higher levels. The MVC III setback algorithm compensates the setback as power levels changes.

The Spark Response Mode is set to 1 for most applications. Certain processes can produce a significant number of low intensity spit sparks that will self extinguish. These sparks generally occur late in the current waveform half cycle. Use a storage oscilloscope to observe the secondary current waveform. If spit sparking is observed, change the Spark Response Mode to number 2. If, with the MVC III set to Spark Response Mode 2, the oscilloscope shows a significant number of sparks that last only one half cycle, Mode 2 is probably beneficial. Mode 2 can also be useful when running Intermittent Energization with an on time setting of one half cycle. Mode 3 may be useful in cases of very low intensity sparking or when running IE with two half cycles of on time. Using a higher mode number setting often causes an increase in KW consumption which is usually interpreted as an indication of increased performance. The increase in KW, however, may be due only to the increased power dissipated in the longer lasting sparks.

If an increased mode number setting causes an ***increase in following field KW or decrease in opacity***, it probably is beneficial. If an increased mode number causes the primary or secondary voltage for that field to decrease, it is counterproductive and should not be used.

! CAUTION !
Do not use modes 2 or 3 with a dual bushing T-R set operating in double half wave mode.

Back Corona Control software is an algorithm designed to periodically check the bus section for the presence of back corona and, if found, limit operation below the back corona onset point. If it is unknown whether the bus section has back corona, run a manual V-I curve or use the automatic V-I curve function in POS to obtain a V-I curve. If the bus section has back corona, using the Back Corona software will usually decrease power consumption and increase collection.

11.9 Suggested MVC III Setup *(con't)*

Adjust the Back Corona software setting to a non zero number to activate the Back Corona algorithm. Each higher number doubles the sensitivity of the program, that is requires a less steep V-I curve to be considered back corona. Adjust the setting to give back corona detection at the desired point on the V-I curve.

Refer to section 9.13 for more details on operation of the Back Corona software.

Intermittent Energization (IE) is another software algorithm designed to eliminate back corona and / or reduce energy consumption. IE rapidly cycles the T-R set primary power synchronous with the line voltage. Power is applied in 1, 2, 3, or 4 half cycles of the line, then blocked for 2, 4, 6, 8, 10, 12, or 14 half cycles. The repeated interruption of secondary current flow impedes the formation of back corona while usually reducing power consumption. In oversized precipitators without back corona, IE can often be used purely as an energy saving device.

! CAUTION !

Some T-R sets may not be compatible with the mechanical and electrical stresses generated by IE. If in doubt, check with the T-R set manufacturer before using IE.

The optimum IE ratio is completely site specific and must be determined by experimentation. For best transformer balance, we suggest using one or three half cycles of on time for full wave T-R sets and two or four half cycles of on time for T-R sets operating in double half wave.

IE is locked out when the Spark Rate is set above 60 SPM or when Back Corona software is enabled. *See section 9.14* for more information.

11.10 Normal Operation

Each time logic power is applied to the MVC III or the **Reset** pushbutton switch is released, a self test is performed. If any errors are detected, the control will halt displaying an error code with all three decimal points lighted in the **Auxiliary Functions** digital readout. *Refer to section 13.1* for the meaning of any observed error codes. After the self test is complete, the control can be started by depressing the front panel **T-R On** switch.

Under normal operating conditions the MVC III will operate automatically without the need for periodic operator attention. The front panel **T-R On** switch, or the **External Restart**, **Stop**, or **ACK Alarm** contact inputs (*requires optional circuitry*) are used to turn the T-R set high voltage on and off. If the MVC III is connected to a Neundorfer POS computer system or a DCS, data link commands can be used to stop, restart, and reset the MVC III.

If during operation, the MVC III trips off or fails to operate properly, refer to the trouble shooting guides in *section 13* to identify probable causes of the problem.

12.0 CALIBRATION POTS, SWITCHES, LED'S, TEST POINTS AND JUMPERS

12.1 Table 13 - Main Logic PCB *(refer to figure 2)*

Logic Board Silk-screen	Item	Description
R24 (PI)	1	Calibration pot, primary current.
R29 (PV)	2	Calibration pot, primary voltage.
R58 (SI)	3	Calibration pot, secondary current.
R48 (KV-A)	4	Calibration pot, secondary voltage bushing "A" or "H1".
R37 (KV-B)	5	Calibration pot, secondary voltage bushing "B" or "H2".
R5 (5V)	6	Calibration pot, +5V DC. Factory preset to +5.00V DC.
S1 (RESET PUSHBUTTON)	7	Pushbutton switch, resets microprocessor. Used to enter Software Configuration Mode.
S2 (LOCAL / REMOTE)	8	Toggle switch, selects front panel keypad, remote control, or keypad lockout.
DS1 (5V)	9	LED, indicates +5V DC power supply is operational.
DS2 (EXT RESTART)	10	LED, indicates External Restart 120 V input signal active.
DS3 (EXT STOP)	11	LED, indicates External Stop 120 V input signal active.
DS4 (EXT TRIP)	12	LED, indicates External Trip 120 V input signal active.
DS5 (EXT ACK ALARM)	13	LED, indicates External Ack Alarm (Reset) 120 V input signal active.
DS6 (RPR)	14	LED, indicates Reduced Power Rapping 120 V input signal active.
DS7 (RUN REQ)	15	LED, indicates Run Request 120 V input signal active.
DS8 (INTERLOCK)	16	LED, indicates External Interlock circuit closed.
DS9 (CONTACTOR CLOSED)	17	LED, indicates Contactor closed 120 V input signal present.
DS10 (RUN ENABLE)	18	LED, indicates Run Enable SSRLY output active.
DS11 (TRIP ALARM)	19	LED, indicates Trip Alarm relay is energized.
DS12 (OPEN BREAKER)	20	LED, indicates Open Breaker relay is energized.
DS13 (GENERAL ALARM)	21	LED, indicates General Alarm relay is energized (not alarming).
TP-1	22	2.5 volt reference for PI and PV
TP-2	23	Normalized primary current referenced to TP-1
TP-3	24	Normalized primary voltage referenced to TP-1
TP-4	25	Service connection, PE0
TP-5	26	Service connection, PE1
TP-6	27	Normalized secondary current referenced to ground + 130 mv
TP-7	28	Normalized secondary voltage - “B” referenced to ground + 250 mv
TP-8	29	Normalized secondary voltage - “A” referenced to ground + 250 mv
TP-9	30	Secondary spark current referenced to ground + 130 mv
TP-10	31	+5 volt test point
TP-11	32	Power supply common (logic ground not earth ground) test point
TP-12	33	+12 volt test point
TP-13	34	-12 volt test point
JMPR1	35	Secondary voltage - bushing “B” input 3 Hz filter
JMPR2	36	Secondary voltage - bushing “A” input 3 Hz filter
U10	37	EPROM program chip
Ass’y No., Serial No.	38	Assembly number and serial number

12.2 Table 14 - Interface PCB *(refer to figure 3)*

Interface Board Silk-screen	Item	Description
R23 (PI)	1	Calibration pot, primary current.
R6 (PV)	2	Calibration pot, primary voltage.
R30 (SI)	3	Calibration pot, secondary current.
R37 (KV-A)	4	Calibration pot, secondary voltage bushing "A" or "H1".
R44 (KV-B)	5	Calibration pot, secondary voltage bushing "B" or "H2".
DS1 (5V)	6	LED, indicates unregulated DC power supply is operational.
F1	7	120 VAC logic power fuse
TP-1	8	Primary voltage input signal relative to TP-2 [1] **WARNING 600 VAC**
TP-2	9	Primary voltage input signal relative to TP-1 [1] **WARNING 600 VAC**
TP-3	10	Primary current input signal relative to TP-4
TP-4	11	Primary current input signal relative to TP-3
TP-5	12	Secondary current + input signal relative to TP-6
TP-6	13	Secondary current - input signal (T-R set ground) relative to TP-5
TP-7	14	Secondary voltage bushing “A” - (signal) input relative to TP-8
TP-8	15	Secondary voltage bushing “A” + (common) input relative to TP-7
TP-9	16	Secondary voltage bushing “B” + (common) input relative to TP-10
TP-10	17	Secondary voltage bushing “B” - (signal) input relative to TP-9
TP-11	18	Power supply common (logic ground not earth ground) test point
TP-12	19	+26 volt unregulated power supply test point
TP-13	20	+13 volt unregulated power supply test point
JMPR1	21	Primary current transformer burden resistor selection
JMPR2	22	Primary current circuit configuration
JMPR3	23	Primary voltage circuit configuration
JMPR4	24	\
JMPR5	25		
JMPR6	26		KV-a circuit configuration
JMPR7	27		
JMPR8	28	/
JMPR9	29	\
JMPR10	30		
JMPR11	31		KV-b circuit configuration
JMPR12	32		
JMPR13	33	/
JMPR14-16	34	Data link Active / Bypass selection
JMPR17-19	35	Data link Inline (Active) / End line (Bypass) selection
K5	36	Run Enable solid state relay
Ass’y No., Serial No.	37	Assembly number and serial number

Note 1: **INTERFACE** PCB’s with serial numbers above 0019 have TP-1 and TP-2 moved to the low voltage isolated primary voltage signal. ***If TP-1 and TP-2 are present on an interface PCB with a serial number lower than 0020, please remove the test points and do not attempt to use them.***

13.0 TROUBLE SHOOTING

13.1 Diagnostic Error Codes

Certain system errors and subsystem malfunctions can be detected by the microcomputer. If this happens, the controller will shut down and an error code will be displayed in the **Auxiliary Functions** digital readout. Error codes are easily recognized as they are displayed with all three decimal points lighted. Many of these codes indicate an internal microcomputer failure, but several point to external problems that may be customer correctable. The error codes and possible causes are listed in *table 15* followed by a trouble shooting guide, *table 16*. When calling Neundorfer for assistance be sure to note any observed error codes.

Error Code	Cause
1.0.0. - 1.1.0.	Internal processor error
1.1.1.	Not used
1.1.2. - 1.1.5.	Internal processor error
1.1.6.	Not used
1.1.7.	Internal processor error
1.1.8. - 1.2.0.	Not used
1.2.1. - 1.2.2.	Internal processor error
1.2.3.	Not used
1.2.4. - 1.2.7.	Internal processor error
1.2.8.	Internal processor error *(see sections 13.1.1 & 13.1.2)*
1.2.9.	Loss of Zero Cross signal *(see section 13.1.3)*
1.3.0.	Internal processor error (CPU clock failure)
1.3.1.	EPROM memory test error *(see section 13.1.4)*
1.3.2.	RAM memory test error *(see section 13.1.5)*
1.3.3.	Internal processor error (EEPROM test error)
1.3.4.	Primary T-R Size error *(see section 13.1.6)*
1.3.5.	Secondary T-R Size error *(see section 13.1.7)*
1.3.6.	Incorrect CPU clock crystal frequency or incorrect line frequency *(see section 13.1.8)*
1.3.7.	UART receiver Overrun error *(see section 13.1.9)*
1.3.8.	UART receiver Framing error *(see section 13.1.9)*
1.3.9.	Internal processor error (UART FIFO buffer overflow error)
1.4.0.	Internal processor error (Incorrect CONFIG register)
1.4.1.	MVC III powered up with contactor closed *(see section 13.1.10)*
1.4.2.	Invalid Spark Sensitivity setting *(see section 13.1.11)*
1.4.3.	Internal processor error (EEPROM stuck busy)
1.5.1. - 1.5.8.	A/D converter not zeroed *(see section 13.1.12)*
1.6.1. - 1.6.9.	A/D converter not calibrated *(see section 13.1.13)*
H.L.P.	T-R run away *(see section 13.1.14)*

Table 15 - Diagnostic error codes

ITEM	PROBLEM	CAUSE	SOLUTION
13.1.1	Occasional error code 1.2.8.	1. High electrical noise level inside AVC cabinet. 2. Defective or missing SCR snubber circuit.	1. Verify proper grounding per *section 5.2*. 2. Replace SCR snubber network with Neundorfer design.
13.1.2	Control powers up with 1.2.8. error code.	1. Defective EPROM memory chip. 2. **LOGIC** board failure.	1. Replace EPROM memory. 2. Replace **LOGIC** board.
13.1.3	Error code 1.2.9.	1. Loss of Zero Cross signal. 2. **INTERFACE** PCB failure. 3. **LOGIC** PCB failure.	1. Verify presence of T-R line voltage (480 - 600 VAC) at **INTERFACE** board *J2/J3* pin *3* to pin *4*. **WARNING, 600 Volts!** 2. Replace **INTERFACE** board. 3. Replace **LOGIC** board.
13.1.4	Error code 1.3.1.	1. A new program memory chip has been installed. 2. Program memory chip has failed.	1. Follow directions in *section 3.3* to correct this error. 2a. Replace program memory chip. Then follow steps 1-6 and 9-11 in *section 8.0*. 2b. Replace **LOGIC** board.
13.1.5	Error code 1.3.2.	1. RAM memory chip has failed. 2. Failure of other **LOGIC** board components.	1a. Replace RAM memory chip. 1b. Replace **LOGIC** board. 2. Replace **LOGIC** board.
13.1.6	Error code 1.3.4.	1. Primary T-R Size Code is not set to a valid number. 2. CPU failure.	1. See *section 8.2* for setting the correct code then recalibrate primary current. 2. Replace **LOGIC** board.
13.1.7	Error code 1.3.5.	1. Secondary T-R Size Code is not set to a valid number. 2. CPU failure	1. See *section 8.3* for setting the correct code then recalibrate secondary current. 2. Replace CPU chip or **LOGIC** board.
13.1.8	Error code 1.3.6.	1. Power line frequency differs more than 1% from 60 Hz. or is severely distorted. 2. CPU crystal frequency is off by more than 1%.	1. Correct power bus problem. 2. Replace **LOGIC** board.

Table 16 - Diagnostic code trouble shooting guide (continues next page)

ITEM	PROBLEM	CAUSE	SOLUTION
13.1.9	Error code 1.3.7. or 1.3.8.	1. Excessive electrical noise on data link. 2. High electrical noise level inside AVC cabinet. 3. Defective or missing SCR snubber circuit.	1a. Verify proper data line termination. 1b. Verify proper data line wiring. 1c. Verify data line shield is not grounded at multiple points. 2. Verify proper grounding per *section 5.2*. 3. Replace SCR snubber network with Neundorfer design.
13.1.10	Error code 1.4.1. Indicates contactor closed when power applied to logic system.	1. Wiring error can cause false indication. 2. Contactor stuck closed. There is no power at coil. 3. Contactor coil always has power on it. 4. Contactor open, but auxiliary contacts stuck closed. 5. Contactor open, and auxiliary contacts open.	1. Verify wiring against system drawings. 2. Replace contactor. 3a. Verify wiring against system drawings. 3b. Replace solid state relay K5 on **INTERFACE** board, *figure 3, item 36*. 3c. Replace **LOGIC** board. 4. Replace auxiliary contacts. 5a. Verify auxiliary contact wiring. 5b. Replace **LOGIC** board. 5c. Replace **INTERFACE** board.
13.1.11	Error code 1.4.2.	1. Invalid Spark Sensitivity Setting. 2. Failure of CPU.	1. See *section 8.4* for setting the code to 50. 2. Replace CPU chip or **LOGIC** board.
13.1.12	Error code 1.5.1. to 1.5.8.	1. A/D converter not zeroed.	1a. See Appendix A for zeroing procedure. 1b. Call Neundorfer for assistance.
13.1.13	Error code 1.6.1. to 1.6.9.	1. A/D converter not calibrated.	1a. See Appendix A for zeroing procedure. 1b. Call Neundorfer for assistance.
13.1.14	Error code H.L.P.	1. MVC III was unable to stop power flow to T-R after a trip.	1. Diagnose possible shorted SCR in system with no contactor.
13.1.15	All other error codes.	1. Failure of CPU.	1. Replace CPU chip or **LOGIC** board.

Table 16 (con't) - Diagnostic code trouble shooting guide

13.2 MVC III Trouble Shooting Guide

Table 17 following provides a systematic approach to diagnosing MVC III operational problems. These are the kind of problems that are likely to occur at initial startup as a result of wiring problems or during operation as a result of component failure.

Find the entry in the following table that most closely describes the observed problem and follow the cause and solution suggestions.

Certain problems result in an error code being displayed in the **Auxiliary Functions** digital readout with all decimal points lighted. Attempt to resolve any error codes before following other failure symptoms. See *section 13.1*.

Some possible causes listed include things like wiring errors that are only likely to occur on initial startup. Keep in mind if this is an initial startup problem, or a problem that has developed after the MVC III has been functioning properly.

ITEM	PROBLEM	CAUSE	SOLUTION
13.2.1	All LED indicators and readouts are dark.	1. Main breaker off. 2. Control transformer fuses cleared. 3. Fuse F1 *(figure 3, item 7)* on **INTERFACE** PCB cleared.	1. Turn breaker on. 2. Check primary and secondary fuses, replace if needed. 3. Check F1 fuse *(figure 3, item 7)* on **INTERFACE** PCB.
13.2.2	Control does not perform self test.	1. No Zero Cross signal. 2. **INTERFACE** PCB failure. 3. **LOGIC** PCB failure.	1. Verify presence of T-R line voltage at **INTERFACE** PCB *J2/J3* pin *3* to pin *4*. **WARNING, 600 Volts!** 2. Replace **INTERFACE** board. 3. Replace **LOGIC** board.
13.2.3	Contactor will not close when **T-R On** switch closed. **External Trip** indicator.	1. Incorrect wiring to **T-R On** switch. 2. Contactor coil open or shorted. 3. MVC III was stopped by data link command. 4. **External Interlock** is not closed. 5. **External Trip** signal is active.	1. Verify proper wiring. 2. If 120 VAC at coil, replace coil or contactor. 3. Restart by data link command or set S2 to Local position and retry. 4. Determine and remedy cause of lost **Interlock**. 5a. **External Trip** is programmed wrong. See *section 8.1* to correct. 5b. Determine and remedy cause of **External Trip** signal.

Table 17 - MVC III trouble shooting guide (continues next page)

ITEM	PROBLEM	CAUSE	SOLUTION
13.2.3 *(con't)*	Contactor will not close when **T-R On** switch closed. **External Trip** indicator.	6. Failed or missing K4, current monitor relay (CMR). 7. No power to contactor coil when T-R switch is closed.	6. Replace CMR. If no CMR provided, install jumper on **INTERFACE** PCB from J7-7 to J8-4. Note, on early production **INTERFACE** PCB's there is no connection to J8-4 and it is necessary to place a jumper directly in the K4 socket between pins 1 and 4 if there is no CMR present. 7a. Verify correct system wiring. 7b. Replace solid state relay K5 on **INTERFACE** PCB, *figure 3, item 36*. 7c. Replace **LOGIC** board.
13.2.4	**External Trip** after one second, no over limit indicators.	1. **External Trip** signal is true. 2. **External Trip** signal is configured incorrectly.	1. Determine and remedy cause of **External Trip** signal. 2. **External Trip** is programmed wrong. See *section 8.1* to correct.
13.2.5	**Trip** or **Alarm** indicators will not go off when **T-R On** switch is opened.	1. **T-R On** switch stuck closed. 2. Failed **LOGIC** PCB. 3. **INTERFACE** PCB failure.	1. Replace switch. 2. Replace **LOGIC** PCB. 3. Replace **INTERFACE** board.
13.2.6	Kilowatt display reads zero or very low.	1. Primary voltage and current inputs out of phase.	1. Reverse leads on primary current feedback current transformer or at **INTERFACE** board *J7* terminals *17* and *18*.
13.2.7	Primary voltage reads low and secondary voltage reads high at start-up or primary voltage reads high with shorted T-R set.	1. Primary voltage sensing is wired across Current Limiting Reactor (CLR) and not across the primary of the T-R set.	1. Re-wire primary voltage sensing across T-R set as shown on wiring print.

Table 17 (con't) - MVC III trouble shooting guide (continues next page)

ITEM	PROBLEM	CAUSE	SOLUTION
13.2.8	**T-R Secondary Amps** display reads zero.	1. Polarity reversed on secondary current signal input at **INTERFACE** PCB *J7* pins *13* & *14*. 2. No secondary current input signal. 3. **LOGIC** board failure. 4. **INTERFACE** PCB failure.	1. **INTERFACE** PCB *J7-13* should be connected to T-R bridge side of current sensing resistor and *J7-14* should be connected to the T-R set ground point. 2. Check for signal between *J7-13* (positive) and *J7-14* (negative) on the **INTERFACE** circuit board with scope. Should be positive full wave rectified. If inverted, reverse wiring. If no signal, check wiring to T-R set and sensing resistor. 3. Replace **LOGIC** PCB. 4. Replace **INTERFACE** PCB.
13.2.9	Control does not sense sparks.	1. No secondary current signal. 2. Spark Sensitivity not adjusted properly.	1. See solution for previous symptom, "**T-R Secondary Amps** display reads zero" in *section 13.2.8*. 2. Set Spark Sensitivity adjustment to 50 per *section 8.4*.
13.2.10	**T-R Secondary KV** display reads zero. Control trips on Under Voltage.	1. Polarity reversed on secondary KV signal. 2. No secondary voltage input signal. 3. **LOGIC** PCB failure. 4. **INTERFACE** PCB failure.	1. Check bushing "A" signal at **INTERFACE** PCB *J4* terminal *3* relative to *2* and *J4* terminal *8* relative to *7* for bushing "B". It should be a negative sawtooth waveform of -2 to -15 volts. 2a. Check and correct wiring to and signal network and surge arrestors at divider. 2b. Verify the 40 meg-200 meg voltage divider still has the correct value. 2c. Disable KV monitoring for affected high voltage bushing. *See section 8.1*. 3. Replace **LOGIC** PCB. 4. Replace **INTERFACE** PCB.

Table 17 (con't) - MVC III trouble shooting guide (continues next page)

ITEM	PROBLEM	CAUSE	SOLUTION
13.2.11	When **T-R On** switch is closed SCR's do not turn on, contactor closes.	1. Auxiliary contacts on contactor are not closing or wired in. 2. SCR Gate wiring may be reversed. If so, the SCR's may not turn on reliably. 3. No 480 - 600 Volt power to SCR stack. 4a. No firing pulses from the **INTERFACE** PCB. 4b. Faulty SCR stack. 5. **LOGIC** board failure.	1. Check auxiliary contacts on contactor. 2. Check the wiring from the **INTERFACE** PCB (**GATE FIRING CIRCUIT**) to the SCR's. 3. If no 480 - 600 VAC on output of contactor correct open circuit. 4. Use a scope and check for firing pulses at **INTERFACE** PCB *J2/J3* terminals *6* to *5* then *9* to *8*. **WARNING, 600 Volts!** The signal is 6 volts peak to peak, but is connected to the 600 volt line. See *figure 10* for SCR gate waveform. If good gate signal replace SCR stack. If no signal, look for shorted gate wiring or replace **INTERFACE** PCB (**GATE FIRING CIRCUIT**). 5. Replace **LOGIC** PCB.
13.2.12	When **T-R On** switch is closed control goes into over current ***about one second after contactor closes*** and then trips off showing T-R primary or secondary **Over Limit**. It may be necessary to connect a scope to the primary current transformer to determine when current flow begins.	1. Zero Cross signal is lagging the line voltage. 2. Primary current calibration pot has not been set for initial start-up. 3. Incorrect primary current transformer ratio or incorrect setting of **INTERFACE** PCB JMPR1. 4. Incorrect secondary current sensing resistor at T-R set.	1. Replace **INTERFACE** PCB. 2. Turn PI pot, *item 1, figure 2 or 3* completely counterclockwise until a faint click is heard and then turn 15 turns clockwise. 3. See *section 4.2.1 and section 11.1.1* for correct C.T. and JMPR1 setting. 4. See *section 4.2.1* for proper value.

Table 17 (con't) - MVC III trouble shooting guide (continues next page)

ITEM	PROBLEM	CAUSE	SOLUTION
13.2.13	When **T-R On** switch is closed control goes into over current ***the moment the contactor closes*** and then trips off. It may be necessary to connect a scope to the primary C.T. to determine when current flow begins.	1. The SCR stack is wired incorrectly. 2. The SCR's are shorted. 3a. Defective gate firing circuit. 3b. Defective **LOGIC** board.	1. Check the cables attached to the SCR stack. One cable is the feed from the contactor. The other is the output to the CLR or T-R set. One cable connects to the rear heat sink the other cable connects to the front one. 2. Disconnect both pairs of SCR gate leads from the **INTERFACE** PCB (**GATE FIRING CIRCUIT**) and short them together. Try to restart the control. If it trips on over current again, replace the SCR stack. 3. If there is no current flow with SCR gates disconnected and shorted; 3a. Replace the **INTERFACE** PCB (**GATE FIRING CIRCUIT**). 3b. Replace **LOGIC** board.
13.2.14	T-R power levels remain at minimum with **Setback** and **Spark** indicators continuously lit.	1. Secondary current calibration pot has not been set for initial start-up. 2. Spark Sensitivity misadjusted.	1. Turn SI pot, *item 3, figure 2 or 3* completely counterclockwise until a faint click is heard and then turn 5 turns clockwise. 2. Set Spark Sensitivity adjustment to 50. *See section 8.4.*
13.2.15	Control operates at 170° Conduction Angle but does not reach Primary or Secondary Current Limit.	1. There is too much inductance in the primary circuit of the T-R set.	1. Reduce inductance by changing the taps on the Current Limiting Reactor (CLR) and/or the T-R set.
13.2.16	**Unbalance** trip or erratic firing of one or both SCR's.	1. Gate to cathode wiring reversed or open to one or both SCR's. 2. One SCR not firing. 3. Faulty T-R diodes. 4. One SCR is shorted.	1. Check and correct SCR gate wiring from **INTERFACE** PCB (**GATE FIRING CIRCUIT**) *J2/J3* terminals *5*, *6*, *8*, and *9* to the SCR's. If the polarity is reversed the SCR's may not fire or may fire erratically. 2a. Blown SCR fuse. 2b. Perform checks listed under item 13.2.11. 3. Replace T-R high voltage diode stack. 4. Disconnect both pairs of SCR gate leads from the **INTERFACE** PCB (**GATE FIRING CIRCUIT**) and short the gate to cathode lead for each SCR. Restart the control. If current flows or the control trips on **Unbalance**, one of the SCR's is shorted. Replace SCR.

Table 17 (con't) - MVC III trouble shooting guide

13.3 MVC III Setup Problems

Occasionally, the MVC III may refuse to allow the operator to make the desired adjustments to operating setpoints. This is usually caused by errors in T-R size setup, or attempting to run two mutually exclusive software features simultaneously. *Table 18* lists typically encountered MVC III setup problems and their solutions.

Find the entry in *table 18* that most closely describes the observed problem and follow the cause and solution suggestions.

Certain problems result in an error code being displayed in the **Auxiliary Functions** digital readout with all decimal points lighted. *See section 13.1* to resolve any error codes before pursuing symptoms in this section.

ITEM	PROBLEM	CAUSE	SOLUTION
13.3.1	Operating setpoints cannot be adjusted up or down.	1. Keypad is locked out or in remote mode with switch S2 *item 8, figure 2*. 2. Item to be changed has not been selected (no fast blinking status indicator). 3. Defective keypad.	1. Set S2 to Local position. 2. Use **Next** or **Last** key (then **Set** key for Data Link Unit Number) to select item to be adjusted. 3. Replace **DISPLAY** PCB.
13.3.2	Primary Current Limit cannot be adjusted high enough.	1. Primary T-R Size setting is incorrect.	1. See *sections 8.0 and 8.2* for correct setting and procedure.
13.3.3	Secondary Current Limit cannot be adjusted high enough.	1. Secondary T-R Size setting is incorrect.	1. See *sections 8.0 and 8.3* for correct setting and procedure.
13.3.4	Spark Rate cannot be set above 60 SPM.	1. IE is enabled, that is the IE ratio is not 0.00.	1. Set IE ratio to 0.00 to access higher Spark Rates. See *section 9.14*.
13.3.5	IE cannot be actuated.	1. SPM set above 60 2. Back Corona software enabled.	1. Set SPM to 60 or less. 2. Disable Back Corona software. *See section 9.13*.
13.3.6	Back Corona software cannot be actuated.	1. IE is enabled.	1. Disable IE. *See section 9.14*.

Table 18 - MVC III setup problem trouble shooting guide

13.4 Precipitator Trouble Shooting Guide

Precipitator operational problems often arise that are external to the MVC III controller. The MVC III is merely the messenger since it is often the only window into precipitator operations.

It is important to be able to determine which symptoms are indicative of a control problem and which indicate an external problem. External problems may be with the rapping system, ash handling system, fuel, flue gas conditioning, or precipitator mechanical condition.

This section does not attempt to be a precipitator training manual, but merely touches on the more common problems. Find the entry in *table 19* that most closely describes the observed problem and follow the cause and solution suggestions.

ITEM	PROBLEM	CAUSE	SOLUTION
13.4.1	**Unbalance** trip	1. Operating a dual bushing T-R set in double half wave can cause **Unbalance** trips if the load differs significantly between bushings.	1. Switch T-R set to full wave on each bushing.
13.4.2	Control trips on Setback, and **T-R Secondary KV Over Limit**.	1. High resistivity inside the precipitator causes the secondary voltage to increase at very low current.	1. More inductance in the primary circuit of the T-R set, will allow the control to operate at higher Conduction Angle. Inductance can be added by changing the taps on the Current Limiting Reactor (CLR) and/or the T-R set.
13.4.3	Spark rate greatly exceeds SPM setting, **Setback** light is *not* flashing.	1. Rapidly changing spark over voltage inside precipitator. 2. Swinging discharge wire inside precipitator.	1a. Increase Setback. *See section 9.8.* 1b. Increase Spark Rate. *See section 9.7.* 2. Remove or replace discharge wire.
13.4.4	Spark rate greatly exceeds SPM setting, **Setback** light *is* flashing.	1a. Close clearance in precipitator between discharge wires and plates. 1b. Close clearance between high voltage and ground. 1c. Insulator tracking over. 1d. Swinging discharge wire.	1. Isolate part of the electrical field that the T-R set feeds. This can be done with dual bushing T-R set switches or high voltage duct switches. Turn the control off before switching. Re-power control feeding each electrical section separately to determine where the internal clearance problem is. Leave this section off and run the control normally until the unit is off line and an internal inspection can be made.

Table 19 - Precipitator trouble shooting guide (continues next page)

ITEM	PROBLEM	CAUSE	SOLUTION
13.4.5	High pri Amps. Low pri Volts. High sec current. Low or no KV.	Shorted electrical field or low resistive path to ground. Causes: 1a. Broken wire. 1b. Ash build up in the hoppers. 1c. Warped plates touching wires. 1d. Dirty, broken or cracked insulators tracking to ground. 1e. Defective feed through bushings.	1. Isolate part of the electrical field that the T-R set feeds. This can be done with dual bushing T-R set switches or high voltage duct switches. Turn the control off before switching. Re-power control feeding each electrical section separately to determine where the internal clearance problem is. Leave this section off and run the control normally until the unit is off line and an internal inspection can be made to determine the exact cause of the problem.
13.4.6	Low pri Amps. High pri Volts. Low sec current. High KV.	An increase of resistance in the precipitator. Causes: 1. Plate buildup. 2. Wire buildup. 3. Open conductor between T-R and precipitator. 4. change in ash chemistry.	1. Diagnose & correct rapping system problem. 2. Diagnose & correct rapping system problem. 3. Shut down T-R set. Ground out T-R and field. When safe inspect and repair high voltage transmission system. 4. If opacity is OK, may be new normal operation. Adjust flue gas conditioning system. Try IE or Back Corona software.
13.4.7	High pri Amps. Pri Volts lower than normal. Low to no sec current. Low KV.	1. Shorted T-R set secondary. 2a. Shorted secondary current sense resistor or surge protector. 2b. Damaged secondary current feedback wiring.	1. Megger T-R set following all safety precautions. 2. Inspect and repair as needed.
13.4.8	High pri Amps. Low pri Volts. Low to no sec current. Low to no KV.	1. Short in T-R primary circuit. 2. Shorted T-R diode stack. 3. Shorted bus section. 4. No secondary current feedback signal.	1. Inspect and repair as needed. 2. Megger diode stack and replace as needed. 3. Locate and repair short. 4. Inspect and repair current sensing resistor, surge arrestor and feedback wiring.

Table 19 (con't) - Precipitator trouble shooting guide

13.5 Identifying Causes Of Trips

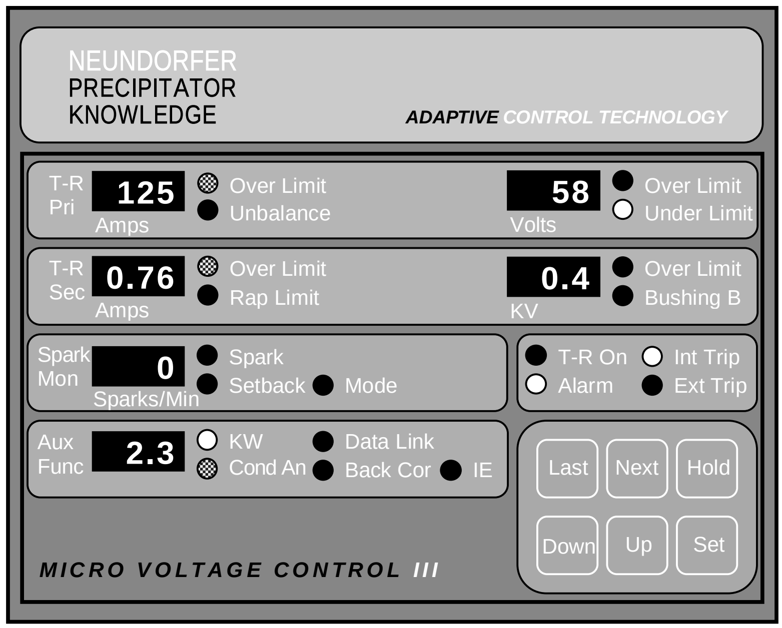
On the following pages are examples of typical MVC III panel readings that may occur after a control trip. The status indicators and readout values provide useful clues to the cause of the trip. Find the example that matches the observed operating or trip conditions.

The numbers are typical based on a 125 Amp, 45 KV T-R set. White status indicators are on while those with a shaded pattern may be on or off. KW is assumed to be the default **Auxiliary Functions** display value.

Problem: Voltage **Under Limit**. Trips off in 30 seconds with near zero KV.

Cause: Hard ground on emitting electrode

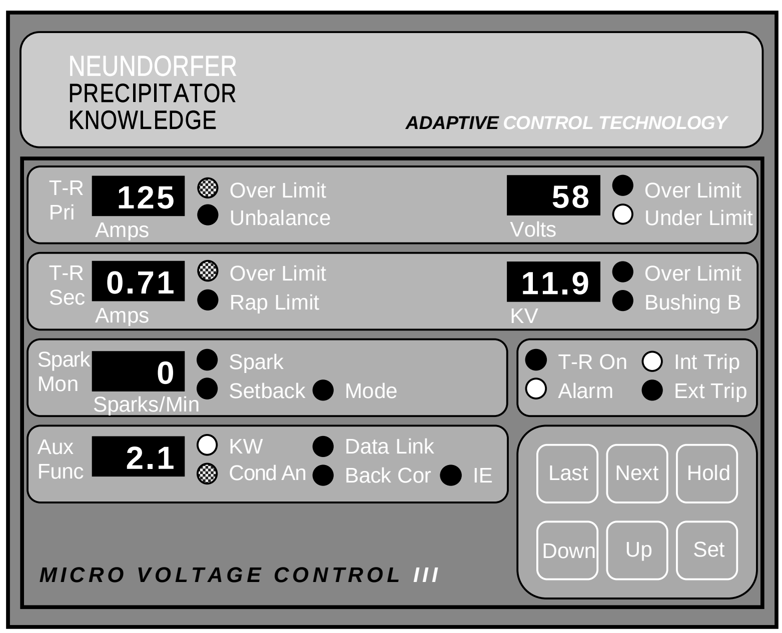
Solution: Isolate shorted T-R bushing. *See section 13.4.4.*



Problem: Voltage **Under Limit**. Trips off in 30 seconds with low KV.

Cause: Shorted diode stack in T-R set. Swinging discharge wire in precipitator.

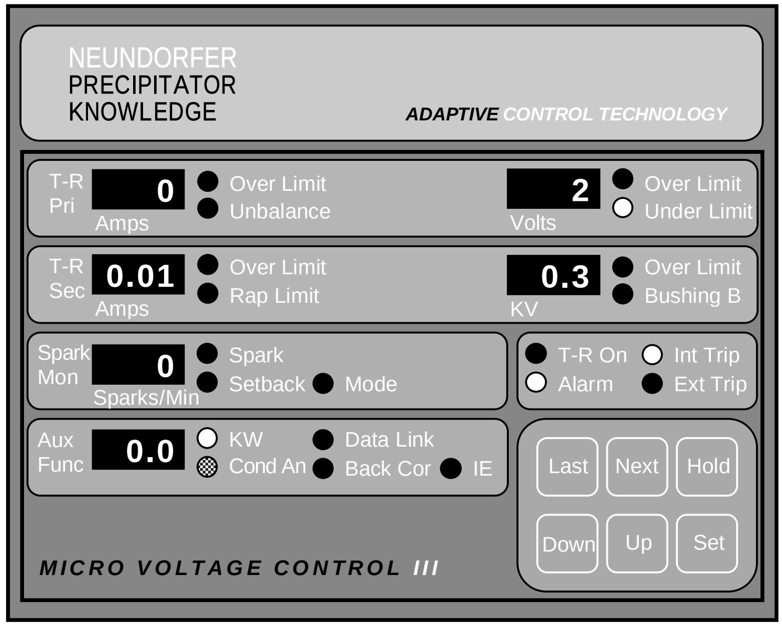
Solution: Remove from service until problem can be resolved during an outage.



Problem: All displays read zero or less than 1% of full scale. Control trips off on under voltage.

Cause: Open feed to T-R set.
Faulty CLR.
Faulty T-R set.

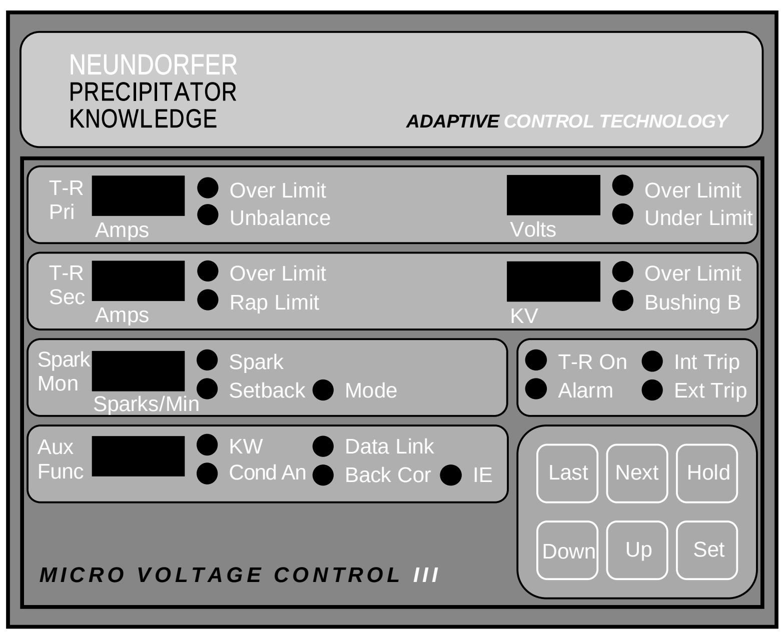
Solution: Check all fuses, breakers and connections.
Check CLR for open circuit.
Check T-R set for open primary.



Problem: All displays and indicators are dark.

Cause: No cabinet power. Main breaker open.
Blown F1 on **INTERFACE** PCB
Control transformer fuses blown.
Faulty control transformer.
Key interlock switch open.

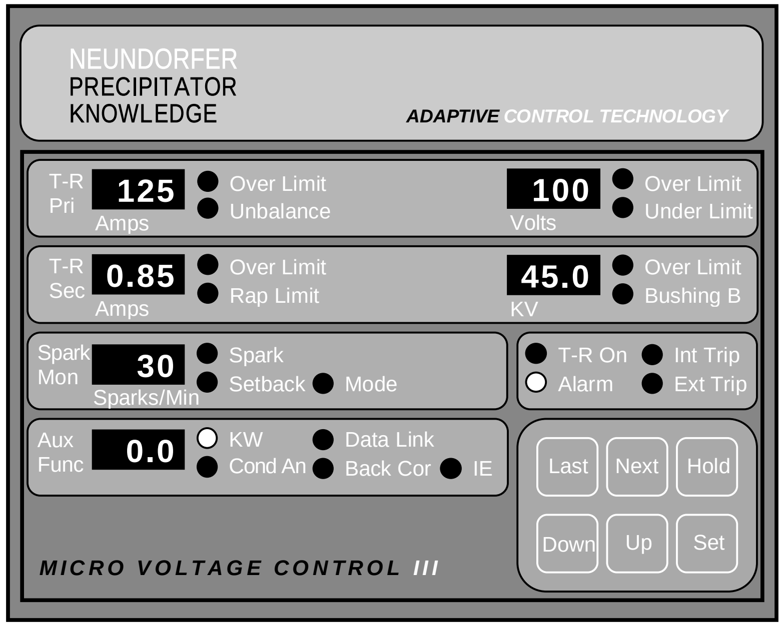
Solution: Locate and correct open circuit.



Problem: Control will not start.
Displays limits.

Cause: Control was stopped by data link command.
No feedback signal from contactor auxiliary contacts.
Faulty K5 SSRLY on **INTERFACE** PCB.
Contactor coil circuit open.
Faulty contactor.

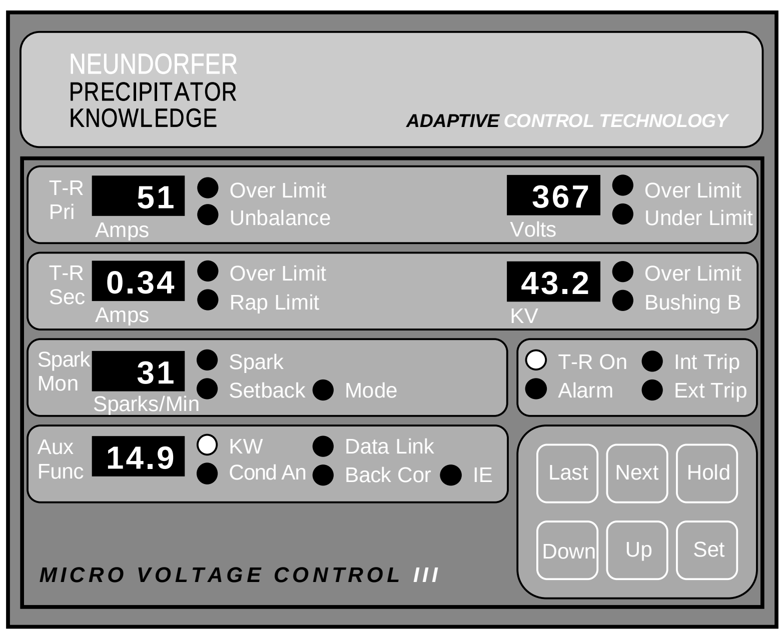
Solution: Issue data link start command.
If contactor is closing, check signal from auxiliary contacts to **INTERFACE** PCB.
Replace K5.
Repair contactor coil circuit.



Problem: Power level half of normal on dual bushing T-R set.

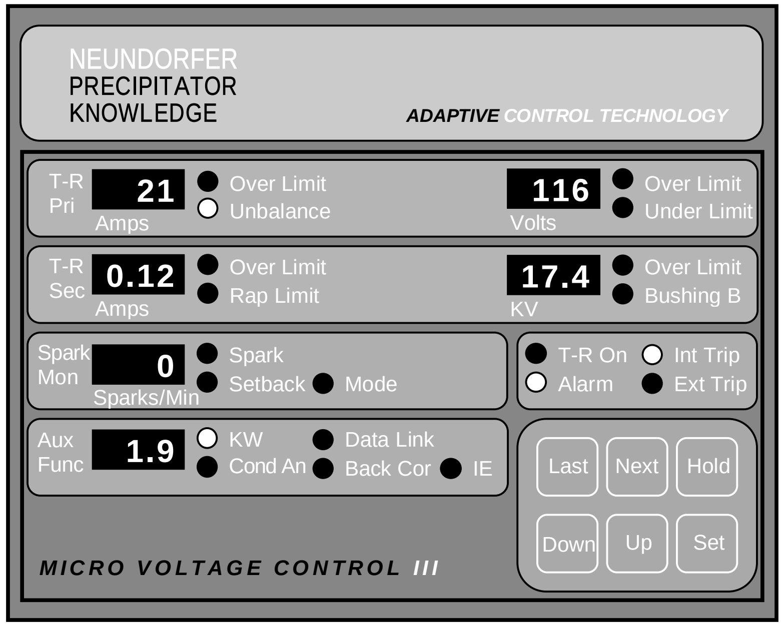
Cause: T-R set output selector switch set incorrectly.
Open circuit from one of the bushings to the bus section.

Solution: Check switch.
Check continuity from both bushings to bus section.



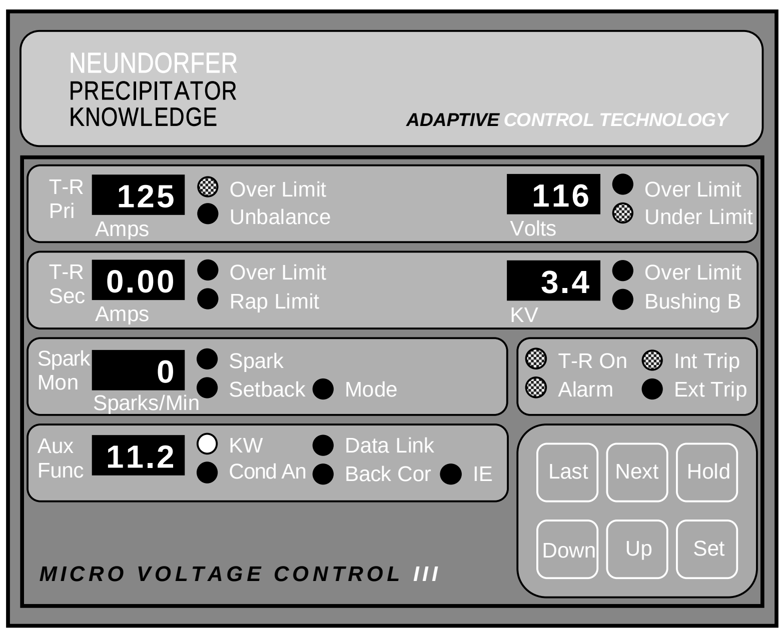
Problem: Control trips on **Unbalance**.

Cause:
Faulty SCR.
Blown SCR fuse.
Faulty **INTERFACE** PCB.
Faulty MVC III **LOGIC** PCB.
Faulty diode stack in T-R set.
T-R set running half wave with large difference in load between bushings.
T-R set running half wave with only one bushing connected.



Problem: No secondary current display.
Control does not sense sparks.
May trip on under voltage.

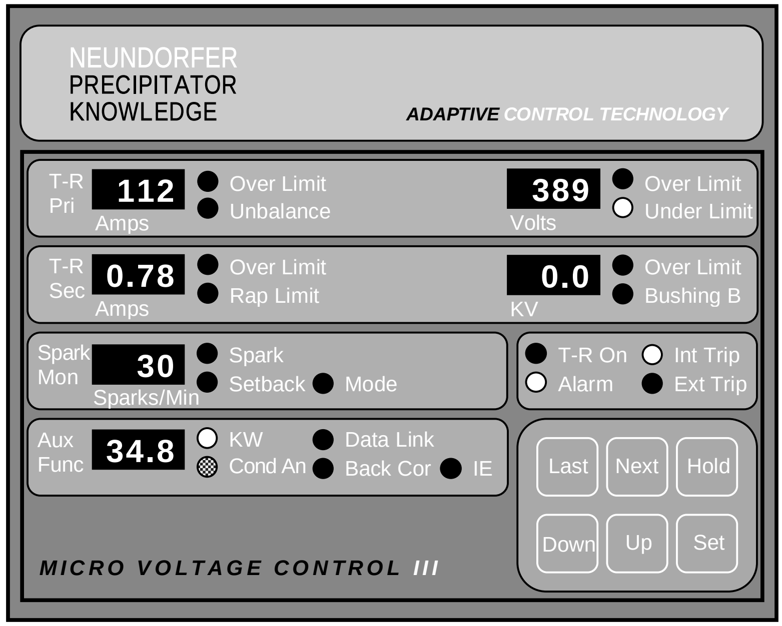
Cause:
Shorted secondary current surge arrestor.
Shorted secondary current feedback wiring.



Problem: No KV display, control trips on under voltage.

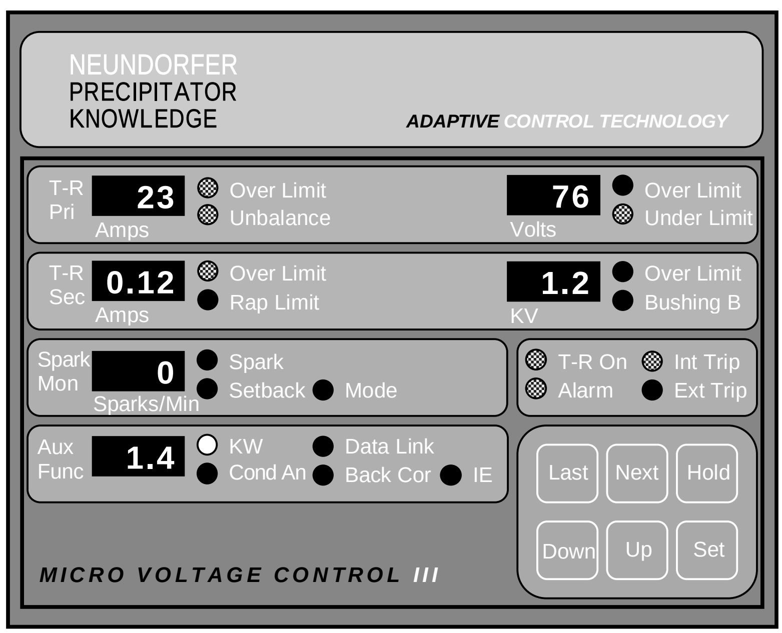
Cause: Shorted KV surge protector.
Shorted or open KV feedback wiring.
Faulty KV divider.

Solution: Temporarily disable the defective KV input to prevent trips. *See section 8.1*.



Problem: Primary and or secondary **Over Limit** trip in less than 2 seconds.

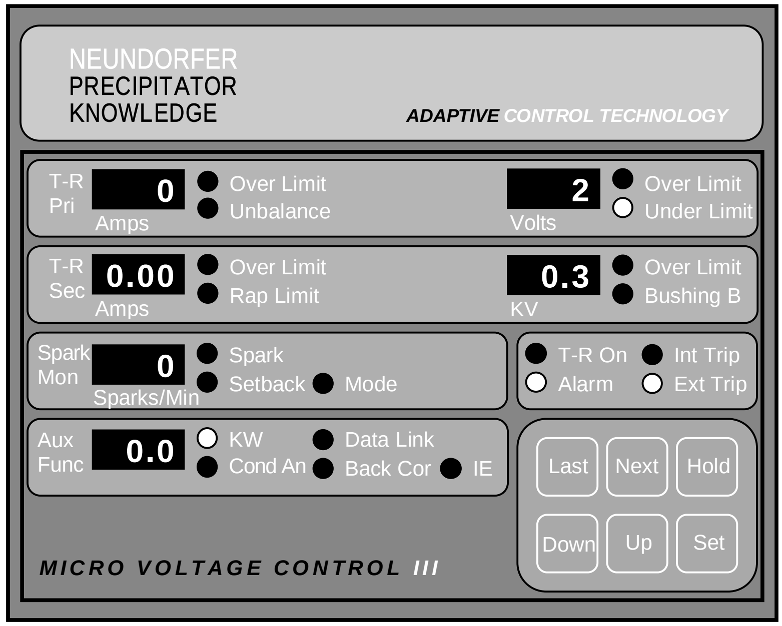
Cause: Shorted SCR.
One SCR installed backwards.
SCR stack wired incorrectly.
Defective **INTERFACE** PCB.



Problem: Control trips instantaneously when started.

Cause: Incorrect software configuration code.

Solution: *See section 8.1* to reprogram.



Problem: Spark rate much higher than setpoint.
Low current
May trip on **Primary Volts Under Limit** or may keep running.
Takes longer than 30 seconds to trip off.

Cause: Swinging discharge wire in precipitator.

Solution: Isolate bushing. Remove wire at next outage. *See section 13.4.4*.