Redkoh Industries

RK2000

Microprocessor Transformer Rectifier Control for Electrostatic Precipitators

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INTRODUCTION: Maximum Flexibility with Minimum Emissions

Redkoh Industries' RK2000 microprocessor transformer-rectifier control is designed specifically for use on electrostatic precipitators.

An extremely high degree of control flexibility is available through the RK2000’s many easily programmed operating parameters and automatic features. This flexibility, in turn, results in maximum precipitator efficiency and minimum outlet emissions.

This manual will define all the pre-programmed and field programmable features of the RK2000 control, as well as provide a description of the control components. A description of typical waveforms, and suggestions for optimizing the control’s operation, are also included.
CHAPTER 1  COMPONENTS AND CONFIGURATIONS

Major System Components

The following descriptions and pictures are presented to familiarize the user with the six components that make up the RK2000 microprocessor transformer-rectifier control: The photos shown are typical and may vary slightly from those shown.

The following is a list and definition of the major control components.

- Keypad and Display Unit
- Interface Unit
- Interface Communications Cable
- Current Transformer
- Potential Transformer
- Secondary Signal Conditioning Resistors

Keypad and Display Unit

The Keypad and Display Unit is the user interface to the various operating modes and variable parameters of the system. It communicates with other Keyboard and Display Units, and Interface Boards. Electrical readings, programming screens, alarm messages, operating messages, and communication information, are displayed on the face of this unit. A keyboard, for programming purposes, is also located on the face of this unit.

Figure 1: Keypad and Display Unit
Interface Unit

The Interface Unit is the interface between the analog and digital signals present in the control and feedback circuits. The SCR firing circuit is located on this Unit. It responds to precipitator operating conditions based on the parameters programmed into the Keyboard and Display Unit. **The switches for setting the Interface ID number are also located on this Unit.**

![Interface Unit Diagram](image)

**Figure 2: Interface Unit**
Interface Communications Cable

This cable is used between the Keypad and Display Unit, and the Interface Unit to provide a communications link for passing data.

![Interface Communications Cable](image)

Figure 3: Interface Communications Cable

Current Transformer

The Current Transformer (CT) and load resistor combination, when properly set, provides a 5V signal, at rated current, to the Interface Unit. The signal is used for primary current display and limit.

![Current Transformer](image)

Figure 4: Current Transformer

Potential Transformer

The Potential Transformer (PT) measures the transformer primary voltage and provides a reference signal to the Interface Unit. The PT has a ratio of 600 volts to 20 volts. The signal is used for primary voltage display and limit.
Signal conditioning resistors are provided for both the secondary current and secondary voltage reference signals. Their values will vary depending on the transformer-rectifier rating. (See schematics for proper values.) These signals are sent to the Interface Unit for secondary voltage and current display and limits, as well as spark pickup. Full scale is represented by a 5V signal.
## QUICK START CHART

### For One-to One System Configuration

(See page 3029)

A one-to-one system configuration is defined as a system where there is one Keypad and Display Unit, and one Interface Unit physically installed on each control cabinet. If you have more than one Keypad and Display Unit associated with more than one Interface Unit see the Quick Start Chat for a One-to Many Configuration (next page).

Not all parameters and operating modes need to be programmed in order to get the control(s) up and running. To get started quickly, for each control cabinet, follow the instructions in the order that they appear below.

1. Enter the Programming security code (page 30).
2. Program the Max Set Size (page 52).
3. Program the Limits (page 35).

The other parameters and operating modes have default values, based on typical precipitator operation. They will allow the control and precipitator to operate, but at less than optimum efficiency. All default values should be reprogrammed, as needed, to optimize the precipitator efficiency and minimize outlet emissions.

If the controls are each going to operate as a stand alone control (without communicating with any other device) all the control IDs and Names can be the same. If the controls are connected together via communication cables so they can talk to each other, or remote devices, the IDs and names will have to be changed to unique numbers/names. To reprogram the control IDs see page 31.
QUICK START CHART

For One-to-Many System Configuration

(See page 30)

A one-to-many system configuration is defined as a system where there is one or more Keypad and Display Units communicating with one or more Interface Units, regardless of location. If you have only one Keypad and Display Unit associated with only one Interface Unit see the chart for the One-to-One configuration.

Not all parameters and operating modes need to be programmed in order to get the control(s) up and running. To get started quickly follow the instructions in the order that they appear below. This must be done for each Keypad and Display Unit and each Interface Unit (control cabinet), as applicable.

1. Enter the security code (page 30).
2. Follow the ID set-up on page 31.
3. Program the Max Set Size (page 52).
4. Program the Limits (page 35).

The other parameters and operating modes have default values, based on typical precipitator operation. They will allow the control and precipitator to operate, but at less than optimum efficiency. All default values should be reprogrammed, as needed, to optimize the precipitator efficiency and minimize outlet emissions.
CHAPTER 2  OPERATING PARAMETERS AND FEATURES

The following is a list of the operating parameters and features incorporated in the RK2000 control. This list is followed by definitions (broken into programmable and non-programmable groups), and later in this manual, detailed instruction on how the parameters are programmed.

Arc Numerical Display
Automatic Display Calibration
Average Readings
Display ID
Efficiency Display
External Alarm/Trip
External Alarm Message Text
Instantaneous Kilowatt Display
Intermittent Energization Background Power
Intermittent Energization Mode
Intermittent Energization Optimize
Manual Control
Message Display
Nonvolatile Memory
Peak Readings
Peak Secondary Current Limit
Pedestal Rate
Phase Back
Power Down Rapping
Pre-Alarm Readings
Pre-Spark Readings
Primary Current Limit
Primary Voltage Limit
Process Sense
Quench Mode
Quench Time
Ramp Rate
Rapper System Set-up
Reinitialize Interface Unit
Reinitialize Keypad and Display Unit
SCR Conduction Angle Display
SCR Firing Delay
SCR Firing Indicators
SCR Imbalance Trip
Secondary Current Limit
Secondary Voltage Limit
Separate Spark and Arc Control Responses
Soft Start
Spark Numerical Display
Spark Rate Control
Spark Response in Manual Mode
True RMS Primary Voltage & Current Display
Under Voltage Time Delay
Under Voltage Trip – Primary
Under Voltage Trip – Secondary
DEFINITIONS OF PROGRAMMABLE PARAMETERS

The following definitions explain the programmable parameters available in the microprocessor transformer-rectifier control. Programming instructions are presented later in this manual. All programmable parameter values are entered into control memory through a 16-key, sealed membrane, dual-function keypad located on the control panel door (see page 256).

To prevent tampering with the control, a four-digit security programming access code is required to gain access to the programming mode (see page 290).

Average Readings

For situations where the process being controlled is highly erratic or fluctuates a great deal, the display can be programmed to show average electrical readings over a 5 second time period. This smoothes the display movement and makes it easier to read.

Definition of Control Responses

A transformer-rectifier will operate at its rated current or voltage levels unless the microprocessor transformer control circuitry detects a transient. When a transient is detected, the control automatically takes action to lower the operating levels of voltage and current.

The types of transients that the control detects are:

Spit – Low current, fast rise time electrical discharge that extinguishes itself instantaneously. Due to self-extinguishing characteristics, the RK2000 takes no control action when a spit is detected.

Spark – Low current, relatively slow rise time electrical discharge that persists for one half cycle or less before extinguishing when the current passes through its zero crossing level. The control phases back (reduces) the power for this condition.

The spark rate that is displayed in the Electrical Reading Screen is a sixty (60) second rolling average of these spark occurrences.

Arc – High current electrical discharge that persists for great than one-half cycle and usually requires removal of electrical power before it will extinguish. The control quenches (turns off) the power for this condition.

The arc rate that is displayed in the Electrical Reading Screen is a sixty (60) second rolling average of these arc occurrences.

Display ID

In order for information to be properly transferred between the Keypad and Display Unit and the Interface Unit, over the communications system, each Keypad and Display Unit must have an ID number.

Efficiency Display

The percentage of operating KV level as compared with the rated KV level can be displayed. This is used as a guide when attempting to maximize the KV operating level, primarily when using Intermittent Energization.
External Alarm/Trip

There are four (4) external alarm inputs that can be used to connect normally closed alarm contacts for such things as high TR temperature, high/low TR oil level, full hopper condition, drag conveyor failure, high O₂, or any other condition where a TR alarm or trip may be desired.

External Alarm Message Text

In conjunction with the external alarm inputs, there are twelve (12) preprogrammed tags (descriptions) that can be associated with each input.

Intermittent Energization

Intermittent Energization (IE) is a control strategy that takes advantage of the capacitive nature of the electrostatic precipitator. Its objective is to reduce power consumption and, in high-resistivity cases, improve precipitator performance by selectively controlling the “charge” time of the transformer-rectifier. More specifically, Intermittent Energization permits the programming of a discrete number of “charge” and “discharge” cycles, allowing the silicon-controlled rectifiers (SCRs) to conduct and not conduct for a programmable number of half cycles.

The power-saving feature is realized through the use of the stored power in the precipitator for particle charging and collecting. The level of energy savings will vary based on application, precipitator size and condition, and emissions level required.

Improved performance is typically related to the use of intermittent energization on high-resistivity applications. This is due to the mitigating effect that Intermittent Energization has on the formation of Back Corona.

The “charge” time and “discharge” time of the IE feature are both programmable (see Preprogrammed Levels And Operating Ranges, page 87).

Intermittent Energization Background Power

When in the Intermittent Energization mode or the Intermittent Energization Optimization mode, the power level during the discharge cycle does not have to be zero. It can be programmed for a power level between zero and 50% of full conduction angle.

Intermittent Energization Optimize

This mode of IE is used when the presence of Back Corona is suspected. In this mode the control automatically changes the charge and discharge cycles in an effort to optimize the value of the secondary voltage min. value. This mode should not be used for energy management purposes.

Max Set Size

The same microprocessor control components are used regardless of the size of the TR they are connected to. In order for the control to know what size TR it is connected to, the TR name plate ratings are field programmed into the control in a programming screen called Max Set Size.

Peak Readings

This is a special display that may be enabled to allow viewing of the TR operating peak, average, and minimum secondary voltage levels along with the secondary current level. When these values are recorded at various
operating levels a voltage vs. current (VI) curve can be drawn. The shape of this curve can provide valuable troubleshooting information.

**Peak Secondary Current Limit**

The Peak Secondary Current limit must be programmed, and remain at, the nameplate peak secondary current rating of the transformer-rectifier being controlled. The peak secondary current limit prevents the transformer-rectifier peak secondary current from exceeding its nameplate rating during operation in the Intermittent Energization mode.

**Pedestal Rate**

This feature operates in conjunction with Quench (see quench definition on page 16). After each Quench, the rate at which the power is reapplied to the precipitator is the Pedestal Rate. The Pedestal Rate is a programmable parameter (see Preprogrammed Levels And Operating Ranges, page 92). The rate is the number of cycles to recover from zero to the equivalent Phase Back level had the arc been a spark. (For a more detailed description of Pedestal Rate see the Discussion of Typical Control Waveforms on page 70).

**Phase Back**

Phase Back is the amount of power reduction that takes place after each spark occurrence. The amount of Phase Back is programmable (see Preprogrammed Levels And Operating Ranges, page 92).

Since it is undesirable to operate at high sparking levels, the Phase Back reduces power in an effort to keep the operating power just below the threshold of sparking. Typically, fewer sparks result in more uniform power in the precipitator and more stable precipitator efficiency. (For a more detailed description of Phase Back, see Discussion of Typical Control Waveforms, page 70).

**Power Down Rapping**

If the TR controller is communicating with a Redkoh MRC-NT Microprocessor Rapper Control over a communications loop, the TR power level can be set for a value below the automatic level when rappers are energized. Lower power levels make it easier for the particulate to be released from its collecting surface.

**Pre-Alarm Readings**

The display shows the last set of electrical readings that were taken prior to an alarm trip. It is used for diagnostic purposes when trying to determine the levels present prior to a trip.

**Pre-Spark Readings**

The display shows the last set of electrical readings that were taken prior to a spark. It is used for diagnostic purposes when trying to determine the kV spark over level.
Primary Current Limit

The Primary Current Limit is typically programmed for the nameplate current rating of the transformer-rectifier being controlled. The Primary Current Limit prevents the transformer-rectifier primary current from exceeding the programmed value. This limit can be used to limit operation of the control below the transformer rated current, or a manual override (% CURRENT) can be used for temporary operation below transformer rated current.

Primary Voltage Limit

The Primary Voltage Limit is typically programmed for the nameplate current rating of the transformer-rectifier being controlled. The Primary Voltage Limit prevents the transformer-rectifier primary current from exceeding the programmed value. This limit can be used to limit operation of the control below the transformer rated voltage, or a manual override (% CURRENT) can be used for temporary operation below transformer rated current.

Process Sense

The Process Sense circuit monitors the time between sparks and arcs. It automatically overrides the Ramp function if a spark or arc does not occur within a programmable period of time from the last spark or arc occurrence. (For a more detailed description of Process Sense, see Discussion of Typical Control Waveforms, page 66).

This control feature assures stable and rapid recovery after a process upset has subsided.

Quench Mode

The Quench Mode is programmable; it can activate the Quench time for “Arcs Only” or for “Sparks and Arcs”.

With the Quench Mode set to Arcs Only, only the detection of arcs will cause the Quench Time feature to become active. This is the preferred operating mode for precipitators collecting ash from the burning of coal.

With the Quench mode set to Sparks and Arcs, the detection of either a spark or an arc will cause the Quench feature to become active (For a more detailed description of Quench Mode, see the Discussion of Typical Control Waveforms, page 66).

Quench Time

When an arc occurs within the precipitator, it is necessary to turn off the power for at least one cycle to ensure the arc is extinguished. Turning off power after an arc is detected is called Quench. The length of time a Quench occurs is the Quench Time, and its length is programmable (see Preprogrammed Levels And Operating Ranges, Page 87).

Ramp Rate

The Ramp Rate is the rate at which the precipitator power increases after a Phase Back. Power recovery starts from the Phase Back level and continues at the Ramp Rate until either current limit or voltage limit is reached or a spark or arc occurs. The time programmed for the Ramp Rate is the time it takes the power to increase from the Phase Back level to pre-spark current level.
The Ramp Rate is field-programmed (see Preprogrammed Levels and Operating Ranges, page 92) for the lowest opacity operation under normal operating conditions (For a more detailed description, see Discussion of Typical Control Waveforms, page 66).

Reinitialize

Selecting this routine erases the contents of control memory and resets all parameters to their default values. There are two different re-initialization routines, one for the Interface Unit and one for the Keypad and Display Unit. The control must be reprogrammed after a re-initialization is requested.

SCR Conduction Angle

The control can be programmed to display the SCR conduction angle. How closely a control is matched to the actual transformer load is judged by comparing the actual conduction angle versus the maximum permissible conduction angle.

Secondary Current Limit

The Secondary Current Limit is typically programmed for the nameplate secondary current rating of the transformer-rectifier being controlled. The Secondary Current Limit prevents the transformer-rectifier from exceeding the programmed value. This limit can be used to limit operation of the control below the transformer rated secondary current or a manual override (% CURRENT) can be used for temporary operation below transformer rated secondary voltage.

Secondary Voltage Limit

The Secondary Voltage Limit is typically programmed for the nameplate secondary current rating of the transformer-rectifier being controlled. The Secondary Current Limit prevents the transformer-rectifier from exceeding the programmed value. This limit can be used to limit operation of the control below the transformer rated secondary current or a manual override (% CURRENT) can be used for temporary operation below transformer rated secondary voltage.

Spark Rate Control

This mode of operation allows a specific spark rate to be programmed into the control. The control will then automatically readjust itself to maintain a maximum spark rate equal to the programmed rate.

Software Version

The display can be enabled to show the part number and the version of the software presently being used in both the Keypad and Display Unit, and the Interface Unit. Physically opening up the control to check these items is no longer necessary.

Under Voltage Trip - Primary

If the primary voltage level drops below the programmed Primary Under Voltage Trip Level, for longer than the number of seconds programmed into the Under Voltage Timer (see Preprogrammed Levels And Operating Ranges, page 87) and the Primary Current is more than 20% of its rated value, the control will automatically de-energize. This feature reduces clinker formation due to full hoppers, increases discharge electrode life by...
eliminating energization of slack wires caused by full hoppers, and reduces the chance of support insulator failure due to tracking.

**Under Voltage Trip - Secondary**

If the secondary voltage level drops below the programmed Secondary Under Voltage Trip Level, for longer than the number of seconds programmed into the Under Voltage Timer (see Preprogrammed Levels And Operating Ranges, page 87) and the Primary Current is more than 20% of its rated value, the control will automatically de-energize. This feature reduces clinker formation due to full hoppers, increases discharge electrode life by eliminating energization of slack wires caused by full hoppers, and reduces the chance of support insulator failure due to tracking.

**Under Voltage Timer**

When an under voltage condition is detected (primary or secondary voltage operating below their under voltage set point level) a delay time can be set to delay the tripping of the control. This time delay allows for a ground condition to clear before the control is de-energized.
DEFINITION OF NON-PROGRAMMABLE FEATURES

The following are definitions of the non-programmable features that are built into the control.

Arc Numerical Display

The Electrical Reading Screen shows the number of Arcs Per Minute that are occurring.

Automatic Display Calibration

External variable resistors perform the calibration for the control feedback signals. These resistors are located on the primary current transformer (CT) and on the secondary current and secondary voltage signal conditioning resistor panel. It is not necessary to recalibrate any part of the control if replacing a Keypad and Display Unit or an Interface Unit.

SCR Imbalance Trip

Should either of the SCR firing circuits fail, the unbalanced firing would trigger a control shutdown. This prevents half wave DC voltage from being impressed on the primary of the transformer-rectifier set and protects the primary winding of the high-voltage transformer.

SCR Firing Delay

A firing delay of 40 microseconds is designed into the firing circuit. This delay allows the timing and synchronization pulses in the microprocessor CPUs to take place at zero crossing without being interfered with by SCR firing transients.

Soft Start

When the control is energized, it slowly increases the conduction angle of the SCR. This in turn slowly increases the power to the precipitator. This slow power rise eliminates current inrush on the power feeders and substations.

Spark and Arc Control Response

The default operating mode is for a spark to initiate a Phase Back, and an arc to initiate a Quench. An alternate response of both arcs and sparks initiating a Quench available.

Spark Rate Numerical Display

The Electrical Reading Screen shows the number of Sparks Per Minute that are occurring.

True RMS Primary Voltage and Current Displays

The primary voltage and current are displayed as true RMS values, not average values.

Manual Control

Should the need arise; the control can be operated in the Manual mode. An auto/manual dip switch is located on the Interface Unit. When switched to Manual mode, the message “Manual Mode” will be displayed on the display status line. When in manual, the control can be operated between 0 and 60% of rated current by adjusting the Manual bias trim pot located on the Interface Unit. If an over-current condition occurs while the control is in the
Manual mode, the control will de-energize and the Manual Overload light on the Interface Unit will illuminate.

**Manual Spark Response**

When placed in the Manual mode, the control will continue to sense sparks and quench for a preprogrammed time period at each occurrence. This will prevent spark/arc bursting conditions that could be detrimental to insulators and internal components. When in the Manual mode, the spark occurrences are indicated on the spark indicator LED on the Interface Unit.

**Non-Volatile Memory**

The RK2000 utilizes EEPROM (electronically erasable programmable read only memory) for storage of all preprogrammed and field-programmed information. EEPROMs do not require battery backups and are a nonvolatile memory with indefinite storage life.

**Watt Meter**

The instantaneous power consumption of each TR control is displayed on a continuous basis on the Electrical Reading screen.
CHAPTER 3  DIGITAL DISPLAY

The digital display is an integral part of the Keypad and Display Unit and is located on the control cabinet front door. All operating and programmable parameters are viewed on this 4 line by 20-character liquid crystal display (LCD).

There are individual screen views that are used for programming and display purposes. These screens are:

Device Selection Screen

When controlling more than one Interface Unit from a Display and Keyboard Unit, this screen shows the Interface Unit the display is communicating with and allows choosing an Interface Unit for data display or programming.

This is the opening screen if one Keypad and Display Unit is being used to control more than one Interface Unit or Control Cabinet.

If the Keypad and Display Unit is present on each control cabinet, the opening screen will be the Device Status Screen.

Using the up and down arrow keys on the keypad, the desired ID number/TR Name is scrolled in between the arrows. Pressing the ENTER key now will bring up the Device Status Screen for the chosen ID number.

Screen 1: Device Selection Screen

<table>
<thead>
<tr>
<th>Device Selection</th>
<th>&gt; ID 1  AVC-01  &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 2  Comm Fault</td>
<td></td>
</tr>
<tr>
<td>ID 3  Comm Fault</td>
<td></td>
</tr>
</tbody>
</table>

Device Status Screen

The device status screen displays operating conditions for an individual control. Data such as Run/Stop, alarm messages, status messages, etc. are shown here.

This is the opening screen if each control cabinet contains its own Keypad and Display Unit.

If the Keypad and Display Unit controls more than one control cabinet, this screen comes up when an ID number is chosen from the Device Selection Screen.

Screen 2: Device Status Screen

<table>
<thead>
<tr>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop.</td>
</tr>
<tr>
<td>Open Contactor</td>
</tr>
<tr>
<td>Continuous</td>
</tr>
</tbody>
</table>

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**Electrical Reading Screen**

Shows the electrical levels of the primary and secondary voltages and currents as well as spark and arc rates. Instantaneous kW consumption and operating mode are also shown.

Pressing the ENTER key while in the Devise Status Screen brings up the Electrical Reading Screen for the same control ID.

**Screen 3: Electrical Reading Screen**

```
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>205 V</td>
<td>159 A</td>
</tr>
<tr>
<td>56 kV</td>
<td>1874 mA</td>
</tr>
</tbody>
</table>
```

Or if only one secondary voltage signal is being used:

```
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>205 V</td>
<td>159 A</td>
</tr>
<tr>
<td>56 kV</td>
<td>1874 mA</td>
</tr>
</tbody>
</table>
```

The “Mode” area will display various messages (such as Stop, Avg., Pre Spk, Deg, and Inst. as they occur – these abbreviations will be explained later in the manual). When in the Stop mode a decimal point will flash after the “p” to indicate the Keypad and Display unit is working. The control default-operating mode is “Instantaneous” energization. In this operating mode “Inst.” will appear in the mode window.

If the control being viewed on the Electrical Reading Screen encounters a Communication Error alarm, the values for all the readings will reset to zeros and six question marks will appear in the mode area. The control may still be operating normally, however, the Keypad and Display Unit has no way of knowing the status at the Interface Board.

**Prompt Screen**

Displays all the parameters (one at a time as the up and down arrows are pressed) that are available for programming under the PROMPT key. When the desired parameter appears in the display and the ENTER key is pressed, the display changes to that Parameter Screen.

**Screen 4: Prompt Screen**

```
<table>
<thead>
<tr>
<th>Parameter Name</th>
</tr>
</thead>
</table>
```

**Parameter Screen**

Permits the programming of the selected parameter, showing valid choices.
Screen 5: Parameter Screen

Parameter Name
Programming Choices

Alarm Summary Screen

Identifies control names and alarms associated with those controls. The elapse time from the alarm occurrence in days, hours, minutes, and seconds is also provided. The arrow keys are used to scroll between multiple alarms on the same control as well as alarms on other controls.

If no key has been pressed for five minutes, and an alarm occurs, the control will automatically switch to the Alarm Summary Screen.

Note: If any of the above screens display “Update in Progress” it means the Keypad and Display Unit has requested data from the Interface Unit and it is waiting for the data. This condition should normally last only a fraction of a second. If this phrase remains on the screen it may indicate a communications problem between the two units.

The following is a list of the alarm and status message that may appear in the Device Status Screen. The detailed meaning of each message will be fully explained later in this manual.

Status Messages

<table>
<thead>
<tr>
<th>Status Message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Mgt Mode</td>
<td>-energy management mode active</td>
</tr>
<tr>
<td>IE Mode</td>
<td>-intermittent energization mode active</td>
</tr>
<tr>
<td>Manual Mode</td>
<td>-manual mode of operation active</td>
</tr>
<tr>
<td>Open Contactor</td>
<td>-control has de-energized the main contactor</td>
</tr>
<tr>
<td>Stop Mode</td>
<td>-Control is “off”</td>
</tr>
<tr>
<td>Power Down Rapping</td>
<td>-reduced KV limit active</td>
</tr>
<tr>
<td>Under Voltage</td>
<td>-Under voltage detected and trip may follow</td>
</tr>
<tr>
<td>Stand Alone</td>
<td>Interface switch in Stand Alone position</td>
</tr>
<tr>
<td>Wash-Down Active</td>
<td>Wet ESP wash down cycle active</td>
</tr>
<tr>
<td>Relay X Active</td>
<td>Relay timer is active</td>
</tr>
<tr>
<td>Communications Error</td>
<td>-communication error between Keypad &amp; Display Unit, and the Interface Unit</td>
</tr>
<tr>
<td>Software Conflict</td>
<td>Software version conflict between Keypad &amp; Display Unit and the Interface Unit</td>
</tr>
</tbody>
</table>

Alarm Messages  See appendix III

<table>
<thead>
<tr>
<th>Alarm Message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Overload</td>
<td>-trip due to over current condition</td>
</tr>
<tr>
<td>Full Hopper</td>
<td>-hopper beneath TR area is full</td>
</tr>
<tr>
<td>High O₂ Trip</td>
<td>-Trip due to high O₂ in flue gas</td>
</tr>
<tr>
<td>High SCR Temp</td>
<td>-main SCR heat sink is at an over temperature level</td>
</tr>
<tr>
<td>Low T/R Level</td>
<td>-low transformer-rectifier oil level</td>
</tr>
<tr>
<td>High T/R Temp</td>
<td>-high transformer-rectifier oil temperature</td>
</tr>
<tr>
<td>MRC Comm. Error</td>
<td>-communication error between the TR control and the Rapper control when in Power Down Rapping mode</td>
</tr>
<tr>
<td>Master Fuel Trip</td>
<td>-control de-energized due to master fuel trip</td>
</tr>
<tr>
<td>Memory Clear</td>
<td>-memory has been cleared, backup active</td>
</tr>
</tbody>
</table>
### Alarm Messages

<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR Unbalance</td>
<td>Trip due to SCR unbalance</td>
</tr>
<tr>
<td>Under voltage Trip</td>
<td>Trip due to under voltage condition</td>
</tr>
<tr>
<td>Alarm 1</td>
<td>User defined alarm/trip</td>
</tr>
<tr>
<td>Alarm 2</td>
<td>User defined alarm/trip</td>
</tr>
<tr>
<td>Alarm 3</td>
<td>User defined alarm/trip</td>
</tr>
<tr>
<td>Alarm 4</td>
<td>User defined alarm/trip</td>
</tr>
</tbody>
</table>

If more than one alarm or status message occurs at the same time, they will be scrolled at two (2) second intervals in the mode area of the Electrical Reading Screen. Any number of alarm or status messages may be present.

**NOTE:**

Alarms that cause a control to trip require that the ON/OFF switch on the front of the control cabinet be turned to OFF then ON to reset the control. The Alarm Clear key must be pressed to clear the alarm from the display after the cause has been remedied. If the alarm condition is still present, the control will again trip.
CHAPTER 4  KEYPAD DESCRIPTION

The keypad (see below) contains 16 hermetically sealed keys. All operating parameters, status checks, and On/Off functions are programmed into the memory through keypad.

The keys are labeled as follows:

Limit/O
Ramp/1
Phase Back/2
Ped/3
Quench/4
Ie/5
6
↑/7
Hold/8
Help/9
Code/●
Prompt/↓
Esc
Clear Alarm
Enter
Device Select

Figure 7: KEYPAD

KEY FUNCTION

The following is a description of the function of each key.

**Numerical keys** – The numerical keys are used for entering numerical values for the programmable parameters.

**LIMITS key** – Used to check (or in conjunction with a security code to program) the control limits (primary voltage limit, primary current limit, secondary current limit, secondary voltage limit and Under Voltage trip). (For programming ranges, see Preprogrammed Levels And Operating Ranges, page 92.)

**RAMP key** – Used to check (or in conjunction with a security code to program) the value of the Ramp Rate. (For programming range, see Preprogrammed Levels And Operating Ranges, page 92.)

**PHASE BACK key** – Used to check (or in conjunction with a security code to program) the value of the Phase Back. (For programming range, see Preprogrammed Levels And Operating Ranges, page 92.)

**PED key** – Used to check (or in conjunction with a security code to program) the value of the Pedestal Rate. (For programming ranges, see Preprogrammed Levels And Operating Ranges, page 92.)

**QUENCH key** – Used to check (or in conjunction with a security code to program) the value of the Quench time. (For
programming ranges, see Preprogrammed Levels And Operating Ranges, page 92.)

IE key – Used to check (or in conjunction with a security code to program) the value of the Intermittent Energization On time, Total cycle time, and On/Off toggle. (For programming ranges, see Preprogrammed Levels And Operating Ranges, page 92.)

↑ key – Used to scroll up through the programmable parameters after pressing the prompt key.

HOLD Key – When electrical readings are being viewed or recorded by hand from the Electrical Reading Screen pressing the HOLD key will freeze the display. All the electrical levels are now presented with the same time base. Pressing the HOLD key again places the display back to normal. If the HOLD key is not pressed again, the screen automatically returns to normal after 5 minutes.

HELP Key – Displays the Technical Help phone number. Also provides the screens necessary to set up the total number of devices communicating with an individual Keypad and Display Unit and the ID of the Keyboard and Display unit. Screens for setting up the timer relay coordination system are also presented under this key.

CODE key – Used for entry of a security code before most parameters and features can be programmed. To keep unauthorized personnel from changing the programmable parameter settings, a security code is required to make changes to most control parameters. Without the proper security code, it is impossible to program or make changes to most control parameters and set points.

When a parameter’s Parameter Screen shows an icon of a padlock on the Enter line, it means that a security code must be entered before the parameter can be changed. Two padlock icons indicate that the control must also be in the stop mode to make a parameter change.

The CODE key is accessible at the Device Selection, Device Status, Electrical Reading, and Prompt Screens. If you are in the Parameter Screen press the ESC key. This will back you up one screen to the Prompt Screen. Enter the appropriate security code, and press ENTER a second time to return to the Parameter Screen.

If an invalid code is entered, the display will show “Invalid Code” for 3 seconds and then revert to the screen that was present prior to pressing the CODE key.

To maintain the integrity of the security code system, the control will automatically clear the code five minutes after the last key is pressed. It is recommended that the code be cleared manually after program changes have been completed.

To manually clear the security access code:
Press the CODE key
Press 0 0 0 0
Press the ENTER key

PROMPT / DOWN key – Brings up the first programmable parameter into the Prompt display. Pressing this key again will scroll down through the programmable parameters.

ESC key – Used when a numerical value programmed into the control is incorrect and the programmer wants to ignore the data entered, or when returning from a parameter to the normal display.

CLEAR ALARM key – Used without a security code to view alarms that may be present for each individual ID/control. If an alarm is present, this key is also used to clear the alarm from the alarm screen once the cause of the alarm has been eliminated.

ENTER key – Used to accept numerical data that has been programmed into the keypad.

DEVICE SELECT key – Used to select a control to be viewed or programmed.

In addition to the keys on the keypad, an ON/OFF or push button switch on the control cabinet is provided. This switch is used to energize and de-energize the control components and in turn the power to the Transformer Rectifier.

To de-energize the power to the cabinet control circuits, the breaker must be opened.

When the ON/OFF or push button switch is OFF, and the breaker is closed, the Electrical Reading Display will show zeros for all electrical readings and the mode area will show the message “Stop” (see Screen 6)

Screen 6

<table>
<thead>
<tr>
<th>AVC-01</th>
<th>000V</th>
<th>000 A</th>
<th>000 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>00kV1</td>
<td>00kV2</td>
<td>000 mA</td>
<td></td>
</tr>
<tr>
<td>0000sp</td>
<td>000ar</td>
<td>Stop.</td>
<td></td>
</tr>
</tbody>
</table>

In this OFF condition, all the programmable parameters may be viewed in their appropriate screen (or changed with the proper security code) without energizing the associated transformer-rectifier (T/R).

Note: BEFORE ENERGIZING THE CONTROL FOR THE FIRST TIME, THE “MAX SET SIZE” VALUES MUST BE PROGRAMMED. IF THIS IS NOT DONE THE CONTROL WILL NOT ENERGIZE

When the breaker is closed and the STOP/START switch is placed in the START position, there is a one second delay between the energizing of the contactor and firing of the SCRs. When the SCRs are fired they are done so slowly so there is no inrush on the control electrical feeders or substation. Power is
applied to its associated transformer until either sparking or arcing occurs, or an electrical limit has been reached. If no sparking or arcing is occurring, the display will be similar to Screen 7. If sparking or arcing is occurring, the display will be similar to Screen 8.

Screen 7: No Sparking Present

<table>
<thead>
<tr>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>205 V</td>
</tr>
<tr>
<td>56kV1</td>
</tr>
<tr>
<td>000sp</td>
</tr>
<tr>
<td>159 A</td>
</tr>
<tr>
<td>00kV2</td>
</tr>
<tr>
<td>000ar</td>
</tr>
<tr>
<td>026 kW</td>
</tr>
<tr>
<td>1874mA</td>
</tr>
<tr>
<td>Inst.</td>
</tr>
</tbody>
</table>

Screen 8: Sparking/Arcing Present

<table>
<thead>
<tr>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 V</td>
</tr>
<tr>
<td>22 KV1</td>
</tr>
<tr>
<td>023sp</td>
</tr>
<tr>
<td>167 A</td>
</tr>
<tr>
<td>22KV2</td>
</tr>
<tr>
<td>000ar</td>
</tr>
<tr>
<td>024 kW</td>
</tr>
<tr>
<td>076MA</td>
</tr>
<tr>
<td>Inst.</td>
</tr>
</tbody>
</table>

Note: If an electrical limit is reached, the Status Screen will display the electrical limit that has been reached. The following messages will appear, as appropriate, on the Status Screen:

- Pri. Volt Limit
- Pri. Current Limit
- Sec. Volt Limit
- Sec. Current Limit
- mA Peak Limit
- Full Conduction
CHAPTER 5

PROGRAMMING INSTRUCTIONS

There are two different ways that the RK2000 control can be configured. The first configuration is a one-to-one configuration where there is one Keyboard and Display unit, and one Interface Board, on each control cabinet. The second configuration is a one-to-many configuration where one or more Keypad and Display Units are connected to many Interface Boards in an equal number of control cabinets.

Viewing Parameters

An access code is not required to view any of the control parameters, modes, limits, set points, toggles, displays, etc. A code is also is not required to change screen views. To view information, follow the same instructions as for programming a parameter.

Security Programming Code Entry

Before any programming changes can be made, a security code must be entered into the control. This is accomplished by pressing the CODE key while in the Device Selection, Device Status, or Electrical Reading Screens.
Screen 9

Range: 0000-9999
Enter CODE: 

Press the numerical keys that correspond to the proper security code. As the numbers are entered, pound signs (#) will appear on the Enter Code line and scroll to the left to indicate the quantity of numbers already entered. If the correct security code has been entered, the display will return to the previous screen. If an incorrect security code was entered, the message “Invalid Code” will appear on the status line (see Screen 10), remain for a few seconds, then return to the previous screen.

Screen 10

Range: 0000-9999
Enter CODE: ####
Invalid Code

If a code has not been entered and you attempt to change a parameter that requires a code, an icon of a padlock will appear in the Parameter Screen’s bottom line to remind you that a code entry is required. If two padlock icons are present it is a reminder that a code is required and either the control is running and must be stopped before changing the parameter.

ID Set-Up

Each Keypad and Display Unit, and each Interface Unit must be programmed with their associated ID numbers. This is necessary to insure proper communications between all the Units. For a One-to-One configuration where there is a Keypad and Display unit on each control cabinet, the ID of the Keypad and Display Unit and the Interface Unit can be any number up to 99, as long as each matches the other on a per cabinet basis.

For a One-to-Many configuration, each Keypad and Display Unit must have a unique ID number, and each Interface Unit must have a unique sequential ID number on a communications loop basis. That is, all the Interface Units that talk over the same loop must have different sequential ID numbers amongst themselves, and the Keypad and Display Units on the same loop must have different ID numbers amongst themselves.

To set up the ID numbers for the Keypad and Display Units, as well as set the range of Interface Unit IDs that the Keypad and Display Unit(s) communicate with, proceed as follows:

Press the CODE key
Enter the appropriate code numbers
Press ENTER
Press the HELP key and the Technical Help phone number
screen appears.

Press ENTER or the HELP key again and the Keypad and
Display ID Selection Screen appears (Screen 11).

**Screen 11**

**Keypad/Display Unit
ID Selection
Range: 1-250
Enter: 005**

The acceptable range for the ID is presented to the right of the
word “Range”. In this example, the range is 1 to 250.

The present ID number is presented to the right of the word
“Enter”. In this example the present ID is 005.

If the ID number is to be changed, simply press the numeric keys
corresponding to the new value (the old value will be overwritten)
and press ENTER. If the present operating value is acceptable,
simply press ENTER without making any changes. The Interface
Unit End ID Number Screen will now appear.

**Screen 12**

**Interface Unit
End ID Number
Range: 1-99
Enter: 05**

The Interface Unit End ID number is the last Interface Unit that
you wish this Keypad and Display Unit to communicate with.

The acceptable range for the ID is presented to the right of the
word “Range”. In this example, the range is 1 to 99.

The present end ID number is presented to the right of the word
“Enter”. In this example the present ID is 05.

**Screen 13**

**Interface Unit
Start ID Number
Range: 1-5
Enter: 01**

If the end ID number is to be changed, simply press the numeric
keys corresponding to the new value (the old value will be
overwritten) and press ENTER. If the present operating value is
acceptable, simply press ENTER without making any changes.
The Interface Unit Start ID Number Screen will now appear.

The acceptable range for the ID is presented to the right of the
word “Range.” In this example, the range is 1 to 5, where 5 is
the number entered for the End ID Number.

The present start ID number is presented to the right of the word
“Enter.” In this example the present ID is 01.
If the start ID number is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present value is acceptable, simply press ENTER without making any changes.

Each Interface Unit must be set for its specific ID number. This is accomplished by adjusting two miniature rotary switches on each Interface Board. Set these switches so each Interface Unit has a unique ID number. See Chapter 11, page 73, area 9.

**Coordination Set-up**

If the optional timer relays on the Interface board are to be used for energizing motorized cleaning equipment of the WESP wash down system, the Coordination System must be set-up as explained below. The following coordination prompts will only be displayed if the Keypad and Display ID has been set to “01”.

Screen 13A

| Coordination System  
|---------------------|  
| 0=Disable, 1=Enable 
| Enter: 0            |

If all timers and their associated relays on the Interface Unit are to operate independently, the Coordination System should be disabled. If the timers and relays are to be set-up so selected timers will not operate while other timers are running, the Coordination System should be enabled. The assigning of the timers and relays into anti-coincidence groups is described in the Prompt screen under Rapper System Set-up.

Only the Keypad and Display Unit designated ID #01 can act as the coordination master. If coordination is desired, one, and only one, of the Keypad and Display Units must be programmed as ID#1.

The number representing the present state of the Coordination System is displayed next to the word “Enter”. To change the state of the system, simply enter the desired number, “0” to disable and “1” to enable the system, (the old number will be overwritten), and press ENTER.

If “1” was entered, to enable the system, the Coordination System End ID Number screen will now appear.

Screen 13B

| Coordination System  
|---------------------|  
| End ID Number       
| Range: 1-99         
| Enter: 01           |

The End ID Number represents the last Interface Unit that the Keyboard and Display Unit will coordinate. The acceptable
range for the End ID is presented to the right of the word “Range”. In this example, the range is 1 to 99.

The present End ID number is presented to the right of the word “Enter”. In this example the End ID is 05.

If the End ID number is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The Coordination System Start ID Number Screen will now appear.

Screen 13C

<table>
<thead>
<tr>
<th>Coordination System Start ID Number Range: 1-1 Enter: 01</th>
</tr>
</thead>
</table>

The acceptable range for the Coordination System Start ID is presented to the right of the word “Range.” In this example, the range is 1 to 05, where 5 is the number entered for the End ID Number.

The present start ID number is presented to the right of the word “Enter.” In this example the present ID is 01.

If the start ID number is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

KV2 Display
The default display shows both KV1 and KV2 for TRs that operate in the dual half wave mode (two output bushings). This screen permits hiding the KV2 signal for TRs that operate in the full wave mode (single bushing or dual bushings that are tied together to act as a single TR output).

<table>
<thead>
<tr>
<th>KV2 Display 0=Disable, 1=Enable Enter: 1</th>
</tr>
</thead>
</table>

Press the 0 key to remove the KV2 reading from the display. Press 1 to restore the KV2 reading.

After the KV2 Display option has been selected, the software part number is displayed for reference.
In the above example, the software part number is “RK2001” and the software version numbers is “1.00”.

Press the Enter key to return to the Device Selection screen.

Programming Discrete Key Parameters

For programming purposes, operating parameters are grouped into two types. One type is the discrete key parameter that is associated with a specific key on the keypad, and the other is a parameter that is associated with the PROMPT key.

The following instructions are for programming the discrete key parameters:

Limits key

The limit key is used to program the limits of Primary Voltage, Primary Current, Secondary Current, Secondary Voltage, and the Under Voltage trip level. These limits are the highest allowable operating levels during normal control operation. The upper limits are determined by the values entered when programming the Max Set Size (see page 53). Press the LIMITS key and the control will automatically walk you through the programming of these limits.

Primary Voltage Limit

Once the LIMITS key is pressed Screen 14 appears.

Screen 14

The acceptable range for the Primary Voltage Limit is presented to the right of the word “Range.” In this example, the range is 25 to 600 volts.

The present operating value for the primary voltage limit is presented to the right of the word “Enter.” In this example the present operating value is 400 volts.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The Primary Current Limit display will now appear.
Primary Current Limit

The Primary Current Limit display is shown in Screen 15.

Screen 15

```
AVC-01
Pri Current Limit
Range: 1-500 Amperes
Enter: 500
```

The acceptable range for the Primary Current Limit is presented to the right of the word “Range.” In this example the range is 1 to 500 amps.

The present operating value for the Primary Current Limit is presented to the right of the word “Enter.” In this example the present operating value is 500 amps.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The Secondary Current Limit display will now appear.

Secondary Voltage Limit

The Secondary Voltage Limit display is shown in Screen 16.

Screen 16

```
AVC-01
Sec. Voltage Limit
Range: 1-99 kV
Enter: 99
```

The acceptable range for the Secondary Voltage Limit is presented to the right of the word “Range.” In this example, the present operating value is 99 kV (Kilovolts).

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The display will now return to normal.

Secondary Current Limit

The Secondary Current Limit display is shown in Screen 17.

Screen 17

```
AVC-01
Sec. Current Limit
Range: 1-3000 mA
Enter: 3000
```

The acceptable range for the Secondary Current Limit is presented to the right of the word “Range.” In this example the range is 1 to 1500 mA (milliamps).
The present operating value for the Secondary Current Limit is presented to the right of the word “Enter.” In this example the present operating value is 3000 mA.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The Secondary Voltage Limit display will now appear.

### RAMP

Press the RAMP key. The Ramp Rate display (Screen 18) appears.

**Screen 18**

```
AVC-01
Ramp Rate
Range: 0.2-60.0 sec.
Enter: 10.0
```

The acceptable range for the Ramp Rate is presented to the right of the word “Range.” In this example, the range is 0.2 to 60 seconds.

The present operating value for the Ramp Rate is presented to the right of the word “Enter.” In this example the present operating value is 10.0 seconds.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. Either way, the display will now return to the previous screen.

### PHASE BACK

Press the PHASE BACK key. The Phase Back display (Screen 19) appears.

**Screen 19**

```
AVC-01
Phase Back
Range: 1-99%
Enter: 20
```

The acceptable range for the Phase Back is presented to the right of the word “Range.” In this example, the range is 1 to 99 percent.

The present operating value for the Phase Back is presented to the right of the word “Enter.” In this example the present operating value is 20 percent.
If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The screen will now revert to either the Device Status Screen or the Electrical Reading Screen depending which screen was active when the PHASE BACK key was pressed.

---

**PED**

Press the PED key. The Pedestal Mode display (Screen 20) appears.

**Screen 20**

<table>
<thead>
<tr>
<th>AVC-01 Pedestal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range: 1-10 Cycles</td>
</tr>
<tr>
<td>Enter: 02</td>
</tr>
</tbody>
</table>

The acceptable range for the Pedestal Rate is presented to the right of the word “Range.” In this example, the range is 1 to 10 cycles.

The present operating value for the Phase Back is presented to the right of the word “Enter.” In this example the present operating value is 2 cycles.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The screen will now revert to either the Device Status Screen or the Electrical Reading Screen depending which screen was active when the PED key was pressed.

---

**QUENCH**

Press the QUENCH key. The Quench Time display (Screen 21) appears.

**Screen 21**

<table>
<thead>
<tr>
<th>AVC-01 Quench Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range: 1-9 Cycles</td>
</tr>
<tr>
<td>Enter: 4</td>
</tr>
</tbody>
</table>

The acceptable range for the Quench time is presented to the right of the word “Range.” In this example, the range is 1 to 9 Cycles.

The present operating value for the Quench time is presented to the right of the word “Enter.” In this example the present operating value is 4 cycles.

If the operating value is to be changed, simply press the numeric key corresponding to the new value (the old value will be overwritten) and press ENTER.
overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The screen will now revert to either the Device Status Screen or the Electrical Reading Screen depending which screen was active when the PED key was pressed.

Press the IE key. The first of seven Intermittent Energization displays (Screen 22) appears.

Screen 22

```
AVC-01
IE Charge ½ Cycles
Range: 1-30 ½ Cyc
Enter: 02
```

The acceptable range for the Intermittent Energization Charge half cycles (half cycles “ON”) is presented to the right of the word “Range.” In this example, the range is 1 to 30 half cycles.

The present operating value for the IE Charge ½ Cycles is presented to the right of the word “Enter.” In this example the present operating value is 2 half cycles.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the IE Discharge Cycles display (Screen 23).

Screen 23

```
AVC-01
IE Discharge Cycles
Range: 1-16 Cycles
Enter: 01
```

The acceptable range for the Intermittent Energization Discharge Cycles (total “Off” cycles) is presented to the right of the word “Range.” In this example, the range is 1 to 16 cycles.

The present operating value for the Intermittent Energization Discharge Cycles is presented to the right of the word “Enter.” In this example the present operating value is 1 cycle.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the third IE Background Power display (Screen 24).
There are certain conditions where having some small amount of power available during the discharge cycle time is advantageous to precipitator operation. This power is called IE Background Power.

The acceptable range for the IE Background Power is presented to the right of the word “Range.” In this example, the range is 0 to 50 percent of full conduction angle.

The present operating value for the IE Background Power is presented to the right of the word “Enter.” In this example the present operating value is 00%.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the IE Optimize display (Screen 25).

IE optimize automatically tries to optimize the secondary voltage minimum (KV min) value. This is the best place to operate if Back Corona is present in the precipitator. Back Corona is a condition that is present if the process results in a high resistivity particulate. The control will automatically readjust the charge and discharge times and measure differences in the kV min to determine if Back Corona is present. If it is present it will operate at the point where the kV min is the greatest value. After the Auto/Opt. time period, the control will again vary the charge and discharge times to test for the kV min value.

To turn-on (enable) the IE Optimize function, press the 1 key, to turn off (disable) the IE Optimize function press the 0 key. Your selection will appear opposite the word Enter, and become active when the ENTER key is pressed.

If the present operating mode is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the IE Auto/Opt. time display (Screen 26).
Screen 26

**AVC-01**

**IE Timer**
Range: 5-180 minutes
Enter: 5 minutes

The Auto/Opt. time is the time the control will run in the optimized mode before re-optimizing.

Enter the desired time value from 5 to 180 minutes. Your entry will be displayed opposite the word Enter and become active when the Enter key is pressed. If the present operating mode is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the IE Enable/Disable display (Screen 27).

Screen 27

**AVC-01**

**IE Enable/Disable**
0=Disable, 1=Enable
Enter: 0

To turn-on (enable) the IE function press the 1 key, to turn off (disable) the IE function press the 0 key. Your selection will appear opposite the word Enter, and become active when the ENTER key is pressed.

If the present operating mode is acceptable, simply press ENTER without making any changes. The screen will now revert to either the Device Status Screen or the Electrical Reading Screen depending which screen was active when the IE key was pressed.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

**PROMPT**

Pressing this key brings up the Prompt screen that allows additional parameters to be viewed and programmed. See Programming Prompt Key Parameters that follows this section.

**Clear Alarm**

Pressing this key activates the Alarm Summary Screens. These screens show which, if any, controls have an alarm, the elapsed time since the alarm occurred, and the name of the alarm (Screen 28).
Screen 28

<table>
<thead>
<tr>
<th>Alarm</th>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>-01 18:23:37</td>
</tr>
<tr>
<td></td>
<td>Undervoltage Trip</td>
</tr>
<tr>
<td>Scroll using</td>
<td>↑ or ↓</td>
</tr>
</tbody>
</table>

Scrolling through the alarms will show any additional alarms for a specific ID, or alarms for other IDs.

The first two numbers after the “−” on the time line show number of days, the next six numbers show the hours: minutes: seconds since the alarm condition has occurred.

**When the cause of an alarm is repaired, it is necessary to return to the CLEAR ALARM screen, scroll to the appropriate ID number and press the CLEAR ALARM again to clear the alarm from the display.**
Programming Prompt Key Parameters

PROMPT Key

The functions not found on the discrete keys are programmed through the use of the PROMPT key. Pressing the PROMPT key brings up the first of eighteen (18) prompts of additional programmable parameters.

Pressing the up and down arrows (↑↓) scrolls the display forward and backwards through the 18 prompt displays.

The following programmable parameters appear sequentially when pressing the PROMPT key and then the down arrow (↓) key.

Averaged Readings
Pre-spark Readings
Peak Readings
SCR Conduction Angle
Efficiency Display
Spark Rate Control
Quench Mode
Process Sense
Peak Limits
Software Version
Reinitialize Keypad and Display Unit
Reinitialize Interface Unit
Max. Set Size
External Alarm trip
External Alarm Message Text
Under Voltage Setup
Energy Mgt Setup
Wash Down System
Power Down Rapping
Motorized Rapping Timer Set-up

If you are in a prompt screen, and return to the Electrical Reading Screen or the Device Status Screen, when you press the PROMPT key again you will be returned to the last prompt that was displayed. If the security code times out before returning to the PROMPT key, the prompts will start with the Run/Stop prompt.

The following are instructions on programming all the parameters found under the PROMPT key. They are listed in the order found by pressing the down arrow.

Average Readings

Press the PROMPT key and the “Averaged Readings” prompt screen appears (Screen 29).

Screen 29

Averaged Reading
Press ENTER and the ‘Averaged Readings’ parameter screen will appear (Screen 30).

Screen 30

```
AVC-01
Averaged Reading
0=Disable, 1=Enable
Enter: 0
```

This screen allows the Averaged Readings display to be enabled (1) or disabled (0). If the Averaged Reading is enabled, the “normal” display will show electrical readings that are averaged over a five (5) second period. The mode area of the Electrical Reading Screen will display “Avg.” (Screen 31).

Screen 31

```
AVC-01
205 V 161 A 026 kW
56kV1 00kV2 1887mA
000sp 000ar Avg.
```

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Pre-Spark Readings

Press the PROMPT key and then the ↓ key until the “Pre-Spark Readings” Prompt Screen appears (Screen 32).

Screen 32

```
AVC-01
Pre-spar k Readings
```

Press ENTER and the “Pre-Spark Readings” Parameter Screen will appear (Screen 33).

Screen 33

```
AVC-01
Pre-spar k Readings
0=Disable, 1=Enable
Enter: 0
```
This screen allows the Pre-Spark Readings display to be enabled (1) or disabled (0). If the Pre-Spark Reading is enabled, the Electrical Reading Screen will show the electrical readings that were present prior to the last spark, and the mode area will display "Pre Spk" in the mode area (Screen 34). The display will hold those readings until another spark occurs and then display the electrical reading prior to that spark. If no spark occurs within five minutes, the display returns to "normal" with the Pre-Spark Readings mode still active. As soon as a spark occurs, the last reading prior to the spark will again be displayed.

If both the Pre-Spark Readings and the Averaged Readings are enabled at the same time, only the Pre-Spark Readings will be displayed. When the Pre-Spark Readings are disabled, the Averaged Readings will automatically be displayed along with "Avg." displayed in the mode area.

Screen 34

If the HOLD key is used while in the Pre-Spark Readings mode, only the first two lines of the display are frozen. The Spark and Arc readings continue to update in real-time.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Peak Readings

Press the PROMPT key and then the ↓ key until the “Peak Readings” Prompt Screen appears (Screen 35).

Screen 35

Press ENTER and the ‘Peak Readings” Parameter Screen will appear (Screen 36).
Screen 36

AVC-01
Peak Readings
0=Disable, 1=Enable
Enter: 0

The peak readings display is primarily used as a diagnostic tool in evaluating the secondary voltage ripple and the relationship between the secondary voltage maximum value (peak value) and the minimum value.

If the operating mode is to be changed, simply press the 0 or 1 key corresponding to the new mode (the old value will be overwritten) and press ENTER. If the present operating mode is acceptable, simply press ENTER without making any changes. If enable (1) was selected, the Peak Readings Display (Screen 37) will replace the Electrical Reading Screen. “Peak” will appear in the mode area of the screen to indicate this is the Peak Readings display.

Screen 37

AVC-01
033 kVMin 055 kVMax
044 kV1Avg 1789 mAPk
000 kV2Avg Peak

To return to the Electrical Reading Screen to “normal,” return to the Peak Reading Prompt Screen and disable (0) the Peak Readings mode.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

SCR Conduction Angle

Press the PROMPT key and then the ↓ key until the “SCR Conduction Angle” Prompt Screen appears (Screen 38).

Screen 38

AVC-01
SCR Conduction Angle

Press ENTER and the “SCR Conduction Angle” Parameter Screen will appear (Screen 39)
Screen 39

```
AVC-01
SCR Conduction Angle
0=Disable, 1=Enable
Enter: 0
```

The SCR Conduction Angle Screen is used to view the SCR conduction angle in the Electrical Reading Screen. If the operating mode is to be changed, simply press the 0 or 1 key corresponding to the new mode (the old value will be overwritten) and press ENTER. If the present operating mode is acceptable, simply press ENTER without making any changes. If enable (1) was selected, the Electrical Reading Screen will show the SCR conduction angle (xxxDeg) in the mode area (Screen 40).

Screen 40

```
AVC-01
205 V 158 A 026 kW
56kV1 00kV2 1885mA
000sp 000ar 161 Deg
```

To return the Electrical Reading Screen to "normal" return to the SCR Conduction Angle Prompt Screen and disable the SCR conduction angle mode.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Efficiency Display

Press the PROMPT key and then the ↓ key until the "Efficiency Display" Prompt Screen appears (Screen 40A).

Screen 40A

```
AVC-01
Efficiency Display
```

Press ENTER and the "Efficiency Display" Parameter Screen will appear (Screen 40B).

Screen 40B

```
AVC-01
Efficiency Display
0=Disable, 1=Enable
Enter: 1
```
The Efficiency Display is used when it is desirable to display the percentage of actual KV level versus the rated KV level. If this display is Enabled the operating KV will be displayed as a percentage of rated KV in the lower right corner of the Electrical Readings Screen (usually “Inst.” is displayed in this location – however if the percentage does not show in the display one of the other functions such as conduction angle or pre spark readings may be enabled). Disable other functions if the efficiency display does not appear.

Press the 0 or 1 key corresponding to the desired display mode (the old value will be overwritten) and press ENTER. If the present operating mode is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

---

Spark Rate Control

Press the PROMPT key and then the ↓ key until the “Spark Rate Control” Prompt Screen appears (Screen 41).

Screen 41

```
AVC-01
Spark Rate Control
```

Press ENTER and the “Spark Rate Control” Parameter Screen will appear (Screen 42).

Screen 42

```
AVC-01
Spark Rate Control
0=Disable, 1=Enable
Enter: 1
```

The Spark Rate Control is used when it is desirable to set a maximum number of sparks the control will allow, rather than have the control determine the optimum number of sparks. For Spark Rate Control to operate properly, the Phase Back must be set to at least 10%. If the operating mode is to be changed, simply press the 0 or 1 key corresponding to the new mode (the old value will be overwritten) and press ENTER. If the present operating mode is acceptable, simply press ENTER without making any changes.

The Spark Rate Parameter Screen now appears (Screen 43). The acceptable range for the Spark Rate is presented to the right
of the word “Range”. In this example the range is from 2 to 200 sparks per minute.

**Screen 43**  

| AVC-01 | Spark Rate Control | Range: 2-200 Spk/min  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter: 024</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The present operating value for the Spark Rate is presented to the right of the word “ENTER.” In this example the present operating value is 24 sparks per minute.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and present ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. The spark rate value will remain at the chosen value regardless of whether the Spark Rate Control is enabled or disabled.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

---

**Quench Mode**

Press the PROMPT key and then the ↓ key until the “Quench Mode” Prompt Screen appears (Screen 44).

**Screen 44**

<table>
<thead>
<tr>
<th>AVC-01</th>
<th>Quench Mode</th>
</tr>
</thead>
</table>

Press ENTER and the ‘Quench Mode” Parameter Screen will appear (Screen 45).

**Screen 45**

| AVC-01 | Quench Mode | 0=Arc, 1=Arc & Spark  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter: 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The normal operating mode for the Quench parameter is Arc mode. In that mode, only when an Arc occurs will the control Quench (turn-off) the power for the number of half cycles programmed into the Quench Time (under the discrete Quench key). Under some circumstances, like extreme upset conditions, it may be desirable to quench the power when either an Arc or a Spark occurs.
If the operating mode is to be changed, simply press the 0 or 1 key corresponding to the new mode (the old value will be overwritten) and press ENTER. If the present operating mode is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Process Sense

Press the PROMPT key and then the ↓ key until the “Process Sense” Prompt Screen appears (Screen 46).

Screen 46

AVC-01
Process Sense

Press ENTER and the ‘Process Sense” Parameter Screen will appear (Screen 47).

Screen 47

AVC-01
Process Sense
Range: 10-99 sec
Enter: 90

Process Sense is the time interval where the control senses to see if sparking has occurred. If sparking has not occurred in this time period, and the control is not at a limit, the control will rapidly raise the power level at a preprogrammed ramp rate, until a spark or a limit is reached. This allows a rapid recovery after an upset condition.

The acceptable range for the Process Sense time period is presented to the right to the word “Range.” In this example the range is 10 to 99 seconds.

The present operating value is presented to the right of the word “Enter”. In this example the present operating value is 90 seconds.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.
Press the PROMPT key and then the ↓ key until the “Peak Limits” Prompt Screen appears (Screen 48).

Screen 48

AVC-01
Peak Limits

Press ENTER and the “Peak Limits” Parameter Screen will appear (Screen 49).

Screen 49

AVC-01
Peak Sec. Current
Range: 1-9000 mA
Enter: 2000

The values in the peak secondary current and voltage screens are actually peak limits. They are automatically activated only when the control is placed in the Intermittent Energization (IE) operating mode. Their purpose is to limit the peak secondary current and voltage that is present during the recharge cycle of the IE operation. The value of the peak secondary current is automatically calculated based on the values entered when programming Max set Size.

The acceptable range for the Peak Secondary Current is presented to the right to the word “Range.” In this example the range is 25 to 2000 milliamps.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Reinitialize Interface Unit

Press the PROMPT key and then the ↓ key until the “Re-init Interface” Prompt Screen appears (Screen 50).

Screen 50

AVC-01
Re-init Interface
Press ENTER and the ‘Re-init Interface’ Parameter Screen will appear (Screen 51).

Screen 51

<table>
<thead>
<tr>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-init Interface</td>
</tr>
<tr>
<td>0=No, 1=Yes</td>
</tr>
</tbody>
</table>

To reinitialize the Interface Unit, press the 1 key and then the ENTER key. The Interface Unit will reinitialize and the screen will change to the display shown in Screen 52. If the Interface Unit is reinitialized, its memory will be erased and all parameters will be reset to their default values.

Screen 52

<table>
<thead>
<tr>
<th>TR Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initializing Memory</td>
</tr>
</tbody>
</table>

NOTE: AFTER REINITIALIZING THE INTERFACE UNIT IT IS NECESSARY TO REPROGRAM THE “MAX SET SIZE” AND THE “LIMITS”. IF THIS IS NOT DONE THE CONTROL WILL NOT ENERGIZE.

Reinitialize Keyboard and Display Unit

Press the PROMPT key and then the ↓ key until the “Re-init Keypad/Disp” Prompt Screen appears (Screen 53).

Screen 53

<table>
<thead>
<tr>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-init Keypad/Disp</td>
</tr>
</tbody>
</table>

Press ENTER and the “Re-init Keypad/Disp” Parameter Screen will appear (Screen 54).

Screen 54

<table>
<thead>
<tr>
<th>AVC-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-init Keypad/Disp</td>
</tr>
<tr>
<td>0=No, 1=Yes</td>
</tr>
</tbody>
</table>

Enter: 0
To reinitialize the Keypad and Display Unit, press the 1 key and then the ENTER key. The Keypad and Display Unit will reinitialize, and the screen will change to the display shown in Screen 55. If the Keypad and Display Unit is reinitialized, its memory will be erased and all parameters will be reset to their default values.

Screen 55

AVC-01
Re-init Keypad/Disp
Initializing Memory

After a 2 second delay, the display will change to a Prompt Screen (Screen 53).

If a re-initialization is not desired, press the 0 key and the ENTER key. The Re-init Keypad/Disp Prompt Screen will appear.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Software Version

Press the PROMPT key and then the ↓ key until the “Software Version” Prompt Screen appears (Screen 56).

Screen 56

AVC-01
Software Version

Press ENTER and the “Software Version” Parameter Screen for the Keypad and Display Unit will appear (Screen 57).

Screen 57

AVC-01
Software Version
Keypad/Display Unit
RK-2001 Ver 1.00

In the above example, the software part number is “RK2001” and the software version numbers is “1.00”.

Press ENTER and the “Software Version” Parameter Screen for the Interface Unit appears.
In the above example, the software part number is “RK2000” and the software version number is “1.23”.

Press ENTER or ESC to return to the Software Version Prompt Screen and press the ↓ or ↑ key to view more programmable parameters. Or, press ESC twice to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Max Set Size

Press the PROMPT key and then the ↓ key until the “Max Set Size” Prompt Screen appears (Screen 59).

Press ENTER and the ‘Max Set Size” Parameter Screen will appear (Screen 60).

Note: The values for the max TR ratings can be found on the TR nameplate. Use values for the output of the diode bridge and not the AC transformer (if both are shown).

The acceptable range for the rated TR maximum primary current is presented to the right to the word “Range.” In this example the acceptable range is 1 to 500 amperes.

The present TR rated maximum primary current value is presented to the right of the word “Enter.” In this example, the rated maximum primary current is 160 amps.

If the rated TR primary current is to be changed, simply press the numeric keys that correspond to the new value (the old value will be overwritten) and press ENTER. If the present rated TR
primary current value is acceptable, simply press ENTER without making any changes. In either case, the second display “Max Sec Current” will appear (Screen 61).

Screen 61

| AVC-01 | Max Sec Current | Range: 1-3000 mA | Enter: 1000 |

The acceptable range for the rated TR maximum secondary current is presented to the right of the word “Range.” In this example the range is from 1 to 3000 milliamps.

The present rated TR maximum secondary current value is displayed to the right of the word “Enter.” In this example the rated maximum secondary current is 1000 milliamps.

If the present rated TR maximum secondary current is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present rated TR maximum secondary current is acceptable, simply press ENTER, without making any changes. In either case, the third display “Max Sec Voltage” will appear (Screen 62).

Screen 62

| AVC-01 | Max Sec Voltage | Range: 1-99 kV | Enter: 45 |

The acceptable range for the rated TR maximum average secondary voltage is presented to the right of the word “Range.” In this example the acceptable range is 1 to 99 kilovolts.

The present rated TR maximum average secondary voltage value is presented to the right of the word “Enter.” In this example the rated TR maximum average secondary voltage is 45 kilovolts.

If the present rated maximum secondary current is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present rated maximum secondary current value is acceptable, simply press ENTER without making any changes.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

External Alarm Trip

The user has the option of having any of the four external alarm inputs “trip” or “not trip” the control. A trip alarm results in the
SCRs shutting off, the alarm relay closing, an alarm message appearing in the Device Status Screen, and the control cabinet contactor de-energizing. A non-trip alarm closes an alarm relay and displays an alarm message in the Device Status Screen, but the control continues to run.

When a non-trip alarm occurs, the alarm relay closes and stays closed as long as the alarm is active. The alarm line in the Device Status Screen will continue to display the alarm, and the alarm relay will remain closed, until it is manually cleared by pressing the CLEAR ALARM key.

Press the PROMPT key and then the ↓ key until the “External Alarm Trip” Prompt Screen appears (Screen 63).

Screen 63

**AVC-01 External Alarm Trip**

Press ENTER and the ‘External Alarm Trip” Parameter Screen will appear (Screen 64).

Screen 64

**AVC-01 External Alarm 1**

0=Nontrip, 1=Trip

Enter: 0

To trip the control for an external alarm condition on the Alarm 1 input, press the 1 key. To just alarm for an external alarm condition on the Alarm 1 input, press the 0 key. Your selection will appear opposite the word Enter, and become active when the ENTER key is pressed.

If the present operating mode is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the Alarm 2 Trip Parameter Screen (Screen 65).

Screen 65

**AVC-01 External Alarm 2**

0=Nontrip, 1=Trip

Enter: 1

To trip the control for an external alarm condition on the Alarm 2 input, press the 1 key. To just alarm for an external alarm condition on the Alarm 2 input, press the 0 key. Your selection will appear opposite the word Enter, and become active when the ENTER key is pressed.
If the present operating mode is acceptable, simply press ENTER without making any changes.

The same procedure is used for Alarms 3 and 4.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Screen 66 – not used
Screen 67 – not used

External Alarm Message Text

Press the PROMPT key and then the ↓ key until the “External Alarm Message Text” Prompt Screen appears (Screen 68).

Screen 68

![AVC-01 External Alarm Msg Text](image)

Press ENTER and the “External Alarm Message Text” Parameter Screen will appear (Screen 69).

Screen 69

![AVC-01 Use the ENTER key to view the available alarm messages](image)

Press ENTER, and a list of the first four alarm texts that could appear in the Device Status Screen if any of the Alarms 1 through 4 are active, will show. Pressing ENTER again will bring up the next four alarm texts. Keep pressing ENTER until all alarm texts have been viewed. Note the number of the text you would like to appear.

See Appendix III, page 91 for a list of the texts.

When all alarm texts have been viewed, the External Alarm 1 Text Parameter Screen will appear (Screen 70).

Screen 70

![Ext. Alarm 1 Text](image)
The second line in the display shows the present text for this alarm input.

The numbers in the range correspond to the numbers assigned to the various text messages.

If the text message is to be changed, simply press the numeric keys corresponding to the new text desired (the old value will be overwritten) and press ENTER. If the present text is acceptable, simply press ENTER without making any changes. The chosen text is what will appear in the Device Status Screen if Alarm 1 is active. Whether a change is made or not, after the ENTER key is pressed the External Alarm 2 Text Parameter Screen will appear (Screen 71).

Screen 71

<table>
<thead>
<tr>
<th>Ext. Alarm 2 Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Alarm 2</td>
</tr>
<tr>
<td>Range: 1-14</td>
</tr>
<tr>
<td>Enter: 02</td>
</tr>
</tbody>
</table>

The numbers in the range correspond to the numbers assigned to the various text messages that were previously viewed.

The second line in the display shows the present text for this alarm input.

If the text message is to be changed, simply press the numeric keys corresponding to the new text desired (the old value will be overwritten) and press ENTER. If the present text is acceptable, simply press ENTER without making any changes. The chosen text is what will appear in the Device Status Screen if Alarm 2 is active.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key. Whether a change is made or not, after the ENTER key is pressed the External Alarm Message Text Prompt Screen will appear.

Screen 72 – not used

Screen 73 – not used

Under Voltage Setup

Press the PROMPT key and then the ↓ key until the “Under Voltage Setup” Prompt Screen appears (Screen 74).
Press ENTER and the first “Under Voltage Setup” Parameter Screen will appear (Screen 75).

This screen allows the under voltage trip to be activated based on the primary voltage or the secondary voltage.

If the present choice is to be changed, simply press the numeric key corresponding to the new value (the old value will be overwritten) and press ENTER. If the present choice is acceptable, simply press ENTER without making any changes. Whether a change is made or not, after the ENTER key is pressed the “Primary Level” Parameter Screen or the “Secondary Level” Parameter Screen will appear depending on the selection in the UV Detection Screen (Screen 76 and Screen 77).

These screens allow the voltage level, below which a control trip will occur, to be entered.

If the present choice is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present choice is acceptable, simply press ENTER without making any changes. Whether a change is made or not, after the ENTER key is pressed the “Primary Level” Parameter Screen or the “Secondary Level” Parameter Screen will appear depending on the selection in the UV Detection Screen (Screen 76 and Screen 77).
pressed the “UV Delay Time” Parameter Screen will appear (Screen 78).

**Screen 78**

<table>
<thead>
<tr>
<th>TR Name</th>
<th>UV Trip Delay Time</th>
<th>Range: 10-99 sec</th>
<th>Enter: 30</th>
</tr>
</thead>
</table>

If an under voltage trip level is detected (primary or secondary voltage level below the level programmed above) the control will delay tripping until the time period programmed here has passed. This allows time for the condition that caused the low voltage condition (usually a partial ground) to clear, eliminating control trips for random occurrences.

If the present choice is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present choice is acceptable, simply press ENTER without making any changes. Whether a change is made or not, after the ENTER key is pressed the “Under Voltage Setup” Prompt Screen will appear.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

**Energy Mgt Setup**

Press the PROMPT key and then the ↓ key until the “Energy Mgt Setup” Prompt Screen appears (Screen 78A).

**Screen 78A**

**AVC-01 Energy Mgt Setup**

Press ENTER and the “Energy Mgt System #” Parameter Screen will appear (Screen 78B).

**Screen 78B**

**AVC-01 Energy Mgt System #**

| 0=Disable, 1-4 | Enter: 1 |

This screen allows the control to be assigned to one of four separate energy management systems (all four are not always available, check electrical schematics for the Transceiver).
If the present choice is to be changed, simply press the numeric key corresponding to the new value (the old value will be overwritten) and press ENTER. If the present choice is acceptable, simply press ENTER without making any changes. Whether a change is made or not, after the ENTER key is pressed the “EMS Field Assignment” Parameter Screen will appear (Screen 78C).

Screen 78C

**AVC-01**
EMS Field Assignment
Range: 1-6
Enter: 1

This screen allows the control to be assigned to an electrical field that will be controlled by the energy management system in the Transceiver. There are six energy management fields that this control can be assigned to. If there are physically more than six fields, the controls will have to be doubled up. For example, controls from the sixth and seventh field both will be assigned to the sixth field.

If the present choice is to be changed, simply press the numeric key corresponding to the new value (the old value will be overwritten) and press ENTER. If the present choice is acceptable, simply press ENTER without making any changes. Whether a change is made or not, after the ENTER key is pressed the “Energy Mgt Setup” Prompt Screen will appear.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

**Wash Down System**

The optional wash down system is used in conjunction with a Wet Electrostatic Precipitator. If you have this optional system refer to Appendix I for complete instructions on setting up this system.

**Power Down Rapping**

Press the PROMPT key and then the ↓ key until the “Power Down Rapping” prompt screen appears (Screen 79).
Screen 79

**AVC-01**  
**Power Down Rapping**

Press ENTER and the “Power Down Rapping” parameter screen will appear (Screen 80).

Screen 80

**AVC-01**  
**Sec. Voltage Level**  
**Range:** 0-45 kV  
**Enter:** 45

This secondary voltage level is the level the TR secondary voltage will drop to when the TR control's associated MRC rapper clock or Interface Unit motor relay is energized.

The acceptable range for the Secondary Voltage Level is presented to the right to the word “Range.” In this example the range is 0 to 45 kV.

The present operating value (value the secondary voltage will drop to when power down rapping is activated) is presented to the right of the word “Enter”. In this example the present operating value is 45 kV.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

The following screen appears:

Screen 81

**AVC-01**  
**Power Down System**  
**0=Relys 1=MRC 2=Alrm4**  
**Enter:** 1

This screen is used to choose how the Power Down System (PDS) will be initiated. Entering “0” will cause the PDS to be enabled or disabled by the motorized rapper timer relay circuit (see Appendix II). Entering “1” causes the PDS to be activated or deactivated by the microprocessor rapper control. Entering “2” will cause the PDS to be activated by a 120V signal fed into the Alarm4 input.
Pressing Enter will program the control to your selection, and return the display to the Power Down Rapping Prompt screen.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

Pressing “1” will bring up the MRC ID screen:

**Screen 82**

<table>
<thead>
<tr>
<th>AVC-01</th>
<th>MRC ID for Pwr Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range: 1-9</td>
<td>Enter: 1</td>
</tr>
</tbody>
</table>

This screen is used to tell the TR control which of the microprocessor rapper controls (MRCs), if there are more than one, is to activate the TR control’s power down system. The ID of the rapper control that is associated with each of the TR controls can be found in the MRC Programming Data Sheets in the MRC manual.

Enter the numerical value corresponding to the desired ID number and press the ENTER key. The screen will return to the Power Down Rapping Prompt screen.

Press the ↓ or ↑ keys to view more prompt screens or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.

---

**Motorized Rapping Timer Set-up**

The optional motorized rapper relay system is used in conjunction with precipitators having motor driven cleaning devices. If you have this optional system refer to Appendix II for complete instructions on setting up this system.
CHAPTER 6  OPERATING IN THE MANUAL MODE

Switching to Manual Operation

The control can be placed in the Manual operating mode by placing the Auto-Manual DIP switch, on the Interface Unit, in to the Manual position.

Once the Auto-Manual DIP switch is placed in Manual mode, the words “Manual Mode” will appear on the Status Line in the Device Status Display.

The power level in the Manual mode is adjusted by turning the Manual trim pot, also located on the Interface Unit.

When in the Manual mode, the power can only be raised to approximately 60% of the rated primary current. This is to protect the SCRs and transformer from being operating above their ratings.

It is recommended that when operating in the Manual mode, the power level be adjusted to just below the threshold of sparking. If necessary, use a clamp-on amp meter to check for current transients (sparking).
CHAPTER 7  AIR LOAD INSTRUCTIONS

The following steps must be performed prior to energizing the control in the automatic mode for the first time. If at all possible, this procedure should be performed without process gas entering the precipitator and under stack draft condition. This is designed “Air Load Condition.”

Pre-Operating Checkout:

1. Ensure the On-Off switch on the control cabinet is in the off position.
2. Ensure the control cabinet (or MCC/PDP) circuit breaker is in the off position.
3. Remove the control access panel or open the control cabinet door.
4. Place the AUTOMATIC-MANUAL DIP switch located on the Interface Unit in the MANUAL position.
5. Turn the Manual Control trim pot located on the Interface Unit to its full counter-clockwise position.
6. Energize the support insulator heaters at least two hours before performing air load electrical control adjustments. Energization of the support insulator heaters removes condensation that might have formed on the insulator surfaces. Failure to remove condensation may result in electrical tracking of the insulation surface. This in turn can result in electrically grounded and/or physically damaged insulators that may have to be replaced before the precipitator can be re-energized.
7. Make sure the precipitator high voltage frame(s) is connected to the transformer-rectifier (T/R). This should be checked at the T/R pipe and guard interface as well as at the pipe and guard support bushing interface.
8. Energize the transformer-rectifier control cabinet by placing the main circuit breaker in the on position.
9. Enter the code for clearing the memory. This initializes the microprocessor control.
10. Program the control for the correct “Max Set Size” and “Limits”. Also, each Keypad and Display Unit must be programmed for all the Interface Unit IDs on its communication loop. See Chapter 5 Programming Instructions.

The following steps must be performed at each TR control cabinet.

11. Turn the On-Off switch to on.
12. Slowly turn the Manual Control trim pot on the Interface Unit clockwise. As the Manual Control trim pot is slowly turned clockwise, the voltage and current levels should start to
increase. Keep slowly turning the Manual Control trim pot until the end of its travel is reached.

As the Manual pot is rotated, observe the spark and arc LEDs on the Interface Unit. During air load, where no particulate is entering the precipitator, there should not be any sparking or arcing present. If sparking or arcing is occurring, allow the control to sit, while energized, for five or ten minutes and recheck. If sparks and arcs are still present there is probably a problem inside the precipitator. Ambient air conditions, normal buildups on collecting plates, or slightly moist or dirty insulators can also cause this sparking. The cause must be determined and corrected before the precipitator is placed on line or reduced collection efficiency will result.

13. Rotate the Manual trim pot until one half of the rated current is displayed.

14. Place the On-Off switch on the front of the control cabinet in the off position.

15. Place the On-Off switch on the front of the control cabinet in the on position.

16. The control will slowly power up and display increasingly larger values of primary voltage, primary current, and secondary current. This slow power-up will take between 5 and 10 seconds.

17. The control should power up to either rated current or rated voltage. If the control arcs or sparks before reaching a current or voltage limit a problem still exists inside the precipitator. If there is no sparking or arcing but a voltage or current limit is not reached, recheck the programmable parameter settings.

18. The control is now ready to operate on gas load (online conditions) in the automatic mode.
CHAPTER 8  GAS LOAD ADJUSTMENTS

The following adjustments are to be made with the process gas flowing through the precipitator. These adjustments are presented as starting points after the air load adjustments have been completed.

Normal Operation

Starting with the precipitator inlet field transformer-rectifier controls, adjust the programmable parameters on the keypad as follows (refer to the Programming Instructions):

- Program the Quench Mode for Arc Only Mode
- Program the Pedestal Rate to 1 cycle
- Program the Ramp Rate to 10 seconds
- Program the Phase Back to 15 percent
- Program the Process Sense to 30 seconds

Program the precipitator center field transformer-rectifier controls as follows:

- Program the Quench Mode for Arc Only Mode
- Program the Pedestal Rate to 1 cycle
- Program the Ramp Rate to 8 seconds
- Program the Phase Back to 20 percent
- Program the Process Sense to 20 seconds

Program the precipitator outlet field transformer-rectifier controls as follows:

- Program the Quench Mode for Arc Only Mode
- Program the Pedestal Rate to 1 cycle
- Program the Ramp Rate to 3 seconds
- Program the Phase Back to 25 percent
- Program the Process Sense to 10 seconds

Program intermediate precipitator field transformer-rectifier controls so they fall between those outlined above.

High – Resistivity Ash Operation

As a starting point for precipitators collecting high-resistivity ash from the burning of low-sulfur coal (for example), program all the controls for all fields as follows:

- Program the Quench Mode for Arc Only Mode
- Program the Pedestal Rate to 1 cycle
- Program the Ramp Rate to 30 seconds
- Program the Phase Back to 15 percent
- Program the Process Sense to 90 seconds

Process Upset Operation

If conditions exist where normal operation includes frequent process upsets or fast process changes (as encountered in the Basic Oxygen Furnace operation, for example) and a minimum Spark rate is desirable, program all the controls for all fields as follows:
Program the Quench Mode for Arc and Spark Mode
Program the Pedestal Rate to 5 cycles
Program Ramp Rate and Phase Back as listed under Normal Operation
Program the Process Sense to 10 seconds
CHAPTER 9  OPTIMIZING THE OPERATION OF THE PRECIPITATOR CONTROL

A large number of control parameters have been provided to allow a high degree of control flexibility. This does, however, produce some confusion when trying to optimize precipitator efficiency.

The best way to optimize the control, and thus the precipitator efficiency, is to make control parameter changes while observing the instantaneous readings obtained from the stack or flue opacity meter. If a strip chart that displays the instantaneous opacity reading is not in use, it is recommended that one be installed for optimization purposes.

If an opacity meter is not installed on the stack or flue work, it is strongly recommended that one be installed. Without an opacity meter, it is extremely difficult to judge when the control is fully optimized.

The optimum control settings will produce the smoothest opacity trace, at the lowest opacity level with the fewest “spikes.” Adjusting the RK2000 cannot appreciably change spikes produced by re-entrained particulate from the operation of the precipitator rapping system. Changes to the rapper control operation will have to be made.

After the control has been initially set up, fine-tuning should proceed by reprogramming the various parameters in the following order:

- Phase Back
- Ramp Rate
- Quench Mode
- Pedestal Rate
- Process Sense

Using the opacity meter as a guide (use visual stack observation if opacity meter is unavailable), reprogram each parameter, one at a time, until the lowest steadiest opacity readings are obtained. Start with Phase Back parameter. Reprogram the percent Phase Back both lower and higher than the initial settings until the best opacity is obtained, then go to the next parameter and optimize it. Do not attempt to optimize more than one parameter at a time.

Allow from a few hours to a few days (depending on how steady your operation is) between program changes for the precipitator to read “steady state” operation. It is important to have steady boiler or process conditions during this optimization. Swings in process conditions can mask optimization.

Once the control is optimized, observe the opacity to ensure it does not slowly start to increase. If the opacity does slowly increase, readjust the rapper lifts and timing. If the control is optimized and precipitator efficiency increases, the rapping system must be re-optimized to handle the additional collected particulate load.
If there are many controls on the precipitator, optimize all controls by field for the first few tries. That is, adjust all the controls on the same precipitator field to the same operating parameter settings. As time allows, each control can be individually optimized.
CHAPTER 10  DISCUSSION OF TYPICAL CONTROL WAVEFORMS

The waveforms on the following pages show the precipitator peak current waveform versus time for various programmable parameter settings. These waveforms can be duplicated on an oscilloscope with single sweep and storage capability by connecting the positive scope lead to Interface Unit terminal MA(+)A and the ground lead to Interface Unit terminal SEC COMMON (GND). These waveforms show the envelope of the secondary current signal.

Waveform #1, Quench Mode, Arc Only, Pedestal Programmed to 1 Cycle

Starting in the upper left-hand corner, the precipitator current is at its maximum rating. The current is stable at this level until a Spark occurs. The control sense the Spark and within one-half cycle (8 milliseconds) reduces the conduction angle of the SCRs, causing an almost instantaneous reduction in precipitator current. This current reduction after a Spark is called the Phase Back. Phase Back is a discrete key programmable parameter.

Sketch 1: Quench Mode Arc Only

Within one-half cycle after reaching the Phase Back current level, the control starts to increase current towards its rating by increasing the conduction angle of the SCRs. The period of time it takes for the current to increase from the Phase Back level to the current level where the spark occurred is called the Ramp Rate. The Ramp Rate is a discrete key programmable parameter.

If an arc occurs in the precipitator, the control detects the arc and quenches the arc within one-half cycle by interrupting the firing
pulse to the SCRs. This turns off the power to the precipitator for the programmed Quench Time, forcing the arc to extinguish. After the Quench Time, the SCRs are again turned on and the power increases to the Phase Back level in the programmed 1 cycle pedestal rate. At the Phase Back level, the rate of current increase is transferred to the Ramp Rate, which continues to increase the current, but at a slower rate.

This control action repeats every time an Arc and/or Spark occur in the precipitator.

**Waveform #2, Quench Mode, Arc Only, Pedestal Programmed to 5 Cycles**

This waveform is generated by the same parameter responses as described for Waveform #1. The only difference is the Pedestal Rate is now longer than 1 cycle; it’s 10 cycles.

![Sketch 2: Quench Mode Arc Only](image)

**Sketch 2: Quench Mode Arc Only**

After a Quench, the current is increased at a slower rate than in Waveform #1. The Pedestal Rate still transfers operation to the Ramp Rate at the Phase Back level.

Larger Pedestal Rates are used when heavy or repetitive arcing is present in the precipitator. Whipping discharge electrodes, arcing across insulator surfaces, or clinker formation on the discharge electrodes, usually causes heavy or repetitive arcing. Programming the Pedestal Rate for greater than 1 cycle increases the time between Arcs and allows the precipitator to operate at a longer time at reduced current rather than short bursts of higher current rapidly interrupted by arcing, sparking, and current quenches.
Waveform #3 and #4, Quench Mode, Arcs and Sparks, Pedestal Programmed to 1 and 10 Cycles

These two waveforms show typical current waveforms when the control is programmed for a Quench mode of both Arcs and Sparks. In this mode, each Arc and Spark initiates the Quench Time and turns the power off for the programmed time period.

If conditions within the precipitator are extremely severe and a great deal of sparking and arcing is occurring, operating in the Arc and Spark Quench Mode can reduce the wear on the electrodes.

Sketch 3: Quench Mode Arc And Spark

Sketch 4: Quench Mode Arc And Spark

One of the outstanding features of the RK2000 is its ability to automatically readjust the programmable parameters, after initial adjustments have been made, based on actual operating current levels.
The percentage Phase Back and the Ramp Rate should be different for each electrical field within the precipitator. The least Phase Back and greatest Ramp Rate are in the inlet fields; and the greatest Phase Back and the least Ramp Rate are in the outlet field. This is fine for initial adjustments, but what happens as conditions change within the precipitator?

5. TYPICAL AUTOMATIC CONTROL WITHOUT ARCING

5: Typical Control Without Arcing

6. TYPICAL AUTOMATIC CONTROL WITH ARCING

Sketch 6: Typical Automatic Control With Arcing

The Phase Back, Ramp Rate and Pedestal Rate are all referenced to current levels. As current increases, the Phase Back is automatically increased, the Ramp Rate is automatically decreased, and the Pedestal Rate is automatically decreased, based on a preprogrammed formula. Conversely, as power decreases, the parameters change in the opposite direction. This means that once the control has been programmed for normal maximum process operation, there is no need to
reprogram the control as variations in precipitator operation occur.
Waveform #7, Typical Control Waveform

This typical control waveform shows the action and relation of Phase Back Ramp, Quench, Pedestal, and Process Sense.

The leading part of this waveform shows the gradual reduction of precipitator current due to an upset operating condition. When an Arc is encountered, the RKXXX Quenches the current for a programmed Quench Time, then the Pedestal is initiated and the control again tries to reach normal operating power levels. A Spark occurs as the control attempts to increase current and the Phase Back and Ramp go into operation. Sparking becomes more frequent and occurs at lower and lower power levels. The RK2000 phases back after each Spark to establish a new operating level just below the threshold of sparking. Note that as the current gets lower, the amount of Phase Back decreases automatically.

After each Phase Back, the Ramp Rate tries to increase the current level back to maximum. However, due to existing conditions, another Spark is encountered and the current phases back again. Notice that the slope of the Ramp Rate automatically decreases as the current level drops.

If the Process Sense time elapses and a Spark has not occurred, a faster recovery rate takes over and rapidly increases the current level until either current rating is reached or a Spark occurs.

Sketch 7: Typical RK2000 Control Operation
Waveform #8 shows a typical secondary voltage versus secondary current curve for moderate and low resistivity precipitator operation.

Sketch 8: Precipitator Operating Voltage (kV)

Waveform #9 shows a typical secondary voltage versus secondary current curve for high-resistivity precipitator operation where the precipitator is experiencing Back Corona.

Sketch 9: Precipitator Operating Voltage (kV)

Notice that with Back Corona, the current increases without a corresponding increase in voltage. The point where the current starts to increase but the voltage remains the same (or even
decreased) is the optimum operating point for Back Corona operation. Operating at higher current provides no increase in precipitator efficiency and only results in wasted power (and, in most cases, poorer collection efficiency).

The Intermittent Energization Optimization automatically finds this “knee” in the curve and holds the power at this knee. If Back Corona goes away, normal operating parameters again take over the control of the power level.
CHAPTER 11  DESCRIPTION OF INTERFACE UNIT CONNECTIONS AND COMPONENTS

Refer to the following pages for a description of each of the numbered areas.

78 of 113
Description of Interface Unit Connections and Components

The numbers listed below correspond to their associated areas on the above sketch of the cover of the Interface Unit. Next to each number is a description of the area.

Terminal strip screw terminals are located opposite each horizontal line for ease of wiring. The terminal strips are snap apart types, so the individual wires do not have to be removed if an Interface Unit needs replacing.

**Area Description**

1. The connection to the Silicon Controlled Rectifiers (SCR) is made here. G stands for gate and K stands for cathode. If the G and K leads of an SCR are reversed damage to the Interface Unit could occur. If the 1s and 2s are reversed to the SCR the control will not power up.

2. AC power from the control transformer is connected here. The “hot” side of the power leads goes to the terminal marked 120V. The neutral side should go to 0V. If these are reversed the control will not power up.

3. The Alarm Relay terminals are brought out to these terminals. A voltage from an external alarm circuit is fed into these points. For a fail safe system the alarm circuit should be configured for an open circuit to activate an alarm, and connected to the NC and C terminals. If the external alarm circuit is configured for a closed circuit connect it to the NO and O terminals.

4. An external wire runs between the 120V terminal and the C terminal of the contactor relay. One side of the contactor coil is connected to the NO terminal the other to ground. When the control closes this relay the 120 volts is applied to the contactor coil and the contactor is pulls in (energizes). When the control has an alarm trip it opens this relay and the contactor drops out (de-energizes).

5. There are four optional auxiliary relays available for energization of remote starters for mechanical motor driven rapping systems, or for wet precipitator wash down systems. Internal or external power (determined by the rating of the starters) is connected to RR1-2 PWR and/or RR3-4 PWR. The RR1 through RR4 terminals are used to feed this power to the external starters. The return leads for the starters are connected to a common ground. Individual timers, programmable through the Keypad and Display Unit, control the RR 1 through 4 outputs.

6. The RUN/STOP terminal accepts a 120Vac signal (usually from a cabinet on/off switch). When the voltage is present (on/off switch closed) the control will pull in the contactor and start to fire the SCRs. When voltage is
removed (on/off switch open) the control stops firing the SCRs and drops out the contactor.

7. Most contactors have auxiliary contacts mounted on them. If one is present, it is used to place a 110Vac signal on this terminal when the contactor pulls in. This confirms that the contactor has pulled in when the coil is energized. If this signal is not detected when the on/off switch is placed in the on position, the control will not start and a “contactor open” alarm will display on the Keypad and Display Unit.

8. Terminals marked Alarms 1 through 4 are used for bringing in external alarm contacts. These terminals require 120Vac present to be in the “no alarm” state. Therefore, external alarm contacts must be normally closed and connected to a 120Vac power source.

9. The address area refers to the two miniature rotary switches on the circuit board. These switches are set to provide an ID number for this Interface Unit. Each Unit must have a discrete ID number. The upper rotary switch is the tens digit and the lower switch the units digit.

10. The TR secondary current return signal, from the secondary current signal conditioning resistor, is connected to the MA (+)A terminal. This signal has a range of 0 to 5 volts dc, and also carries the spark detection signal.

11. Shields from the appropriate signal wiring are landed on these terminals.

12. Secondary voltage return signals, from the secondary voltage signal conditioning resistors, are connected to these terminals. If only one kV signal is being used, it should be connected to the KV1 terminal.

13. The leads from the primary current transformer (CT) are terminated here. They are not polarity sensitive. This signal has a range of 0 to 5 v ac, and provides the control with a reference signal for the primary current.

14. The leads from the primary voltage potential transformer (PT) are terminated here. They are not polarity sensitive. This signal has a range of 0 to 20 volts ac, and provides the control with a reference signal for the primary voltage.

15. This nine (9) pin terminal is used to connect the communications link between the Keypad and Display Unit and the Interface Unit, or the Interface Unit with other Interface Units.

16. This nine (9) pin terminal is used to connect the communications link between the Keypad and Display
17. Downloading of programs or set-up data is accomplished through this port.

18. This switch, which protrudes through the bottom edge of the cover, is used to place the control in the Automatic, Manual, and Stand-Alone operating mode.

19. These two LEDs (light emitting diodes) flash when a corresponding spark or arc occurs in the precipitator and is detected by the control. This is also indicated on the display of the Keypad and Display Unit.

20. This LED will illuminate if the control is in the manual mode and an over current condition has caused the control to trip.

21. This LED flashes to indicate the microprocessor is operating properly. There are two different flash rates for this LED. The faster rate indicates the control is powered but in the off state. The slower rate indicates the control is powered and in the energized state. If this LED stops flashing it means the microprocessor has failed. The control will automatically to manual mode if the microprocessor fails.

22. A potentiometer is provided to adjust the operating level of the control when placed in the Manual mode of operation. This pot can be adjusted from zero power to approximately 60% of rated current by rotating the pot clockwise. It is prevented from going to full power to protect the SCRs. The setting of this pot has no effect on power levels when in the Auto or Stand-Alone modes of operation.

23. These two LEDs glow with equal brightness if the SCR gates are drawing equal current. They change intensity as the control output power increases and decreases. They are used as a visual indication of the condition of the SCRs and the SCR firing circuit.
CHAPTER 12  TECHNICAL HELP

Technical help and parts can be obtained by contacting Redkoh Industries by any of the following ways:

Phone: 908/369-1590
Fax: 908/369-1594
E-mail: John.jannone@redkoh.com
Web Site: Redkoh.com
U. S. Mail:
Redkoh Industries, Inc.
P.O. Box 801
Belle Mead, NJ 08876
USA
WARRANTY

Return Authorization

Redkoh Industries warrants to Purchaser that the products manufactured by Redkoh Industries are free from defects in material and/or workmanship under normal use and service for 36 months from date of shipment. Liability of Redkoh Industries under this warranty is limited to the repair or replacement of any defective product manufactured and supplied by Redkoh Industries that is used and/or connected in accordance with instructions and/or recommendations provided by Redkoh Industries. Such products are to be returned via prepaid, common carrier to the Redkoh Industries facility within the warranty period. Transportation, field service, removal and/or reinstallation costs (of any kind) are the fiscal responsibility of the Purchaser. Redkoh Industries reserves the right, at its sole option, to inspect Purchaser’s schematic and/or connecting diagrams and/or to inspect job site conditions and installation. Repairs or modifications by Purchaser will void this warranty unless approved by Redkoh Industries. Except for warranties specifically set forth herein, THERE SHALL BE NO WARRANTIES-EXPRESSED OR IMPLIED-NOR SHALL THERE BE A WARRANTY OR MERCHANTABILITY WITH RESPECT TO THE GOODS. In addition, it is expressly agreed by the Purchaser, by the purchasing of the goods, that the liability of Redkoh Industries, if any, shall be LIMITED solely to the replacement or repair of the defective goods in accordance with the Warranties specifically and expressly set forth herein.

A warranty repair authorization number must be obtained prior to returning any equipment for repair.

Address Inquiries regarding shipment of defective parts for repair to:

Mailing Address:
Redkoh Industries
PO Box 801
Belle Mead, NJ 08502

Shipping Address:
Redkoh Industries
300 Valley Road
Hillsborough, NJ 08844

Or call: (908) 369-1590
Or Fax: (908) 369-1594
If this control is being used in conjunction with a wet electrostatic precipitator with a wash down system, optional relays on the Interface Unit and relay timers designed into the Keyboard and Display Unit can be used to control the wash down system.

First, from the Device Selection Screen press the Help key and the Enter key until Coordination System screen appears. Enter 1 to enable the Coordination System, and then set-up the start and end ID numbers for the coordination. Refer to Coordination System screens on Page 33.

The automatic wash down system consist of the following timers:

1. Wash-down Interval
2. Wash-down Delay
3. Wash-down Duration
4. Drain Delay

These timers and the programming sequence for setting them are as follows:

Press the PROMPT key and then the ↓ key until the “Wash-down System” Prompt Screen appears.

```
AVC-01
Wash-down System
```

Press ENTER and the “Wash-down Interval” Parameter Screen will appear.

```
AVC-01
Wash-down Interval
Range: HH:MM:SS
Enter: 00:00:01
```

The wash-down interval is the time between wash-downs in hours, minutes, and seconds. When the wash-down interval timer expires, the control remembers its run/stop state. If the control is in the run mode it automatically stops firing the SCRs and opens the contactor.

The Range of this timer is one second to 99 hours, 59 minutes, 59 seconds. The present operating value for the Wash-down Interval is presented to the right of the word “Enter”. In this example the present operating value is 0 hours, 0 minutes, 1 seconds.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.
Either way, the display will now change to the Wash-down Delay display.

### AVC-01

**Wash-down Delay**  
Range: HH:MM:SS  
Enter: 00:00:01

The wash-down delay is the time interval between the control being de-energized and the start of the wash-down. In actuality, the relay contact between the RR-PWR and RR1 (on the Interface Unit terminal strip) is open until the wash-down delay time out. At that time the contact closes and the power that is applied to RR-PWR is fed to RR1. An external wash down solenoid or wash-down system input would then be energized and a wash-down would start.

The Range of this timer is one second to 99 hours, 59 minutes, 59 seconds. The present operating value for the Wash-down Delay is presented to the right of the word “ENTER”. In this example the present operating value is 0 hours, 0 minutes, 1 seconds.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

Either way, the display will now change to the Wash-down Duration display.

### AVC-01

**Wash-down Duration**  
Range: HH:MM:SS  
Enter: 00:00:01

The wash down duration is the time the relay contact between RR-PWR and RR1 remains closed, and in turn, how long the wash-down continues. When this timer times-out, the relay contact opens and the wash-down ceases.

The Range of this timer is one second to 99 hours, 59 minutes, 59 seconds. The present operating value for the Wash-down Duration is presented to the right of the word “ENTER”. In this example the present operating value is 0 hours, 0 minutes, 1 seconds.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes.

Either way, the display will now change to the Drain Delay display.
The drain delay is a time period between the end of the wash-down duration and the re-energization of the TR control (if it was on when the wash down interval started). This delay is provided to allow sufficient time for the wash-down water to drain out of the precipitator.

The Range of this timer is one second to 99 hours, 59 minutes, 59 seconds. The present operating value for the Drain Delay is presented to the right of the word “ENTER”. In this example the present operating value is 0 hours, 0 minutes, 1 seconds.

If the operating value is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating value is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the Automatic Wash-down display.

The wash down system is turned on (enabled) and off (disabled) through this display. Regardless of the on or off state, the times previously entered remain in memory.

The present operating mode for the Automatic Wash-down is presented to the right of the word “ENTER.” In this example the present operating mode is disabled.

If the operating mode is to be changed, simply press the numeric key corresponding to the new value (the old value will be overwritten) and press ENTER. If the present operating mode is acceptable, simply press ENTER without making any changes. Either way, the display will now change back to the Wash-down System Prompt screen.

Press the ↓ or ↑ keys to view more prompt screens, or press ESC to return the display to either the Electrical Reading Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.
APPENDIX II – Timers for Motor Operated Cleaning Devices (optional)

If this control is being used in conjunction with motor driven rapping systems, four (4) optional relays built into the Interface Unit and relay timers designed into the Keyboard and Display Unit can be used to control the on and off times of the various motors. This allows the rapping cycle time to be tailored to each field in the precipitator.

These timers and the programming sequence for setting them are as follows:

First, from the Device Selection Screen press the Help key and the Enter key until the Coordination System screen appears. Enter 1 to enable the Coordination System, and then set-up the start and end ID numbers for the coordination. Refer to Coordination System screens on Page 30.

Press the PROMPT key and then the ↑ key until the “Rapper System Set-up” Prompt Screen appears.

**AVC-01**

**Rapper System Setup**

Press ENTER and the Global Rapper System screen will appear.

**AVC-01**

**Global Rapper System**

0=Disable, 1=Enable

Enter: 0

The global rapper system refers to the status of all the rapper relays selected under the Coordination System set-up. If the global rapper system is disabled, none of relays will energize. If the system is enabled, all the relays have the capability of being individually energized or individually de-energized.

To disable the Global Rapper System press the “0” key, to enable the Global Rapper system press the “1” key. Your selection will appear opposite the word Enter, and become active when the ENTER key is pressed.

Regardless of your choice, the Rapper Program # screen appears.

**AVC-01**

**Rapper Program #**

Range: 1-6

Enter: 0
Each Interface Unit (AVC-01 to AVC-XX), that houses the relays, can have up to six different “set-ups” regarding the Interval time and the On time of each rapper relay. The program number refers to which of these six different programs is presently being programmed. The following programming instructions are applicable to all six programs; program 1 will be used for this example.

The Range of the program number is 1 to 6. The present operating value for the Rapper Program # is presented to the right of the word “ENTER”. In this example the present program is program # 1.

If the program # is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present program # is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the Rapper Interval screen.

Rapper “1” refers to relay number 1 (of the 4 relays available), the control will prompt for all program information for all four relays. It will run through all the parameter settings for rapper 1 then repeat it for rapper 2, 3, and 4 until all four rappers have been programmed. Rapper #1 is used for example in the following program instructions.

The Interval is the off time of the relay. The Range of the Interval is 1 second to 99 hours, 59 minutes, 59 seconds. The present time for the Interval is presented to the right of the word “ENTER”. In this example the present Interval time is 2 minutes.

If the Interval time is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present Interval is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the Rapper On Time screen.

The On Time is the on time of the relay. The Range of the On Time is 1 second to 99 hours, 59 minutes, 59 seconds. The present time for the Interval is presented to the right of the word “ENTER”. In this example the present On Time is 1 minute.
If the On Time is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present On Time is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the Rapper Mode screen.

The rapper Mode refers to the grouping of the relays for anticoincidence purposes. All rapper relays (from AVC-01 to AVC-XX) that should not be energized at the same time can be grouped together, and two groups are available. Mode 1 is one group and Mode 2 is a second group. None of the relays assigned to Mode 1 can be On at the same time, and none of the relays assigned to Mode 2 can be On at the same time, however any relay in Mode 1 can be On when any relay in Mode 2 is On. Mode 0 is used to make the relay totally independent of any other relay so it will operate based on its Interval and On Time without regard to other relay times.

The Range of the Mode is 0 to 2. The present Mode is presented to the right of the word “ENTER”. In this example the present Mode is 0.

If the Mode is to be changed, simply press the numeric keys corresponding to the new value (the old value will be overwritten) and press ENTER. If the present Mode is acceptable, simply press ENTER without making any changes. Either way, the display will now change to the Rapper 1 Power Down screen.

Power down refers to power down rapping. Power down rapping means reducing the power to the TR control that energizes the area of the precipitator the motor driven rappers are cleaning while the relay is energized. The KV level the TR is reduced to is programmed under the Power Down Rapping prompt.

If the power to the TR is to be reduced during relay operation, press “1” to enable Power Down. If it is not desirable to reduce the power during relay operation, press “0” to disable Power Down. Your choice will appear next to the word Enable.

After you have made your selection press the ENTER key and the Rapper 1 Enable/Disable screen will appear.
This screen is used to choose whether or not this rapper relay will operate or not. If it is Enabled, the relay will run through its Interval and On Time as programmed. If it is Disabled, the relay will not operate regardless of the Interval and On Time. Choose the desired operating mode for this rapper relay by pressing a “0” or “1”. Your choice will appear next to the word Enter.

After you have made your choice press the ENTER key and the Rapper 2 Interval Screen will appear. Program the operation of Rapper relay 2, 3, and 4 in the same manner as above.

When the last screen for Rapper 4 (Rapper 4 Enable/Disable) has been programmed and the ENTER key pressed the screen will return to the Rapper System Setup prompt. Press the ↑ or ↓ keys to view more prompt screens or press ESC to return the display to either the Electrical Readings Screen or the Device Status Screen depending on the screen you were in prior to pressing the PROMPT key.
## APPENDIX III – List of Alarm Texts

The following alarm messages can be assigned to any of the four external alarm inputs on the Interface Unit. Enter the appropriate number of your choice during Alarm programming.

<table>
<thead>
<tr>
<th>No.</th>
<th>Alarm Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>External Alarm 1</td>
</tr>
<tr>
<td>2</td>
<td>External Alarm 2</td>
</tr>
<tr>
<td>3</td>
<td>External Alarm 3</td>
</tr>
<tr>
<td>4</td>
<td>External Alarm 4</td>
</tr>
<tr>
<td>5</td>
<td>High SCR Temp</td>
</tr>
<tr>
<td>6</td>
<td>Low T/R Level</td>
</tr>
<tr>
<td>7</td>
<td>High T/R Temp</td>
</tr>
<tr>
<td>8</td>
<td>Full Hopper</td>
</tr>
<tr>
<td>9</td>
<td>Master Fuel Trip</td>
</tr>
<tr>
<td>10</td>
<td>High O₂ Trip</td>
</tr>
<tr>
<td>11</td>
<td>T/R Overpressure</td>
</tr>
<tr>
<td>12</td>
<td>Fan Fault</td>
</tr>
<tr>
<td>13</td>
<td>Interlock Error</td>
</tr>
<tr>
<td>14</td>
<td>Ext. Charge Stop</td>
</tr>
<tr>
<td>15</td>
<td>Rapper Motor Failure</td>
</tr>
<tr>
<td>16</td>
<td>Impact Rap Failure</td>
</tr>
<tr>
<td>17</td>
<td>Overload Relay Trip</td>
</tr>
<tr>
<td>18</td>
<td>High Cabinet Temp</td>
</tr>
</tbody>
</table>
TABLE 1  PREPROGRAMMED LEVELS AND OPERATING RANGES

The Max Set Size and the LIMITS must be programmed for the control to energize. All other parameters will operate on the preset values shown below. If the transformer-rectifier control line voltage has been removed, the control will operate on the last set of information entered when the line voltage has been restored.

<table>
<thead>
<tr>
<th>Function</th>
<th>Preprogrammed Value</th>
<th>Range</th>
<th>Keyboard Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Primary Current</td>
<td>001 A</td>
<td>1 – 500 A</td>
<td>1 amp increments</td>
</tr>
<tr>
<td>Max Secondary Current</td>
<td>0001 ma</td>
<td>1 – 3000 ma</td>
<td>1 milliamp increments</td>
</tr>
<tr>
<td>Max Secondary Voltage</td>
<td>01 kV</td>
<td>1 – 99 V</td>
<td>1 kilovolt increments</td>
</tr>
<tr>
<td>Primary Voltage Limit</td>
<td>400V</td>
<td>25-800 V</td>
<td>1 V increments</td>
</tr>
<tr>
<td>Primary Current Limit</td>
<td>000A *</td>
<td>1-500 A</td>
<td>1 A increments</td>
</tr>
<tr>
<td>Secondary Current Limit</td>
<td>0000MA *</td>
<td>1-3000 mA</td>
<td>1 mA increments</td>
</tr>
<tr>
<td>Secondary Voltage Limit</td>
<td>00kV **</td>
<td>1-99 kV</td>
<td>1 kV increments</td>
</tr>
<tr>
<td>Primary Under Voltage Trip</td>
<td>100V</td>
<td>20-300 V</td>
<td>1 V increments</td>
</tr>
<tr>
<td>Secondary Under Voltage Trip</td>
<td>20kV</td>
<td>05-99 kV</td>
<td>1 kV increments</td>
</tr>
<tr>
<td>Ramp</td>
<td>10</td>
<td>0.2-60 seconds</td>
<td>1 second increments</td>
</tr>
<tr>
<td>Phase Back</td>
<td>20%</td>
<td>1-99%</td>
<td>1% increments</td>
</tr>
<tr>
<td>Pedestal</td>
<td>2</td>
<td>1-10 cycles</td>
<td>1 cycle increments</td>
</tr>
<tr>
<td>Quench Time</td>
<td>1</td>
<td>1-9 cycles</td>
<td>1 cycle increments</td>
</tr>
<tr>
<td>Quench Mode</td>
<td>0</td>
<td>0 or 1</td>
<td>0 = Arc, 1 = Arc &amp; Spark</td>
</tr>
<tr>
<td>Process Sense</td>
<td>90</td>
<td>10-99 seconds</td>
<td>1 second increments</td>
</tr>
<tr>
<td>Spark Rate Control</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Disable, (1) Enable</td>
</tr>
<tr>
<td>Spark Rate</td>
<td>24</td>
<td>2-200 SPM</td>
<td>1 SPM increments</td>
</tr>
<tr>
<td>Under Voltage Trip Delay Time</td>
<td>30</td>
<td>10-99</td>
<td>1 second increments</td>
</tr>
<tr>
<td>Under Voltage Trip Detection</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Primary, (1) Secondary</td>
</tr>
<tr>
<td>External Alarm Text</td>
<td>1,2,3,4</td>
<td>1-14</td>
<td>See Appendix III</td>
</tr>
<tr>
<td>External Alarm 1 Trip</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Nontrip, (1) Trip</td>
</tr>
<tr>
<td>External Alarm 2 Trip</td>
<td>1</td>
<td>0 or 1</td>
<td>(0) Nontrip, (1) Trip</td>
</tr>
<tr>
<td><strong>ID Ranges</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keypad/Display Unit ID</td>
<td>001</td>
<td>001 - 250</td>
<td>1 unit increments</td>
</tr>
<tr>
<td>Interface Unit End ID Number</td>
<td>01</td>
<td>1 – 99</td>
<td>1 unit increments</td>
</tr>
<tr>
<td>Interface Unit Start ID Number</td>
<td>01</td>
<td>1 - ***</td>
<td>1 unit increments</td>
</tr>
<tr>
<td><strong>Intermittent Energization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE Charge Time</td>
<td>2</td>
<td>1-30</td>
<td>½ cycle increments</td>
</tr>
<tr>
<td>IE Discharge Time</td>
<td>1</td>
<td>1-16</td>
<td>1 cycle increments</td>
</tr>
<tr>
<td>IE Background Power</td>
<td>0</td>
<td>0-50%</td>
<td>1% increments</td>
</tr>
<tr>
<td>IE Auto/Opt Time</td>
<td>15</td>
<td>5 to 180</td>
<td>1 minute increments</td>
</tr>
<tr>
<td>IE Enable</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Disable, (1) Enable</td>
</tr>
<tr>
<td><strong>Peak Limits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Secondary Current</td>
<td>0000 *</td>
<td>01 to ** ma</td>
<td>1 mA increments</td>
</tr>
<tr>
<td>Displays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Reading</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Disable, (1) Enable</td>
</tr>
<tr>
<td>Pre Spark Reading</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Disable, (1) Enable</td>
</tr>
<tr>
<td>SRC Conduction Angle</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Disable, (1) Enable</td>
</tr>
<tr>
<td>Averaged Readings</td>
<td>0</td>
<td>0 or 1</td>
<td>(0) Disable, (1) Enable</td>
</tr>
</tbody>
</table>

* These values will change to the values entered for the Max values.
** Three times the programmed Maximum Secondary Current.
*** Value entered for Interface Unit End ID Number
**** Value entered for Coordination System End ID Number
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The following troubleshooting instructions are based on controls that have been installed correctly and have operated properly for some period of time.

If you are having problems while installing the control or upon initial operation, or if you have followed all the troubleshooting procedures and are still having a problem, please call our technical service department at 908/3691590.
PROBLEM
No Primary Voltage Reading (all other readings okay)

COURSE OF ACTION

The primary voltage signal is taken from the secondary of a potential transformer (PT) whose primary is across the primary of the transformer rectifier (TR). The PT has a voltage ratio of 600/20 volts. Therefore a voltage between 0 and 20 volts ac can be expected at the secondary of the PT, and across the two “VOLT” terminals on TB-5 of the Interface Unit, that is representative of 0 to 600 volts on the primary of the TR.

Measure the voltage at the primary of the TR (after the CLR, and calculate the appropriate ratio [(600/20) * (TR primary voltage/ X)]. The value of X is the secondary voltage that should be across the two “VOLT” terminals. If the expected voltage is not present start tracing the voltage back to the PT. Either the wiring/connection between the PT and the Interface board is bad, the PT is bad or the signal to the primary of the PT is missing.

Some controls have fuses in series with the primary of the PT. These fuses may be either in the control cabinet, the low voltage junction box on the TR, or in the CLR enclosure mounted on the TR. Don't forget to check the fuses.

If the proper voltage is present across the two “VOLT” terminals, there is a malfunction on the Interface Unit. Return the Unit for repair.
PROBLEM

No Primary Current Reading (all other readings okay).

COURSE OF ACTION

The primary current signal is a voltage reference signal derived across a shunt resistor that is located across the current transformer (CT). When the control is initially calibrated this resistor is set using the formula \[\frac{15,000}{\text{transformer primary current rating}}\]. Once adjusted, the signal across the resistor will be 0 to 5 volts ac, corresponding to 0 to current rating.

Check the current with a true RMS ac clamp-on ammeter. Using the ratio \([\text{rated current}/5] \times \text{(measured current/x)}\) determine the voltage that should be across the resistor. That voltage should appear across the two “AMP” terminals on TB-5 on the Interface Unit. If the voltage is not present, start tracing the voltage back to the resistor. If the voltage is present at the resistor, the wiring or connections between the resistor and the “AMP” terminals are defective. If the voltage is not present across the resistor, the CT or the resistor could be defective. Replace these items, re-calibrate the resistor, and recheck the signal at the Interface Unit.

If the proper voltage signal is present across the two “AMP” terminals, there is a malfunction on the Interface Unit. Replace the Interface Unit and return it for repair.
PROBLEM

No Secondary Current Reading (all other readings okay).

COURSE OF ACTION

The secondary current signal is a voltage reference signal derived across a circuit on the TR signal-conditioning panel. This panel is located in the low voltage junction box or TR ground switch enclosure. Two resistors are calibrated during initial set-up to provide a 0 to 5 volt dc signal across terminals “MA(+)/A” and “SEC COMMON (GND)” on TB-5 on the Interface Unit, when 0 to rated secondary current is present at the output of the transformer rectifier (TR). Using a ratio of the rated primary current to the actual measured primary current, an approximation of the secondary current signal can be made [(measured primary current/rated primary current)*5]. This approximate voltage should be present at terminals 40 and 15 on TB-3 on the Interface Panel.

If the approximated voltage is not present across terminals “MA(+)/A” and “SEC COMMON (GND)”, trace the signal back to the signal conditioning panel. This panel is located in either the low voltage junction box or the TR ground switch enclosure. If the voltage is present at the signal-conditioning panel the wiring or connections between the interface panel and the conditioning panel are defective. If the voltage is not present at the conditioning panel, replace the panel, re-calibrate, and recheck the signal. If the signal still is not present there is probably a fault within the transformer tank. At this point call the manufacturer of the TR for help.

If the signal is present on the Interface Unit across terminals “MA (+)/A” and “SEC COMMON (GND)”, there is a malfunction on the Unit. Replace the Unit and return it for repair.
**PROBLEM**

No Secondary Voltage Reading (all other readings are okay).

**COURSE OF ACTION**

The secondary voltage signal is a reference voltage signal derived across a circuit on the TR signal-conditioning panel. This panel is located in the low voltage junction box or TR ground switch enclosure. A trim pot is provided for adjustment of each leg of the KV signal (KV1 & KV2) during initial set-up to provide a 0 to 5 volt dc signal across terminals “KV1” and “SEC COMMON (GND)” and “KV2” and “SEC COMMON (GND)” when 0 to rated secondary voltage is present at the output of the transformer rectifier (TR). Using the formula [(operating primary volts/rated primary volts) * 5] you can approximate the voltage that should be present between terminals “KV1” and “SEC COMMON (GND)” and “KV2” and “SEC COMMON (GND)”.

If the approximated voltage is not present at the Interface Unit, trace the voltage back to the signal-conditioning panel. If the voltage is present at the signal conditioning panel, the wiring or the connections between the conditioning panel and the Interface Unit are defective. If the voltage is not present at the conditioning panel, replace the panel, re-calibrate, and recheck the signal. If the signal is still not present there is probably a fault with the voltage divider resistor or the connection to the voltage divider resistor.
PROBLEM

Under Voltage Trip (low or no primary or secondary voltage, high or rated primary or secondary current).

COURSE OF ACTION

If the primary voltage drops below the setting of the Under Voltage trip limit while the primary current remains greater than 20% of the rated current, the control will trip off. If this occurs, the message line on the display will read Under Voltage trip.

The cause of this condition is either a resistance ground or a dead short to ground downstream of high voltage transformer. In weighted wire type precipitators, a broken wire is the common cause. Additional causes could be a full hopper or high voltage insulators that have electrically tracked.

To isolate the problem, disconnect the precipitator load from the high voltage transformer rectifier (TR) and re-energize. If primary and secondary voltage is now present (there should be no primary or secondary current) the ground is located within the precipitator. If the voltage is still low or zero the problem is within the TR tank. For problems within the TR tank consult Redkoh Industries. For problems within the precipitator perform a complete internal inspection.
PROBLEM
Over Current Trip

COURSE OF ACTION
If the microprocessor control system is programmed and operating properly, the only way an over current trip can occur is if one or both of the SCRs are shorted or miss firing. Start troubleshooting by disconnecting the gate and cathode leads of both SCRs at the Interface Unit. Tape the leads individually so they cannot touch other components. Re-energize the control and note the current and voltage levels. With the SCRs disconnected the current and voltage should be zero. If current and voltage are obtained one or both of the SCRs is defective (either shorted or leaking). For reliability sake, replace both SCRs, or single power pack, based on the existing arrangement.

If after disconnecting the SCRs and re-energizing the control the current and voltage are zero, the SCRs are okay and the problem probably lies within the Interface Unit. Replace the Interface Unit. Be sure not to accidentally swap the SCR1 leads with the SCR2 leads. If they do get switched you will not get any power out of the control when it is re-energized.

If after replacing the Interface Unit the control continues to trip on over current call Redkoh Industries Technical Help at 908/874-5588.
PROBLEM

SCR Imbalance Trip

COURSE OF ACTION

The SCR imbalance trip initiates when the amplitude of the primary current positive and negative waves differs by more than 20%. This difference could be caused by defective SCRs, defective Interface Unit, or an unequally loaded transformer rectifier set.

Replacing the SCRs is the first step. If this does not solve the problem replace the Interface Unit. If the problem still exists, and you have a double half wave output on the TR operating in the half wave mode, place a full wave jumper between the output bushings. If the imbalance trip continues, follow the TR manufacturer’s troubleshooting instructions to determine if the diodes in the bridge rectifier have failed. If the imbalance trips stop with the full wave jumper in place there is a major difference in the loading between the two frames. An internal inspection should be performed.
PROBLEM

Breaker Trips

COURSE OF ACTION

If the microprocessor control is operating properly it will de-energize the control and display an over correct trip message without tripping the breaker. Therefore, if the breaker is tripping, either the microprocessor Interface Unit is defective and not regulating the conduction angle of the SCRs, one or both of the SCRs are shorted or defective, or there is a short to ground between the breaker and the SCRs.

To eliminate a short to ground in the control cabinet as the problem, disconnect the field wiring going to the primary of the transformer rectifier. Connect four 110 volt incandescent lamps in series across the output of the cabinet. Since the cabinet no longer has a substantial load, re-energizing the cabinet should produce line voltage and very very low current. If moderate or high current is present, a short exists. Keep disconnecting components in-route back to the breaker until the defective device/wiring is found.

If after disconnecting the TR load and the current is zero, the problem probably lies with the SCRs, the Interface Unit, or the breaker. Reconnect the wiring to the TR. Re-energize the control and watch the primary current display. If it goes above the rated current for that cabinet recheck the control programming. If the programming is correct, disconnect each SCR gate and cathode lead from the Interface Unit (tape them individually to keep them from contacting anything). Re-energize the control and again watch the current, it should be zero. If there is any current, one or more of the SCRs are shorted or leaking. Replace the defective SCR or SCR block.
If after disconnecting the SCRs the current is zero, the problem lies within the Interface Unit. Replace the Unit with a known working (or new) one.

If after performing all the above checks it is determined that all components are in proper working order yet the breaker continues to trip, replace the breaker. As a double check, place a recording amp meter on the line feed between the breaker and the contactor. If the current does not exceed the control rating, yet the breaker keeps tripping, the breaker is definitely defective.
PROBLEM

No Primary or Secondary Current (high or rated primary voltage).

COURSE OF ACTION

This condition occurs when there is no load on the control and/or the TR. The first step in determining the cause is to place a temporary ground on the high voltage bushing of the TR. If the TR is a double half wave configuration (two output bushings) make sure the two bushings are tied together for full wave operation.

With a ground on the secondary of the TR the control should reach the primary or secondary current limit programmed into the control, and no voltage. If rated current is present the problem lies in an open circuit between the TR output bushings and the support bushing tie in point for the high voltage frame.

If after grounding the TR high voltage bushing(s) the current is still zero, the problem lies between the control and the output bushings. Verify that the wiring between the TR control and the primary input to the TR is not open. If it is open, replace the defective wiring. If it is not open the problem is within the TR tank.

Megger the primary and secondary of the TR, per the manufacturers instructions. If an open circuit exits on the primary, the TR will have to be removed for repair. If the open is on the secondary, remove and check the full wave diode bridge for an open leg(s). If the diode bridge is open, replace the diode stack and retest. If the current is still zero check the RF coils located between the diode bridge and the output bushing(s) for an open condition. If the no current condition still exists the secondary winding of the transformer core is open and the core will need to be replaced.
PROBLEM
Low Voltage and Low Current.

COURSE OF ACTION
When both the voltage and current are low it usually means that either excessive sparking is occurring in the precipitator or electrical noise is entering the control cabinet. Electrical noise can enter the control through the electrical line feed or through the feedback signals from the secondary of the TR.

Usually, the only noise that affects the control through the line feed is fast rise time transients generated by variable frequency drives or SCR type motor speed controls. An Oscilloscope will be necessary to detect these transients. If they are present, adding inductive filters to the feed of the offending motor control will usually solve the problem.

The common entry of noise is through the TR secondary feedback signals. In particular, the secondary current signal. Electrical noise on this line can be interpreted by the control as sparking, and cause the control to back down on power in an effort to maintain a reasonable spark rate.

To check for noise on the secondary current signal, disconnect the lead connected to MA(+)A on TB-5 on the Interface Unit. This will remove both the secondary current signal and the spark signal. Place the control in the manual mode of operation. Slowly raise the power from zero via the manual potentiometer. If the electrical readings hold steady at a level above the level achieved in automatic, then noise is present on the secondary current signal.
If the electrical readings become unstable at about the same levels as when the control was in automatic, then the sparking is real. An inspection of the electrical connections at the TR, within the pipe and guard, and within the precipitator will be required.
PROBLEM

No Power After Performing Electrical Repairs in Cabinet.

COURSE OF ACTION

This condition occurs most often after SCRs or the control transformer have been replaced. The SCRs are synchronized to line phase. Therefore, if the SCR1 and SCR2 gate and cathode leads get switched or the wiring to the new control transformer get switched, or the new transformer is wound differently, the SCRs will be out of phase and no power will flow.

To fix this problem, either swap the SCR1 and SCR2 gate and cathode leads on TB1 and TB2 of the Interface Unit, or swap the wiring on the secondary of the control transformer.

An out of phase condition can also be detected by placing the display in the conduction angle mode and observing the conduction angle. If the conduction angle is full on (158 degrees) and the control has no power output, both SCRs are out of phase or open circuited.
PROBLEM

Contactor will not Pull-in, or Pulls-in and Immediately Drops Out when Control is Switched to On - Open Contactor and Stop Mode displayed on message line.

COURSE OF ACTION

This can be caused by either of three failures. One is an open in the cabinet wiring or the contactor coil, another is a defective or poor contactor auxiliary contact, and the third is a defective Interface Unit.

To determine which failure it is, measure the voltage between the “CONTACTOR STATUS” terminal on TB-4 and the 0V terminal on TB-3, on the Interface Unit. With the ON/OFF switch to ON, there should be 120 volts across these terminals.

If 120 volts is not present, start tracing the wire connected to the “CONTACTOR STATUS” terminal back to the contactor aux. contact. If 120 volts is not present at the aux. contact keep tracing back to the fuse. Most likely a wire or connection is open. If the fuse were blown the display on the control would not illuminate. If you get 120 volts at the line side of the aux. contact but not the terminal “CONTACTOR STATUS” side, the contact is dirty or defective.

If 120 volts is present at the “CONTACTOR STATUS” terminal, check the voltage at the “RUN/STOP” terminal. If there is no voltage at the “RUN/STOP” terminal with the ON/OFF switch in the ON position, then the wiring from the switch, or the switch, is defective.
PROBLEM
No Sparking is Occurring and No Electrical Limit is Being Reached

COURSE OF ACTION
If the control is not under Energy Management Control, not in manual mode, and there is no sparking or arcing, at least one of the electrical parameters should be at a limit. This limit could be one of the ratings of the transformer, or it could be a lower value programmed into the control. Regardless of what the limit is, some limit should be reached. You can tell when a control parameter is at its limit by the little square that illuminates to the upper right of the individual electrical displays.

If a limit is not being reached when there is no sparking, place the display in the conduction angle mode (refer to instruction manual). If the conduction angle is at 158 degrees the current limiting reactor is defective (usually due to shorted turns).

If the control is not operating at 158 degrees the Interface Unit is probably defective. Replace it with a known working unit.
PROBLEM

Communications Error on the status line of the Device Status Screen and “Comm Fault” on Device Select Screen

COURSE OF ACTION

These communication errors mean that the Keypad and Display Unit is not communicating with the Interface Unit

In order of probable cause: defective Interface Unit, defective communications cable connection, or defective Keypad and Display Unit.
PROBLEM

Control will not come out of Manual Mode.

COURSE OF ACTION

There are two ways a control can operate in the manual mode. One way is placing the control in manual by throwing the AUTO/MANUAL/STAND ALONE switch located on the bottom of the interface panel into the MANUAL position. The other is the failure of the microprocessor (or other components) on the Interface Unit causing the circuit to automatically switch to the manual mode.

In either case, if the control will not switch back to automatic the Interface Unit is defective and should be replaced.

An indication of a microprocessor failure, on the Interface Unit, is when the CPU RUN indicator stops blinking.