



Graphic Rapper Controller™ (GRC) User's Guide

Rev. 3.1

Revisions

Rev.	Date	Author	Description
1.0	11/2/99		Original
1.1	8/10/05		Added multiple rap feature
2.0	1/13/06	FGS	Updated for new display screens
2.1	5/25/10	FGS	Added board changing procedure to Troubleshooting section
2.2	5/17/11	RAZ	Added 240V Migi Device Type
3.0	3/13/14	FGS	Added DSP SCPU feature
3.1	7/9/14	FGS	Updated Datamap & Local/Remote Control

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Chapter 1: Introduction

NWL's Graphic Rapper Controller

NWL Transformers' 3rd Generation rapper controller – The Graphic Rapper Controller (GRC). Years of electrostatic precipitator controls experience have resulted in the design of this state-of-the-art rapper controller.

The GRC System consists of three major components (see figure 1), the Smart-CPU (S-CPU), the Smart-Rap (S-Rap), and the Hand-Held Programmer (HHP). The main function of the S-CPU is to store and run complex operating programs. The S-CPU offers many other features such as Power Off Rapping, Trending, Anti-Coincidence Grouping making it the most powerful rapper controller in the industry. The S-Rap module operates in two fashions, “stand-alone” or part of the complex system controlled by the S-CPU. When the S-CPU has control, the S-Rap will energize devices and monitor the current levels for alarm conditions. In stand-alone mode, the S-Rap uses either on-board switch settings or internal memory settings to energize and monitor the devices. Should the S-CPU have trouble at any time, the S-Rap modules will automatically switch to stand-alone and maintain rapper activity. The third major component of the GRC System is the HHP. Through the HHP, the user can create and modify operating programs, monitor rapper activity and alarms, and troubleshoot system faults. Using a graphical 16 line, 40 character Liquid Crystal Display (LCD), the HHP provides the most information in the industry.

GRC Block Diagram

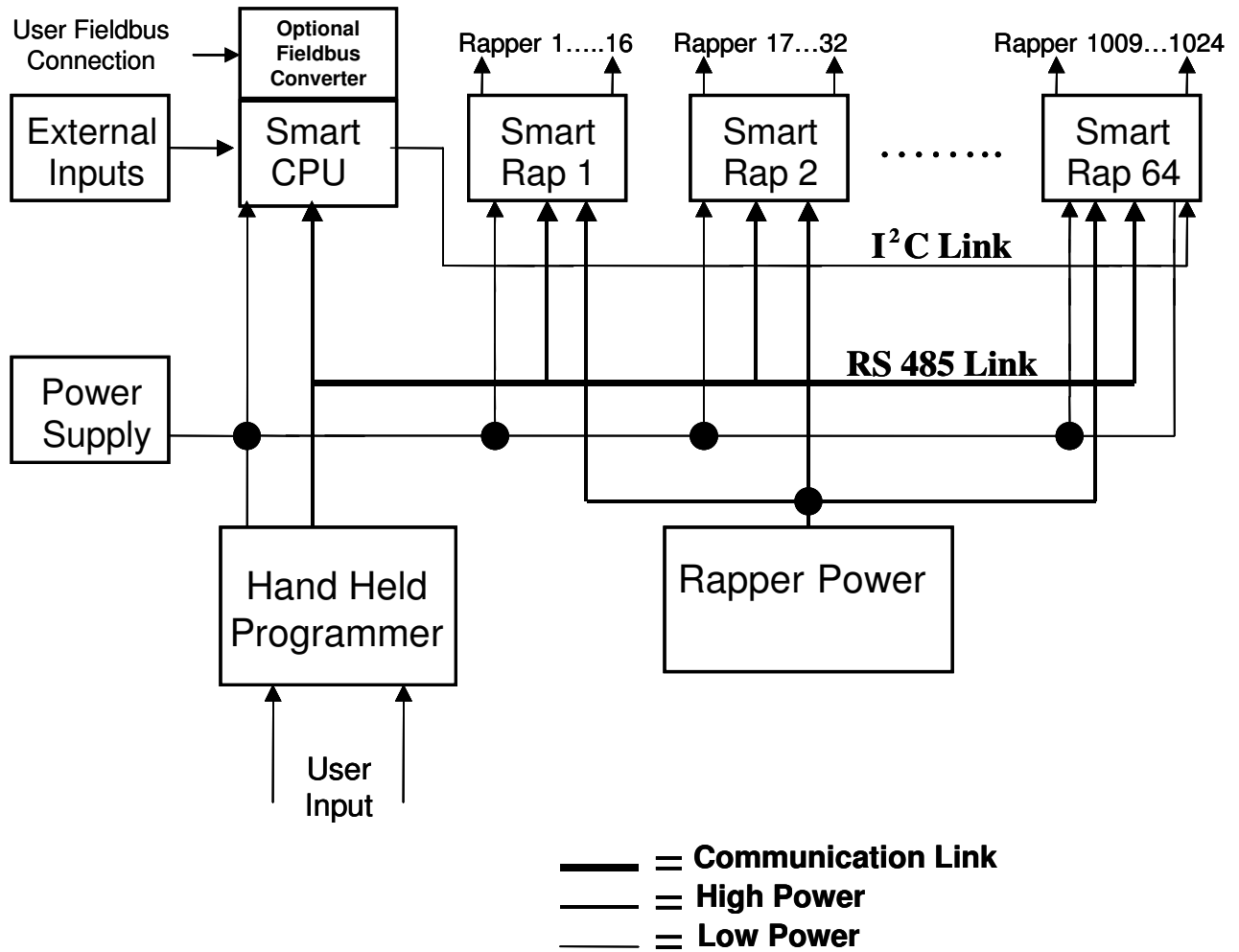


Figure 1 - GRC Block Diagram

Unique “Smart System” Features

R-Scan

The GRC’s R-Scan feature will check and report the operating status of each rapper output within seconds. By applying a small amount of power to each output, the GRC can determine whether a device is within the preset normal operating ranges or whether it requires attention by technicians. R-Scan reduces the time for total system checkout to minutes rather than hours. Today, with plant technicians assuming more responsibility than ever, saving man-hours is not only a convenience, but also a necessity.

Opacity Spike Detection

Creating operating programs without causing “opacity spikes” due to re-entrainment has been the task of many plant engineers. The GRC will monitor and detect opacity spikes caused by specific rappers. This information eliminates the trial and error method of creating the most efficient rapper program.

Support for Over 1000 Devices

The GRC will support up to 1024 devices on a single controller. In the past, precipitators with a large number of rappers required separate “stand-alone” controllers. Separate controllers meant more hardware, more maintenance and more system attention. With the technological advance in today’s microprocessors, the limitations of the past are gone. The GRC brings total control of a precipitator’s rapping responsibility to a single Hand-Held Programmer. Increasing demands on the precipitator require more complex rapping schemes. With the GRC, the plant engineers tasks become more manageable.

Auto-Lift Calibration

Temperature changes and rapper “wear and tear” cause changes in a device’s performance. Constant attention had to be paid to rappers in order to maintain optimum precipitator performance. With the GRC, you simply select the desired lift in inches, and the system will do the rest. Monitoring current levels and making adjustments on the fly provides “lift regulation” in changing conditions.

System Redundancy

When a rapper controller fails, ash begins to build up on plates and may eventually cause a necessary precipitator shutdown. With the GRC, you have the option for rapping redundancy. The redundancy is accomplished with the S-Rap modules. Each S-Rap will can be configured to automatically begin to fire each output to maintain rapper activity in the event of an S-CPU failure. Using this option provides the plant with a level of redundancy virtually eliminating precipitator downtime due to rapper controller failure.

Automatic Program Selection

Changes in operating loads of a precipitator require different operating programs to maintain efficiency. The GRC will allow automatic program changes based on boiler load ranges, time of day, or remote input signals. Operators no longer have to worry about changes to program settings when the levels of a precipitator change.

High Resolution, 16 Line x 40 Character Display

The GRC's Hand-Held Programmer uses a graphical, 16 line, 40 character Liquid Crystal Display to provide the most information in the industry. Graphical capabilities means opacity and boiler load trending right at the programmer and a simple "menu-driven" interface for ease of use. 16 lines of 40 characters means up to 640 characters on the display at one time.

Opacity and Boiler Load Graphical Trending

Opacity and boiler load signals can be supplied to the GRC for graphical trending and used for automatic system features. The HHP provides a graphical trend of the information giving the operator immediate feedback caused by changes to system settings.

NWL's Last ½ Cycle Variation

Several methods of obtaining precise lift are used in the industry. Applying full ½ cycles of energy gives less control over rafter lift. Phasing back ½ cycles to accomplish more lift variations results in magnetism problems. NWL's GRC uses a combination of the two methods providing precise lift control without causing magnetism. Applying full ½ cycles of power and then phasing back power on only the last ½ cycle gives repeatable lift control to the ½ inch.

NWL's Patented Ramped Intensity Pulsing – “Rip/Rap”

The energy applied to the lower area of precipitator plates is reduced. In order to clean the bottom of the plate, higher rapper lifts are required. This causes problems with re-entrainment. When ash re-enters the gas flow, it's either re-collected by the next field or makes its way to the stack. NWL's “Rip/Rap” (Patent # 4928456), applies several “Rips” with increasing energy levels. Each successive “Rip” will clear an area of the plate eventually reaching the bottom. Before and after opacity strip charts show significant reduction of spikes when Rip/Rap is applied.

Document Standards

Throughout this Guide we make use of some special typefaces and print conventions to represent what you see on the display and keys you push to operate the GRC Hand-Held Programmer.

Options you choose from a list or menu are written in upper/lower case bold, such as **Setup**.

On-screen fields that allow you to make choices, set parameters or displays information will be in upper/lower case bold italics: ***Relay Logic***.

Examples of information you enter into a field will be in upper/lower case italics: *On, Off, 15 Min.*

The names of the keys you use to enter information on the keypad will appear inside angle brackets: <Left Arrow>, <Enter>.

Technical Support

NWL's Environmental Technologies provides 24-hour support for plant personnel. During normal business hours - 8:00AM to 5:00PM ET, NWL representatives can be reached at 1-800-PICK NWL. After hours, the same number will access the automated technical support system. Leave your name and number and a NWL representative will return your call. NWL has its own Website <http://www.nwl.com> where all GRC software upgrades will be posted along with other product enhancements.

How to Use This Manual

The guide is divided into 6 chapters. Each chapter covers a crucial aspect of the GRC operation.

Chapter 1: Introduction

Provides a summary of the GRC's main features, and general information related to this document.

Chapter 2: Quick Start Guide

A simple checklist for initial GRC System configuration.

Chapter 3: User Interface

An explanation of how to use the Hand-Held Programmer for monitoring and configuration of the GRC system.

Chapter 4: Troubleshooting

Detailed procedures for using the GRC's built-in troubleshooting features.

Chapter 5: Configuration Summary

A handy guide to the switch settings on the Smart-CPU and Smart-Rap module.

The manual is designed to be a practical, user-oriented description of each function and procedure. You'll find it easy to understand. Actual pictures of the on-screen displays are included to make the text easier to follow.

Use the checklist below to ensure proper configuration prior to energizing the GRC System. For a more detailed description of the Smart System board setup, see the Configuration Summary chapter.

Smart-CPU Configuration

- Board Address – Rotary Switch 1
- Program the Serial Communication Address via HHP
- Configure Power Feed Values via HHP
- Create Operating Program via HHP
- Create POR Program via HHP
- Configure Anti-Coincidence Grouping via HHP
- Program all S-CPU associated values (Load Scale, etc.) via HHP
- Optional – Configure the fieldbus converter parameters via the HHP

Smart-Rap Configuration (each module)

- Board Address – DIP Switch 8 (positions 3 through 8)
Each S-Rap Board Address is associated with assigned rapper output range.
- Calibration or Standard Lift Table for DC Impact Devices – DIP Switch 8 (position 1)
- Stand Alone On/Off – DIP Switch 1
- Set Module Device type – DIP Switch 7
- Select DIP or Internal Registers “Fire” Settings – DIP Switch 2
- For DIP Settings – set Device Fire Settings – DIP Switch 6
- For Internal Register Settings – set Device Fire Settings via HHP
- Set Initial Wait, Cycle, and Wait Time – DIP Switches 3, 4, & 5
- Select Gain setting – DIP Switch 10
- Configure Overcurrent/Undercurrent settings via HHP

Chapter 3: User Interface

Using the Hand-Held Programmer

Keypad

The GRC's HHP keypad consists of just nine membrane keys (see Figure 2). These keys demand positive operation. In other words, you must exert some pressure on them before they register. This helps eliminate accidental activation. However, they are remarkably tough. Don't be afraid to press hard. There is a tactile response when they engage.

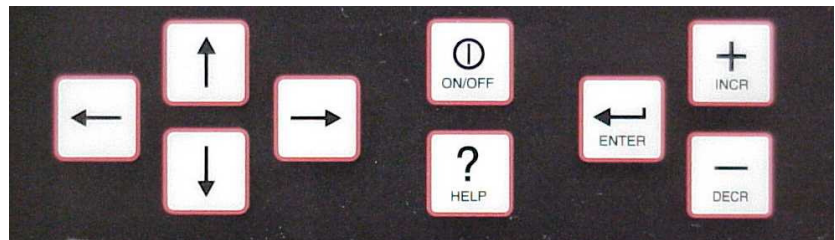


Figure 2 - HHP Keypad

The keys include:

Four <Arrow> keys (left, right, up, down) for moving around within any window in the display area – called “scrolling” in this manual.

<On/Off> which will activate/de-activate the operating program.

<? Help> to access on-line help information for the GRC.

<Enter> used to move from the main menu at the top of the screen to the data area. Also, used to register a choice or change to a setting you have made.

<+Incr> and <-Decr> through which you change settings in the entry windows.

Shortcut: Sometimes you may wish to return to the main menu quickly, without changing any other settings in the entry window. Similar to “Escape” on a computer keyboard, pressing any two <Arrow> keys while the cursor is in the data entry area of a window will return the cursor to the main menu.

Menu Bars

The top two lines of the display are the main menu (see Figure 3). Each option has one or more associated windows and is accessible using the <Arrow> keys. Pressing the <Enter> key on one of the selections will move the cursor into the data entry area – provided you have the necessary security clearance.

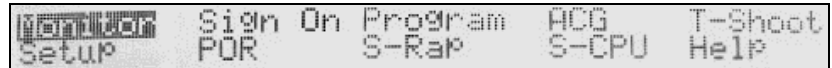


Figure 3 - HHP Menu Bars

Data Section

The middle of the display (lines 4 – 14) contains system settings and option for entry into additional windows. The information contained in the data section is determined by where the menu bar cursor sits.

| Grp# | InitWait | Cycle | Wait | Mode | SEQ |
|------|----------|----------|----------|------|-----|
| 1 | 00:00:05 | 00:01:00 | 00:00:00 | Norm | SEQ |
| 2 | 00:00:10 | 00:02:00 | 00:00:00 | Norm | SEQ |
| 3 | 00:00:25 | 00:03:00 | 00:00:00 | Norm | SEQ |
| 4 | 00:00:40 | 00:01:00 | 00:00:00 | Norm | SEQ |
| 5 | 00:01:00 | 00:02:00 | 00:00:00 | Norm | SEQ |
| 6 | 00:01:20 | 00:03:00 | 00:00:00 | Norm | SEQ |
| 7 | 00:02:00 | 00:00:30 | 00:05:00 | Norm | SEQ |
| 8 | 00:00:00 | 00:00:00 | 00:00:00 | Norm | SEQ |

Figure 4 - HHP Data Section

Status Lines

The bottom line of the display is the status line and is used to report system critical information to the user regardless of which display is being viewed. Rapper activity, help messages, and alarm information will all be displayed on the status line.

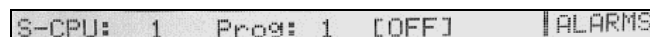


Figure 5 - HHP Status Lines

On-Line Help

A major advantage of a multi-line display is the amount of information that can be presented at one time. The HHP contains on-line help information available for immediate access. Simply press the <?Help> key and information relevant to the current window will be displayed. Descriptions of system settings and their ranges are available.

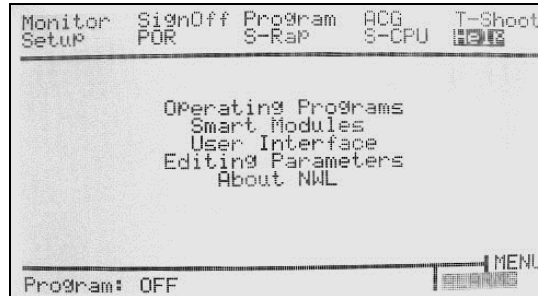


Figure 6 - On-Line Help Window

Signing On

The GRC System uses password-controlled security to prevent unauthorized personnel from making changes to system settings. Access to several windows requires the user to log on to the system. Enter the 2 character alphanumeric password at the **Sign On** using the <+Incr> and <-Decr> keys and press <Enter>. If a valid password is entered, the cursor will return to the **Monitor** window and **Sign Off** will replace **Sign On** on the menu bar. When you're finished making changes, simply press <Enter> on the **Sign Off** option. If you forget, the HHP will automatically log off within a period of inactivity.

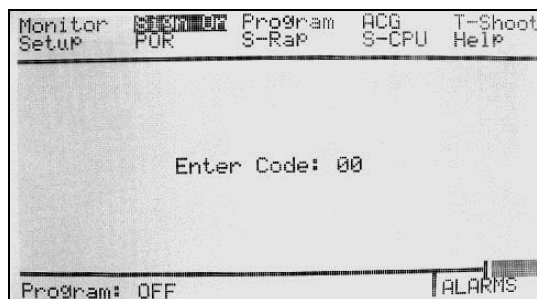


Figure 7 - Sign On Window

Monitoring

Rapper Activity

The **Monitor** window provides operators with a 9-second window of the GRC System's rapper activity. Up to 6 rappers can be energized in 1 second.

| | PROGRAM STATUS | ACG FIFO | TREND |
|----|----------------|----------|-------|
| -4 | 0 | 0 | 0 |
| -3 | 0 | 0 | 0 |
| -2 | 36 | 0 | 0 |
| -1 | 5 | 7 | 0 |
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 2 | 10 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 41 | 0 | 0 |

S-CPU: 1 Prog: 1 [ON] ALARMS

Figure 8 - Monitor Window

PROGRAM STATUS

Pressing <Enter> on this field will open the Program Status window.

ACG FIFO

Pressing <Enter> on this field will open the Anti-coincidence FIFO (First In First Out) window.

TREND

Pressing <Enter> on this field will open the Opacity and Boiler Load Trend window.

-4 ... 0 ... 4

If the operating program is running, the Monitor window will show the current rapper activity. For example, the line of activity at **-4** represents rappers that are scheduled to fire in approximately 4 seconds. Line **0** will show rappers that have just been energized.

S-CPU

This field contains the address of the currently selected S-CPU module (1-16). To select a different S-CPU, press the <+Incr> or <-Decr> key and press <Enter>. The HHP will start to monitor the rapper activity and alarm information for the new S-CPU.

Prog

Each S-CPU can hold 5 operating programs. This field shows which of the 5 programs is selected. To change the active program, press the <+Incr> or <-Decr> key and press <Enter>. If the program selected is valid, the S-CPU will start to run the new program, otherwise an error message will be displayed.

Operating Programs

While creating and modifying operating programs, an operator can use the **Program Status** window to “watch” the program in action. This window will display the times and next rapper scheduled to fire for each group. Press the <+Incr> or <-Decr> key to change which groups are monitored.

| Grp# | InitWait | Cycle | Wait | NextRap |
|------|----------|----------|----------|---------|
| 1 | 00:00:00 | 00:00:03 | 00:00:00 | 9 |
| 2 | 00:00:00 | 00:00:04 | 00:00:00 | 16 |
| 3 | 00:00:00 | 00:00:13 | 00:00:00 | 28 |
| 4 | 00:00:00 | 00:00:05 | 00:00:00 | 33 |
| 5 | 00:00:00 | 00:00:26 | 00:00:00 | 37 |
| 6 | 00:00:00 | 00:00:29 | 00:00:00 | 42 |
| 7 | 00:00:00 | 00:00:00 | 00:03:13 | 45 |
| 8 | 00:00:00 | 00:00:00 | 00:00:00 | 0 |
| 27 | 0 | 0 | 0 | ALARMS |

Figure 9 - Program Status Window

Grp#

Shows the current rapper group (1-64).

InitWait

Display the amount of initial wait time remaining for a rapper group. If this value is at 00:00:00, the rapper group is in either cycle or wait time mode.

Cycle

Displays the amount of cycle time remaining for a rapper group. When the cycle time counts down to 00:00:00, the ***NextRap*** will be energized.

Wait

After completing a rapper sequence, a group will enter a wait period (if programmed to do so). Once the wait time counts down to zero, the group will re-enter the cycle mode and start to energize rappers again.

NextRap

This field shows the next rapper schedule to fire for group.

Anti-Coincidence Buffers

During normal rapper program operation, an Anti-coincidence scheme (see ACG in Configuration chapter) can be setup to prevent “gas-flow” rapping and eventual re-entrainment. The **ACG FIFO** will display rappers that are currently held due to ACG conflicts.

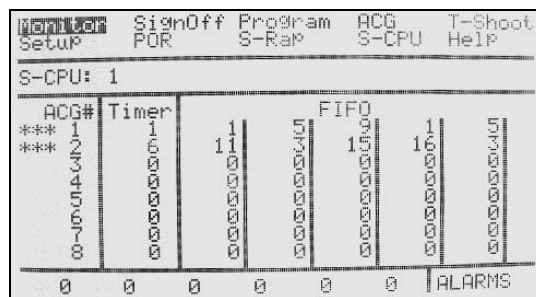


Figure 10 - Anti-Coincidence Buffer Window

ACG#

Shows the Anti-coincidence group number (1-64).

Timer

Indicates the amount of time remaining for the ACG. When this time counts down to 0, the next device in the FIFO will be scheduled to fire and has priority over the normal rapper activity.

FIFO

FIFO, or First In First Out, shows the list of devices that have been held due to a ACG conflict. As the name implies, the first rapper entered into the list is the first to be removed.

Alarms

The S-CPU module will continuously monitor for S-Rap alarms. The bottom right corner of the display will indicate whether any alarms exist.

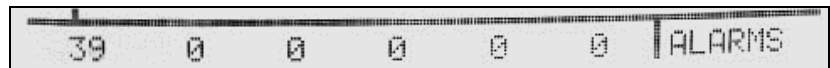


Figure 11 - Status Line Alarm Notification

User will be notified if any of the following alarms occur:

- 1) Operating Program is OFF.
- 2) SRAP alarm(s):
 - a) S-RAP does not communicate with the S-CPU
 - b) Overcurrent, Undercurrent, or Half-wave occurred

User will be notified of the Alarm(s) by the word **ALARMS** that will appear on the *Status line*. To determine what kind of alarm(s) occurred User will select **ALARMS** from the Status Line of the HHP and press <Enter> key.

The screen will change to **S-RAP Alarm Summary** screen that is shown below.

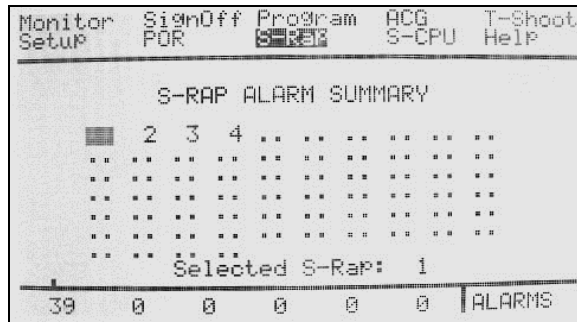


Figure 12 – S-RAP Alarm Summary screen

2, 3, 4, 5, ..

The numbers are the Board Addresses of S-RAP(s) being alarmed. To determine what kind of S-RAP alarm (s) occurred User will select the S-RAP and press <Enter> key on the HHP. The screen will change to **SRAP Alarms** screen for the particular S-RAP. The screen is shown below.

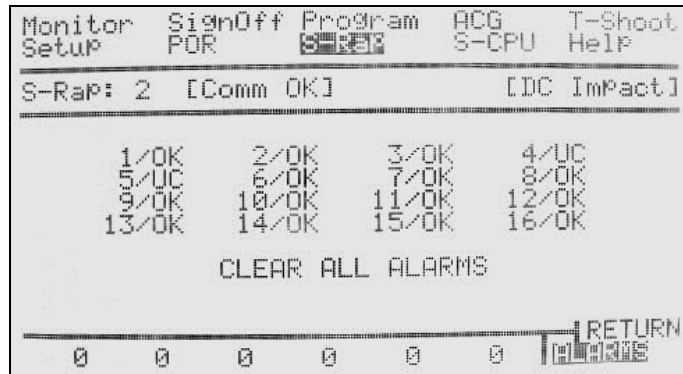


Figure 13 - S-RAP Alarms screen

S-Rap

Shows the address of the currently selected S-Rap module.

#/OK

The operating status of each output on the S-Rap module will be stored. The operator can manually disable an output by using the <+Incr> or <-Decr> keys and pressing <Enter>. The 2 character text next to the output number represents the status (see table below).

| Alarm | Description |
|-------|--------------------------------------|
| OK | Functioning properly |
| DS | Manual disabled |
| OC | Failed on overcurrent check |
| UC | Failed on undercurrent check |
| HW | Failed on half-waving check |
| SO | Suspected of failing on overcurrent |
| SU | Suspected of failing on undercurrent |
| SW | Suspected of failing on half-waving |

CLEAR ALL ALARMS

Pressing <Enter> on this field will clear the alarms on all each S-Rap outputs.

Comm OK/No Comm

Shows whether a particular S-Rap communicates (**Comm OK**) or does not communicate (**No Comm**) with the HHP.

Trending

The HHP uses it's graphical capability to display a 1-minute trend of the opacity and boiler load signals.

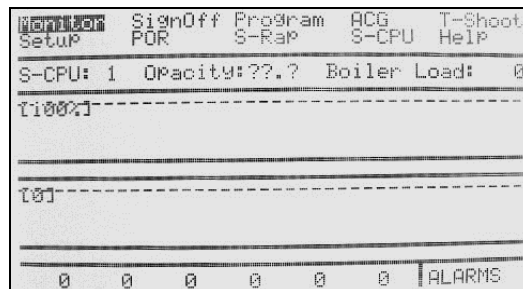


Figure 14 - Opacity and Boiler Load Trend Window

S-CPU

Shows the address of the S-CPU currently selected.

Opacity

Shows the value of the opacity 4-20mA input on the S-CPU module. The input scale of the opacity is always 0 to 100%. However, the HHP will automatically re-scale the display to provide a better trend.

Boiler Load

Shows the value of the boiler load 4-20mA input on the S-CPU module. The scale of the boiler load is setup in the **S-CPU** window (see S-CPU in Configuration chapter).

Opacity Spike Detection

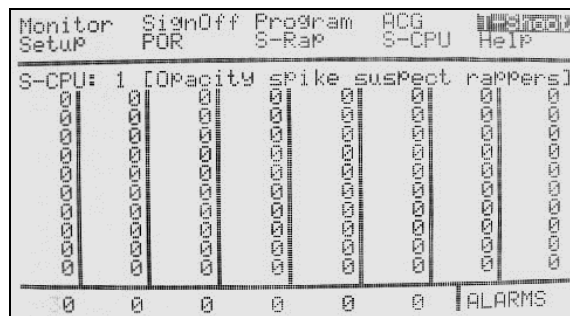


Figure 15 - Opacity Spike Detect Window

Rappers that are suspected of causing opacity spikes will be displayed in this window. When an opacity spike is detected, all rappers that fire within the **Flow Delay** (see Smart-CPU window) will be flagged. Rappers that are flagged in three consecutive occurrences will be logged to this list.

Configuration

Smart-CPU

The **S-CPU** module requires setup of several values for proper system operation.

```

Monitor  SignOff Program  ACG    T-Shoot
Setup:   POR      S-Rap   [SIGNAL] Help
-----
S-CPU: 1          Ver: [v4.04]  Password: 51
-----
Relay Lgc: N.O.           Time: 09:56:05
Prog Off: Alarmed        Date: 03/18/14
Num Alarms: 1            Rem. Enable: Disabled
Pr9 Restr: Re-start      FldBus Ctrl: Disabled
Load Scale: 340          NetPrt Baud: 19200
Flow Delay: 3            NetPrt Mode: NWL
OPac Spike: 10 %
CLR OPAC SPK LIST
-----
Program: OFF             SUB-MENUS
-----
ALARMS
    
```

Figure 16 - Smart-CPU Window

S-CPU

This field shows the address of the currently selected S-CPU module.

Version

Shows the version of firmware loaded into the SCPU card.

Password

To prevent unauthorized or accidental parameter entry, the HHP requires an operator to sign on with a proper password. The password is a 2 digit alphanumeric value. Programmable from 00 – ZZ. If the user is not signed on, this field will be displayed as **.

Relay Logic

When the number of rapper alarms (*Num Alarms*) is reached, the S-CPU will activate the alarm relay. This relay can be used to notify operators in a control room, sound an alarm horn, or simply light an indicator. The logic of the relay is programmable as *N.O.* (normally open – closes on alarm), or *N.C.* (normally closed – opens on alarm).

Prog Off

If you would like the GRC to generate an alarm if the rapping program is turned off, set this parameter to *Alarmed*. If you want to be able to turn the rapping program off without getting an alarm set this parameter to *No Alarm*.

Num Alarms

Being notified of every alarm may eventually become a nuisance. By setting the number of alarms value to something other than 1, the S-CPU will delay activation of the alarm relay until that number of alarms occurs. Programmable from 0 – 99.

Prg Restart

When the operating program is turned on, the S-CPU will either re-start the program or continue from where it previously left off. Re-starting the operating program causes all timers to be initialized at 0 and the sequence pointer returns to the start of the rapping sequence. Programmable as *Continue* or *Re-start*.

Load Scale

If the boiler load 4-20mA signal is connected to the S-CPU, the scale value represents what value should be displayed at 20mA or full scale. Programmable from 0 – 9999.

Flow Delay

The flow delay is defined as the amount of time it takes for gas to completely travel through the precipitator. This value is used for determining which devices are suspected of causing opacity spikes. Programmable from 0 – 99 seconds.

Opacity Spike

The GRC system has a unique feature that identifies which rappers are suspected of causing opacity spikes. This value defines what percentage of an increased in sudden opacity is required to enable a opacity spike scan. Programmable from 0 – 99%.

CLR OPAC SPK LIST

Pressing <Enter> on this field will send a command to the S-CPU to clear its current list of rappers suspected of causing opacity spikes. This is useful for resetting the list after a new or modified program is being tested. The Status line will briefly flash a message confirming the command has been sent.

Time

The S-CPU module contains a built-in timekeeper. Use the <+Incr> or <+Decr> key to change the hours, and press <Enter>. The cursor will move to the minute's field. Continue changing the minutes, and seconds and finalize your selection by pressing <Enter>. The new time value will be sent to the S-CPU. The format of the ***Time*** value is *00:00:00* to *23:59:59*. The time value can be used by the S-CPU to automatically change operating programs.

Date

Similar to the ***Time*** field above, the S-CPU will store the date. Currently, the date is informational only.

Rem. Enable:

Note: Please, refer to the GRC System schematics for reference designators.

This is a software switch that will allow the User to operate the GRC in **Local** or **Remote** modes. The switch has 3 settings: **Disabled**, **Discrete**, and **Network**. To change from one setting to another use +/- key on the HHP keypad.

a) **Disabled**

This is a default setting. It will appear on the HHP screen when the new software is installed on the S-CPU board. Most of the Users will operate in this mode. They will be able to send write commands to the GRC locally (from HHP) and remotely (PCAMS/NT and DCSi).

b) **Discrete**

In this mode the system software will monitor and respond to

Rem_Prg_On input (1TB – 22 on the GRC System schematics) as long as the system configured to **Remote** mode (120VAC is applied to **Loc/Rem Enable** input located on 1TB – 21 on GRC System Schematics).

If system is configured to **Remote** mode **all** write commands from HHP will be rejected. Write commands can be sent via PCAMS/NT or DCSi (**except Program ON/OFF command**).

To turn the Program ON remotely 120VAC must be applied to **Rem_Prg_On** input (1TB – 21 on GRC System schematics).

To turn the Program OFF remotely 120VAC must be disconnected from **Rem_Prg_On** input.

If 120VAC is not applied to **Loc/Rem Enable** input then the system will be in **Local** mode which means that write commands from HHP only will be accepted.

c) **Network**

In this mode the system software will monitor and respond to commands originating from PCAMS/NT or DCSi only as long the system configured to **Remote** mode (120VAC is applied to **Loc/Rem Enable** input located on 1TB – 21 on GRC System schematics). If system is in **Remote** mode **all** write commands from HHP will be rejected, **all** write commands from PCAMS/NT and DCSi will be accepted.

If 120VAC is not applied to **Loc/Rem Enable** input (1TB – 21 on GRC System schematics) then the system will be in **Local** mode and accept write commands from HHP only.

Fldbus Ctrl

This parameter is used to define which port is to be able to write commands to the GRC. If set to *NWL Net*, the Net Port is the only port able to write commands. If set to *Fielsbus*, only the optional fieldbus module is able to write commands. If set to *All*, both the Net Port and the fieldbus module can write commands.

NetPrt Baud

This parameter sets the baud rate for the Network port. The possible settings are, *9600*, *19200*, *38400*, *57600*, and *115200*. In order for the GRC to communicate with the NWL PCAMS or GRC-DCSi the baud rate should be set for *19200*.

NetPrt Mode

The protocol for network port is selectable between *NWL* and *Modbus*. In *NWL* mode, our proprietary protocol is used to communicate with other NWL products. In *Modbus* mode, the Modbus RTU protocol is used for communications with a PLC or other host computer. The datamap for this mode is located in the appendix of this manual.

Local/Remote Control Table

| "Remote Enable" Setting | "Local/Remote" Discrete Input State | Local Port (NWL protocol only) | Remote Port (NWL protocol or Modbus-RTU) | Anybus Port | "Program On/Off" Discrete Input | "Program Select" Discrete Inputs |
|-------------------------|-------------------------------------|--------------------------------|---|---|---------------------------------|----------------------------------|
| Disabled | Local or Remote | Write access | Write access if "Remote Master" is set to "Net Port" or "All" | Write access if "Remote Master" is set to "Fieldbus" or "All" | Disabled | Enabled |
| Discrete | Local | Write access | Read-only | Read-only | Disabled | Disabled |
| | Remote | Read-only | Read-only | Read-only | Enabled | Enabled |
| Network | Local | Write access | Read-only | Read-only | Disabled | Disabled |
| | Remote | Read-only | Write access if "Remote Master" is set to "Net Port" or "All" | Write access if "Remote Master" is set to "Fieldbus" or "All" | Disabled | Disabled |

SUB-MENUS

There are four additional sub-menus for the SCPU board. They are shown below.

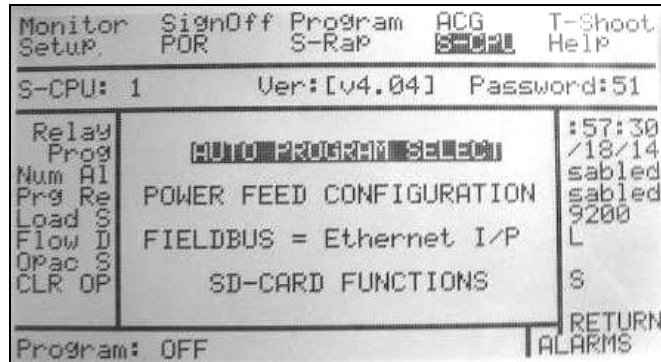


Figure 17 – Sub-Menu Window

AUTO PROGRAM SELECT

Pressing <Enter> on this field will open the window for configuring the automatic program selection feature of the GRC System. See the Auto Select section under the Configuration portion of this manual for more details.

POWER FEED CONFIGURATION

Pressing <Enter> on this field will open the window for defining which slots are connected to each power feed. See the Power Feed section under the Configuration portion of this manual for more detail.

Optional Fieldbus Converter

If an optional fieldbus converter is installed on the SCPU board, that type of fieldbus will be designated in the ***FIELDBUS =*** field. Pressing <Enter> on this field will open the window for configuring the protocol parameters for the specific fieldbus .

```

Meter SetPoint Config Count Network Help
Trend U/I Mode Rating Alarm Hammer Setup
-----
Fieldbus: Ethernet I/P

I P Address: 192.168. 1. 10
Subnet Mask: 255.255.255. 0
Gateway: 0. 0. 0. 0
Servers: WEB
DHCP: Off
Port Speed: Auto

APPLY CHANGES RETURN TO SETUP
<P+DSP>
IA1 :10 HV OFF Setpoint
Loc/Loc
    
```

Figure 18 – Ethernet I/P Configuration Window

Enter the appropriate data for each parameter. Press <Enter> after each entry. Consult with your network administrator for the proper parameter values to be entered.

The Fieldbus Configuration Screens will vary slightly depending upon the specific Fieldbus being used. Ethernet I/P and Modbus TCP use the display shown above. Other examples of Fieldbus displays are shown below.

```

Meter SetPoint Config Count Network Help
Trend U/I Mode Rating Alarm Hammer Setup
-----
Fieldbus: Profinet

I P Address: 192.168. 1. 10
Subnet Mask: 255.255.255. 0
Gateway: 0. 0. 0. 0
Servers: WEB

APPLY CHANGES RETURN TO SETUP
<P+DSP>
IA1 :10 HV OFF Setpoint
Loc/Loc
    
```

Figure 19 – Profinet Configuration Window

```

Meter SetPoint Config Count Network Help
Trend U/I Mode Rating Alarm Hammer Setup
-----
Fieldbus: DeviceNet

Device Address: 1
Baud Rate: 125 kbps

APPLY CHANGES RETURN TO SETUP
<P+DSP>
IA1 :10 HV OFF Setpoint
Loc/Loc
    
```

Figure 20 – DeviceNet Configuration Window

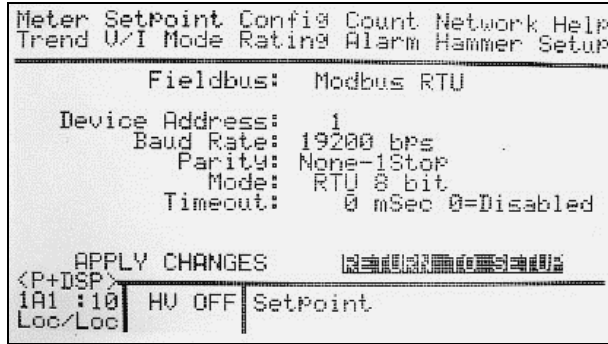


Figure 21 – Modbus RTU Configuration Window

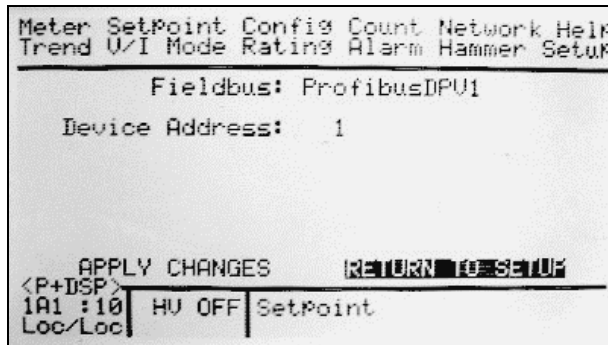


Figure 22 – Profibus Configuration Window

When complete scroll down to the **APPLY CHANGES** and press <Enter>. The cursor will move to the **RETURN TO SETUP** field. Press <Enter> to return.

Installing the Optional Field Bus Converter

If the rapper controller was ordered with the optional fieldbus converter, it will be install at the factory. However, if you need to replace the SCPU board, the converter must be moved from the old board to the new board. To remove the old converter:

1. Remove the field wiring connector that plugs into the converter.
2. Remove the SCPU board from the card cage and place on a flat surface.
3. Turn the two screws on the front plate of the converter counter-clockwise to release the converter from the DSP board.

4. Grab the sides of the converter and gently pull it from the multi-pin jack.

Once removed follow the steps below to install it on the new board.

1. Make sure that the mounting feet on the module are fully retracted by turning the two screws on the front plate counterclockwise.
2. Carefully line up the module with the mounting rails of the jack. Slowly and carefully start to slide the module into the jack. **As the module approaches the pins in the back of the jack, stop and visually verify that all of the pins in the jack are properly aligned and entering the sockets in the module. If the pins are not properly aligned damage will occur to the jack on the DSP board.** If the pins are all aligned, continue to slowly push the module into the jack until it is fully seated.
3. Turn the two screws on the front plate of the module clockwise to secure the module to the DSP board.
4. Replace the SCPU card in the card cage.
5. The users wiring will then connect directly to the connector on the field bus module.

SD-Card

The DSP processor board also has provisions for a 2 or 4 GB SD memory card. The card is located under DSP board near the optional fieldbus module socket.

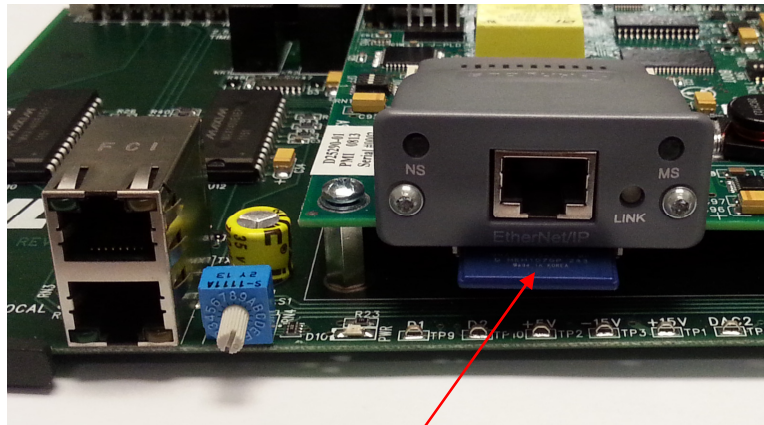


Figure 23 – SD Card Location

The SD card holds the following files:

- User Rapping Programs
- User ACG Data
- GRC Configuration files.

Pressing <Enter> on *SD-CARD FUNCTIONS* on the Sub Menus screen will open the following window.

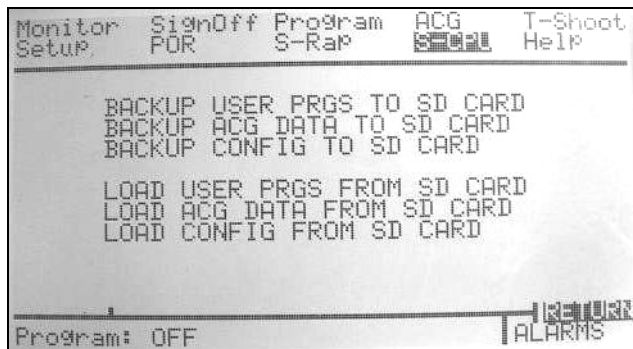


Figure 24 – SD-Card Function Window

Scroll down to the desired command and press <Enter> for the action to initiate.

Smart-Rap

Each S-Rap module stores information specific to its operation. For example, the operating status of each of the 16 rapper outputs is stored. Also, the internal register settings for use in “stand-alone” operation or configured through this window in **Rapper Setup**.

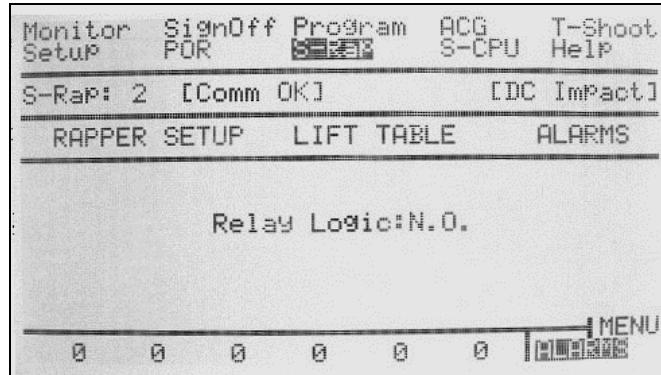


Figure 25 - Smart-Rap Window

S-Rap

Shows the address of the currently selected S-Rap module.

RAPPER SETUP

Pressing <Enter> on this field will open the **Rapper Setup** window for configuration of the S-Rap’s internal register settings.

ALARMS

Pressing <Enter> on this field will open the **Alarms** window for viewing the alarm status of the 16 rappers on the current S-Rap module.

Relay Logic

The logic of the S-Rap module alarm relay is programmable as *N.O.* (normally open – closes on alarm), or *N.C.* (normally closed – opens on alarm).

Rapper Setup

When a S-Rap module is configured to operate in “stand-alone” mode, the information used for firing the rappers is setup in this window. In addition to stand-alone operation, the GRC System S-Rap module will automatically initiate firing rappers with these settings in the occurrence of a S-CPU failure.

| Monitor Setup | SignOff POR | Program S-RAP | ACG S-CPU | T-Shoot Help | | |
|--|-------------|---------------|-----------|--------------|----|--------|
| S-Rap: 2 Lift Reg: Off [DC Impact] | | | | | | |
| Rap# | Lift | Frq | Int | Duration | UC | OC |
| 1 | 4.0 | 200 | | 00:00:00 | 00 | 30 |
| 2 | 4.0 | 200 | | 00:00:00 | 00 | 30 |
| 3 | 4.0 | 200 | | 00:00:00 | 00 | 30 |
| 4 | 4.0 | 200 | | 00:00:00 | 05 | 30 |
| 5 | 4.0 | 200 | | 00:00:00 | 05 | 30 |
| 6 | 4.0 | 200 | | 00:00:00 | 00 | 30 |
| 7 | 4.0 | 200 | | 00:00:00 | 00 | 30 |
| 8 | 4.0 | 200 | | 00:00:00 | 00 | 30 |
| | | | | | | RETURN |
| 39 | 0 | 0 | 0 | 0 | 0 | ALARMS |

Figure 26 - Rapper Setup Window

S-Rap

Shows the address of the currently selected S-Rap module.

Rap#

Shows the rapper output number (1-16) on the S-Rap module.

Lift

Sets the lift in inches for DC Impact type rappers. This value is used in stand-alone and auto-redundant modes only.

Programmable from 0 – 16 inches.

Lift Reg: On/Off

Turns the Lift Regulation ON and OFF. If the Lift Regulation is ON then the number of half-cycles will be adjusted to achieve the desirable Lift value; if the Lift Regulation is OFF then the number of half-cycles will not be adjusted.

[AC/DC Mot]

Current Device Type that S-RAP board is controlling

Frq

Sets the frequency in cycles per minute for Multi-Impact type devices. Programmable in 13 preset steps from 200 to 600 CPM. Valid values are 200, 212, 225, 240, 257, 278, 300, 330, 360, 390, 450, 510, and 600. Press the <+Incr> or <-Decr> key to scroll through the available settings and press <Enter> to accept the change.

Int

Sets the intensity percentage for Vibrator and Multi-Impact type devices. Programmable from 0 – 100%. Changes to the intensity less than 100% will result in ½ cycles of power applied at less than full conduction.

Duration

Sets the duration in seconds of Vibrator, Multi-Impact, and Motor type devices. Programmable from 00:00:00 to 23:59:59.

UC/OC

Each rapper output can be assigned current low and high alarm levels. When the S-Rap module detects 2 consecutive ½ cycles of current lower than the ***UC*** setting, it will flag the rapper output. Two consecutive failures will result in the output to be alarmed and removed from normal firing activity. The same will occur when the S-Rap detects a single ½ cycle of current higher than the ***OC*** setting. Programmable from 0 to 40 amperes.

Hand-Held Programmer

The HHP contains local configuration settings specific to its operation. These settings are stored in the HHP and retained in the event of a power outage.

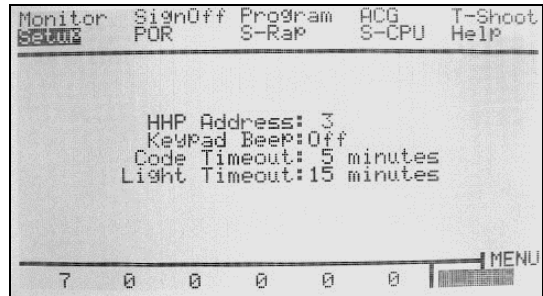


Figure 27 - Setup Window

HHP Address

Serial communication address for Hand-Held Programmer. Programmable from 3 - 9.

Keypad Beep

On/Off switch for audible beep when keys are pressed.

Code Timeout

Amount of time before HHP will sign off when there is no key activity. Programmable from 1 - 30 minutes.

Light Timeout

Amount of time before LCD backlight turns off when there is no key activity. Programmable from 1 - 30 minutes.

Power Feeds

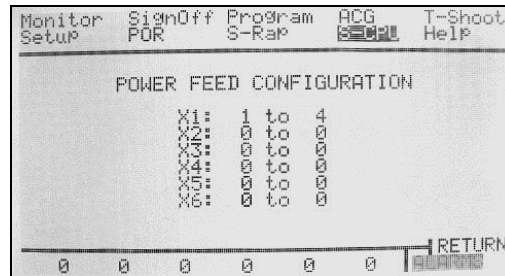


Figure 28 - Power Feed Window

X1 – X6

The GRC System allows up to 6 separate power feeds. Each power feed is assigned to one or more S-Rap cards. Proper configuration of the power feeds is critical for rapper operation. Take a simple example of a GRC System with three S-Rap modules. S-Rap1 and S-Rap2 modules are responsible for energizing 16 DC-Impact style devices each. S-Rap3 module is responsible for energizing 16 AC Vibrator devices. The power feed assignments for *X1* should be *S-Rap 1 to 2* and *X2* should be assigned *S-Rap 3 to 3*. The GRC System’s S-CPU utilizes this information to enable simultaneous rapper operation and to prevent system damage. For safety reasons, if the power feeds are not assigned, the S-CPU will not energize any rappers.

Operating Programs

The most important aspect of a rapper controller is the creation of optimum rapping programs. Rapper programs consist of timing values, lift information, etc. and are all important to achieving optimum performance. Either through experience or trial and error, operators can fine tune programs to produce the most effective results in the precipitator. The GRC System supports what the industry considers a “time-based” rapper controller. This type of controller is more flexible than older style “sequence-based” rapper controllers. Independent groups of rappers can be assigned different timing values. This is important for rapping inlet fields more often than center fields, and center fields more often than outlet fields. The GRC offers the most complex program capabilities in the industry. Up to 64 groups, 48 rappers per group, individual settings per rapper, and

no limitation on assigning rappers to more than one group provide the user with the flexibility to create just about any program they desire. Of course, with the amount of information to be entered, rapper controllers of the past - using 1-4 line displays – were difficult to use. The HHP’s 16 lines of information make program entry simple and easy to follow. The user can “upload” a program into the memory of the HHP and make modifications while rapper firing continues in the background. When the changes are complete, the program can be saved or “downloaded” to the S-CPU and stored in FLASH memory.

| Grp# | InitWait | Cycle | Wait | Mode | SEQ |
|------|----------|----------|----------|------|-----|
| 1 | 00:00:05 | 00:01:00 | 00:00:00 | Norm | SEQ |
| 2 | 00:00:10 | 00:02:00 | 00:00:00 | Rip | SEQ |
| 3 | 00:00:25 | 00:03:00 | 00:00:00 | 2x | SEQ |
| 4 | 00:00:40 | 00:01:00 | 00:00:00 | 3x | SEQ |
| 5 | 00:01:00 | 00:02:00 | 00:00:00 | 4x | SEQ |
| 6 | 00:01:20 | 00:03:00 | 00:00:00 | Norm | SEQ |
| 7 | 00:02:00 | 00:00:30 | 00:05:00 | Norm | SEQ |
| 8 | 00:00:00 | 00:00:00 | 00:00:00 | Norm | SEQ |

Additional UI elements visible in the screenshot include: Monitor Setup, SignOff POR, ProgMan S-Rap, ACG S-CPU, T-Shoot Help, S-CPU: 1, Prog:1, LOAD SAVE CLEAR, and a bottom status bar with zeros and a MENU button.

Figure 29 - Operating Program Window

S-CPU

Shows the address of the currently selected S-CPU module.

LOAD

Pressing <Enter> on this field will open the window for loading a program from the S-CPU into the HHP’s memory.

SAVE

Pressing <Enter> on this field will open the window for saving a new program to the S-CPU’s memory.

CLEAR

This field will clear the program information in the **HHP** only. (All parameters reset to “0”) Pressing <Enter> will open a dialog box: “Confirm program clear?” “Press enter again to confirm”. Pressing any <Arrow> key at this point will prevent the “clear” function and take you back in the program screen.

Grp#

Shows the current group number (1-64). Pressing the <+Incr> or <-Decr> key on this field will scroll the display to a new set of 8 groups.

InitWait

The initial wait time of a group is defined as the “one-time” delay before initiating rapper activity. The initial wait time is useful for offsetting groups of rappers with identical timing. For example, groups 1 and 2 both have 10 rappers and a cycle time of 30 seconds (see Cycle time below). With an initial delay of 0, both groups will schedule rappers to fire at the same time. By assigning a 30-second initial wait time to group 2, group 1 will be completed firing before group 2 starts. Programmable from 00:00:00 to 23:59:59. *See program example section below for a better understanding of the timing interaction.*

Cycle

The cycle time of a group is defined as the amount of time it takes to completely “cycle” through all the assigned rappers. Rappers will be evenly spaced throughout a group’s cycle time. For example, a group with 10 rappers and a cycle time of 30 seconds will attempt to fire a rapper every 3 seconds ($30 / 10 = 3$). Groups that have 0 cycle time will be disabled regardless of whether rappers are assigned. Programmable from 00:00:00 to 23:59:59. *See program example section below for a better understanding of the timing interaction.*

Wait

The wait time of a group is defined as the amount of time to delay after the completion of a cycle period before restarting the cycle mode. For example, a group is assigned a wait time of 30 seconds. When the group completes the rapper sequence (fires all rappers), it will “sleep” for 30 seconds and not attempt to fire any rappers. After the 30 second delay, the group will re-enter the cycle mode and attempt to fire rappers. Programmable from 00:00:00 to 23:59:59. *See program example section below for a better understanding of the timing interaction.*

MODE

With the release of Scpu firmware version 3.00, HHP firmware version 3.00 and Srap firmware version 2.00, the GRC system allows for different “modes” of how the rappers will function. There are five modes to choose from.

1). *Norm*

This mode will raise the individual rapper once, at the assigned **lift** entered in the *SEQ* field, before moving onto the next rapper in that group sequence.

2). *Rip*

This mode is used to turn the GRC feature “Rip/Rap” *On*. When *Rip* is selected, the DC Impact devices will be fired using the Rip/Rap algorithm. Four “Rips” of power with increasing energy are applied to the rappers with the fourth “Rip” equal to the assigned **Lift** entered in the *SEQ* field.

3). *2X*

This mode will raise the individual rapper two times in succession, at the assigned **lift** entered in the *SEQ* field, before moving onto the next rapper in that group sequence.

4). *3X*

This mode will raise the individual rapper three times in succession, at the assigned **lift** entered in the *SEQ* field, before moving onto the next rapper in that group sequence.

5). *4X*

This mode will raise the individual rapper four times in succession, at the assigned **lift** entered in the *SEQ* field, before moving onto the next rapper in that group sequence.

NOTE:

For proper operation, when selecting the Rip, 2X, 3X, or 4X modes, ensure the groups cycle time is set to allow a minimum of 2 seconds for each DC Impact device. For example, lets say group #1 consists of 90 rappers and **Rip** is selected, the group cycle time, at a minimum, would need to be set to 180 seconds or 3 minutes.

SEQ

Pressing <Enter> on this field will open the window for configuring the rapper sequence information for the associated group.

Rapper Sequence

| Seq# | Rap# | Lift | Freq | Int | Duration |
|------|------|------|------|-----|----------|
| 1 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 2 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 3 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 4 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 5 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 6 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 7 | >end | 0.0 | 200 | 0 | 00:00:00 |
| 8 | 0 | 0.0 | 200 | 0 | 00:00:00 |

27 0 0 0 0 0 ALARMS

Figure 30 - Group Sequence Window

Group

Shows the current group number (1-64) of the sequence information being displayed.

Assign .. to .. GO

These fields provide a shortcut for assigning rapper **output numbers** to a sequence(s). Set the starting and ending rapper **output number** and press <Enter> on **GO**. The HHP will automatically assign rappers to the group's sequence.

Seq#

Shows the current **sequence number** (1-48). Do not confuse with the rapper **output number**. **Output number** (1-1024) is linked to a particular S-Rap board address (1-64). Please, refer to **Ch6. Configuration Summary** (S-Rap section) for more information. Sequence number is a way of counting the number of rappers in a group. For example, if the group has 5 rappers then **Seq#** will range from 1 to 5. Pressing <+Incr> or <-Decr> on these fields will scroll the display to the next/previous set of sequence numbers.

Rap#

This field represents the rapper output number to fire when this sequence member is scheduled. The rapper numbers can be auto-assigned using the *Assign* option or by using the <+Incr> and <-Decr> keys. When a “gap” in the sequence is desired, a 0 can be entered. To complete the sequence, change the field below the last member to >end. Programmable from 0 – 1024 or >END.

Lift

If the rapper assigned for this sequence member is a DC Impact type device, enter the desired lift in inches. Otherwise, this field is ignored. Programmable from 0 to 16 inches in .5 inch steps.

Freq

If the rapper assigned for this sequence member is a Multi-Impact type device, enter the desired frequency in cycle per minute. Programmable in 13 preset steps from 200 to 600 CPM. Valid values are 200, 212, 225, 240, 257, 278, 300, 330, 360, 390, 450, 510, and 600. Press the <+Incr> or <-Decr> key to scroll through the available settings and press <Enter> to accept the change.

Int

If the rapper assigned for this sequence member is a Vibrator or Multi-Impact type device, enter the desired intensity value in percentage. Programmable from 0 – 100%. Changes to the intensity less than 100% will result in ½ cycles of power applied at less than full conduction.

This field must be set to 0 for AC/DC Motor type devices to prevent inaccurate results in Program Timing check..

Duration

If the rapper assigned for this sequence member is a Vibrator, Multi-Impact, or Motor type device, enter the desired duration value in seconds. Programmable from 00:00:00 to 23:59:59. For DC Impact type devices, verify this value is 00:00:00 to prevent inaccurate results to the program timing check.

Program Timing Check

The HHP will perform a timing check on the operating program and verify the system has the capability to fire all devices before allowing it to be saved to the S-CPU. This prevents “lost” rappers due to timing constraints.

Program Timing check will not be invoked for AC/DC Motor type devices.

Program Load

The S-CPU will store up to 5 operating programs. The HHP will store one operating program. Use the HHP **Load** option to retrieve a program to modify.

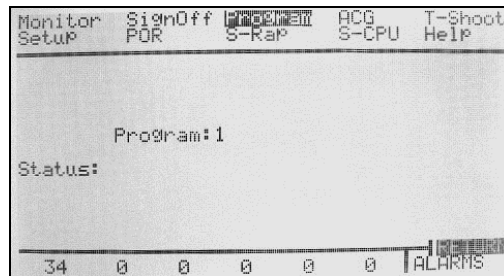


Figure 31 - Load Program Window

Program

Use the <+Incr> or <-Decr> keys to select the operating program number and press <Enter>. The HHP will begin to upload the program from the S-CPU. Select the program “F” to load the program from the HHP’s flash memory.

Status

The **Status** field will indicate which information is currently being retrieved and a percentage completion. If an error occurs during “upload”, it will be reported in this field.

Program Save

When all desired changes are made to the operating program, it must be saved to the S-CPU before it can be used. Rapper activity will be temporarily suspended during program download. When download is complete, the program automatically continues from where it left off. If the “active” operating program is overwritten, the S-CPU will re-start the new program.

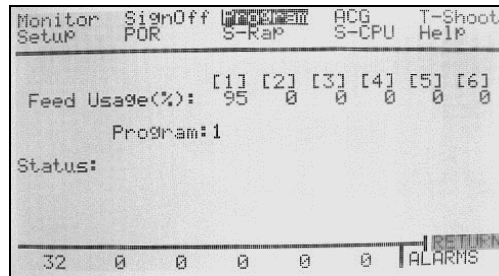


Figure 32 - Save Program Window

Program

Use the <+Incr> or <-Decr> keys to select the operating program number and press <Enter>. The HHP will begin to download the program to the S-CPU. When the program download process is complete, the S-CPU will enter a “Burn FLASH” mode that will take approximately 2 minutes to complete. Select program “F” to save the program to the HHP’s flash memory.

Status

The *Status* field will indicate which information is currently being saved and a percentage completion. If an error occurs during “download”, it will be reported in this field.

Operating Program Example

The following example will illustrate typical program for a better understanding of the interaction of groups and their associated times. This first example does not take into account the possible anti-coincidence delays or Power Off Rapping devices that may affect rapper scheduling. All rappers in this program example are DC Impact type devices.

Given the following program:

| Group | Init. Wait | Cycle | Wait | Mode | Seq. |
|--------------|-------------------|--------------|-------------|-------------|-------------|
| 1 | 00:00:05 | 00:00:10 | 00:00:00 | Norm | 1 |
| | | | | | 2 |
| | | | | | 3 |
| | | | | | 4 |
| | | | | | 5 |
| 2 | 00:00:05 | 00:00:10 | 00:00:10 | Norm | 6 |
| | | | | | 7 |
| | | | | | 8 |
| | | | | | 9 |
| | | | | | 10 |
| 3 | 00:00:05 | 00:00:10 | 00:00:00 | Norm | 11 |
| | | | | | 12 |
| | | | | | 13 |
| | | | | | 14 |
| | | | | | 15 |

When the program is turned on (*time 0*), the following table illustrates when rappers will be scheduled to fire:

| Time | Group 1 | Group 2 | Group 3 |
|------|---------|---------|---------|
| 0 | | | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | 1 | 6 | 11 |
| 6 | | | |
| 7 | 2 | 7 | 12 |
| 8 | | | |
| 9 | 3 | 8 | 13 |
| 10 | | | |
| 11 | 4 | 9 | 14 |
| 12 | | | |
| 13 | 5 | 10 | 15 |
| 14 | | | |
| 15 | 1 | | 11 |
| 16 | | | |
| 17 | 2 | | 12 |
| 18 | | | |
| 19 | 3 | | 13 |
| 20 | | | |
| 21 | 4 | | 14 |
| 22 | | | |
| 23 | 5 | 6 | 15 |
| 24 | | | |
| 25 | 1 | 7 | 11 |
| 26 | | | |
| 27 | 2 | 8 | 12 |
| 28 | | | |
| 29 | 3 | 9 | 13 |
| 30 | | | |
| 31 | 4 | 10 | 14 |

Since groups 1 and 3 have identical cycle and wait times and same number and type of rappers all rappers in those groups will fire with the offset of 250 milliseconds (they need to be offset to prevent transformer overload).

ACG Affect on Program

Configuring a GRC with Anti-Coincidence (ACG) will have an affect on the normal rapper activity. With the same program above, we'll add the following ACG's:

ACG Time is 5 seconds
 ACG 1 contains device # 1 and # 11

When the program is turned on (*time 0*), the following table illustrates when rappers will be scheduled to fire:

Note: rappers that are in the ACG group are enclosed in ().

| Time | Group 1 | Group 2 | Group 3 |
|------|---------|---------|---------|
| 0 | | | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | (1) | 6 | |
| 6 | | | |
| 7 | 2 | 7 | 12 |
| 8 | | | |
| 9 | 3 | 8 | 13 |
| 10 | | | (11) |
| 11 | 4 | 9 | 14 |
| 12 | | | |
| 13 | 5 | 10 | 15 |
| 14 | | | |
| 15 | (1) | | |
| 16 | | | |
| 17 | 2 | | 12 |
| 18 | | | |
| 19 | 3 | | 13 |
| 20 | | | (11) |
| 21 | 4 | | 14 |
| 22 | | | |
| 23 | 5 | 6 | 15 |
| 24 | | | |
| 25 | (1) | 7 | |
| 26 | | | |
| 27 | 2 | 8 | 12 |
| 28 | | | |
| 29 | 3 | 9 | 13 |
| 30 | | | (11) |

As you can see, device 11 caused an ACG conflict with device 1 and was therefore delayed for 5 seconds before firing.

POR Affect on Program

Power Off Rapping programs are similar to normal operating programs. Each POR group is assigned a device sequence with associated firing parameters, and group timing (i.e. cycle time, etc.). Each POR group is also assigned an associated T/R number that is powered down prior to firing the devices in a POR group's sequence. Once rapping is complete, the T/R is returned to its previous power levels. This type of rapping is useful for effective fly-ash removal in high-resistivity conditions.

Given the first example above (no ACG), let's add a simple, 1 group POR program shown below:

| POR Group | Init. Wait | Cycle | Wait | T/R # | Seq. |
|------------------|-------------------|--------------|-------------|--------------|-------------|
| 1 | 00:00:00 | 00:00:05 | 23:59:55 | 1 | 1 |
| | | | | | 2 |
| | | | | | 3 |
| | | | | | 4 |
| | | | | | 5 |

When the program is turned on (*time 0*), the following table illustrates when rappers will be scheduled to fire:

| Time | POR 1 | Group 1 | Group 2 | Group 3 |
|-------------|--------------|----------------|----------------|----------------|
| 0 | 1 | | | |
| 1 | 2 | | | |
| 2 | 3 | | | |
| 3 | 4 | | | |
| 4 | 5 | | | |
| 5 | | 1 | 6 | 11 |
| 6 | | | | |
| 7 | | 2 | 7 | 12 |
| 8 | | | | |
| 9 | | 3 | 8 | 13 |
| 10 | | | | |
| 11 | | 4 | 9 | 14 |
| 12 | | | | |
| 13 | | 5 | 10 | 15 |
| 14 | | | | |
| 15 | | 1 | | 11 |
| 16 | | | | |
| 17 | | 2 | | 12 |
| 18 | | | | |
| 19 | | 3 | | 13 |
| 20 | | | | |
| 21 | | 4 | | 14 |
| 22 | | | | |
| 23 | | 5 | 6 | 15 |
| 24 | | | | |
| 25 | | 1 | 7 | 11 |

Selecting an Operating Program

An Operating Program that User wishes to run can be selected **Manually** or **Automatically**. Manual selection can be performed via HHP or Program Select inputs on the S-CPU; automatic selection can be done using an Auto Program select feature of the GRC system.

Prior to selecting an Operating Program **Rem Enable** software switch located on the S-CPU window of the HHP must be set to **Disabled**.

An operating program can be selected by HHP or by Program Select inputs of the S-CPU.

Selecting an operating program via HHP

To select an active operating Program via HHP the following steps have to be taken by the User:

- 1) Select **Monitor** on the Main Menu of the HHP and press <Enter> key.
- 2) Scroll using right arrow key to the **S-CPU**:
 - 1) Enter the S-CPU address that the Program will run on.
 - 4) Scroll to **Prog:** and enter the Program # that needs to run.
 - 5) Press <Enter> key.
 - 6) Turn the Program ON.
 - 7) Check the **Monitor** screen. The active program number will be shown under **Prog:**

Selecting an Operating Program via Program Select Inputs of the S-CPU

To select an active operating Program via the Program Select inputs the following steps have to be taken by the User:

- 1) Turn the system OFF
- 1) **To run Program 1:** apply 120VAC between 1TB – 4 and 1TB – 9 on the GRC Cabinet Backpanel.
To run Program 2: apply 120VAC between 1TB – 5 and 1TB – 9 on the GRC Cabinet Backpanel.
To run Program 3: apply 120VAC between 1TB – 6 and 1TB – 9 on the GRC Cabinet Backpanel.

To run Program 4: apply 120VAC between 1TB – 7 and 1TB – 9 on the GRC Cabinet Backpanel.

To run Program 5: apply 120VAC between 1TB – 8 and 1TB – 9 on the GRC Cabinet Backpanel.

- 2) Select **Monitor** from the Main Menu on the HHP and press <Enter>
- 3) **Prog:** <selected program> should be displayed. The User will see **Prog:** <selected program> **ON** indication on the HHP.

Auto-Program Select

Automatic changes to the active operating program can be triggered either by boiler load or time of day. This eliminates the need for operators to make constant program changes throughout the day or when load changes occur in the precipitator. Experience shows that different boiler loads require different operating programs to maintain an optimum level of performance.

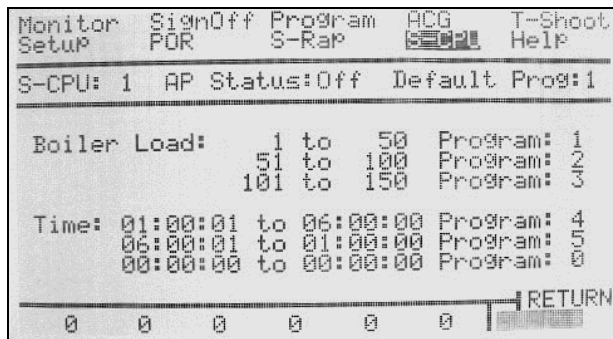


Figure 33 - Auto-Program Select Window

S-CPU

Shows the address of the currently selected S-CPU module.

AP Status: ON/OFF

AP Status: ON enables the Auto – Program feature of the system; AP Status: OFF disables the Auto – Program feature.

Default Program

When the S-CPU performs the auto-program select algorithm and no matches are found, the default program will be used.

Boiler Load .. to .. Program

Set the minimum and maximum boiler load ranges and the associated operating program. The S-CPU will then automatically make the changes for you as the boiler load changes. In order to enable this feature, the 4-20mA boiler load signal must be connected to the S-CPU module.

Time .. to .. Program

Automatically switch to a “faster” program at midnight or switch programs at each shift change. Simply set the time ranges and associated program and the changes will automatically occur. Verify the S-CPU time is set properly.

Power Off Rapping

Separate from the normal operating programs, rappers can be scheduled to fire while power is removed or reduced from T/R sets. This type of rapping provides a more effective cleaning especially in situations with “sticky” fly ash. An output can be assigned to each Power Off Rapping (POR) group to signal third party T/R’s to reduce or remove power while POR occurs. NWL’s Precipitator Management and Control System for Windows NT (PCAMS/NT) will monitor the GRC for POR activity and automatically reduce power to the associated NWL ESP Power Optimizer T/R controller. The GRC System supports up to 32 POR groups with 48 sequence members per group. Several POR program parameters are identical to normal operating program’s parameters but will still be covered in this section for simplicity.

| Grp# | InitWait | Cycle | Wait | Out# | |
|------|----------|----------|----------|------|--------|
| 1 | 00:02:00 | 00:04:00 | 00:00:00 | 17 | SEQ |
| 2 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| 3 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| 4 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| 5 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| 6 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| 7 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| 8 | 00:00:00 | 00:00:00 | 00:00:00 | 0 | SEQ |
| | | | | | ALARMS |

Figure 34 - Power Off Rapping Window

S-CPU

Shows the address of the currently selected S-CPU module.

LOAD

Pressing <Enter> on this field will open the window to upload the POR program.

SAVE

Pressing <Enter> on this field will open the window to save or download the POR program.

Grp#

Shows the current POR group number (1-32). Pressing <+Incr> or <-Decr> on these fields will scroll the display to the next/previous set of POR group numbers.

InitWait

The initial wait time of a POR group is defined as the “one-time” delay before initiating rapper activity. Programmable from 00:00:00 to 23:59:59.

Cycle

The cycle time of a POR group is defined as the amount of time it takes to completely “cycle” through all the assigned rappers. Programmable from 00:00:00 to 23:59:59.

Wait

The wait time of a POR group is defined as the amount of time to delay after the completion of a cycle period before restarting the cycle mode. Programmable from 00:00:00 to 23:59:59.

Out#

The output number is used to notify third-party T/R controllers prior to initiating rapper activity for a POR group. Programmable from 0 to 1024. Note, the output number must be an output located on a Smart-Rap card configured for POR output.

SEQ

Pressing <Enter> on this field will open the window for configuring the rapper sequence information for the associated POR group.

| Seq# | Rap# | Lift | Freq | Int | Duration |
|------|------|------|------|-----|----------|
| 1 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 2 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 3 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 4 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 5 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 6 | 1 | 4.0 | 200 | 0 | 00:00:00 |
| 7 | >end | 0.0 | 200 | 0 | 00:00:00 |
| 8 | 0 | 0.0 | 200 | 0 | 00:00:00 |

Figure 35 - POR Group Sequence Window

POR Group

Shows the current POR group number (1-32) of the sequence information being displayed.

Assign .. to .. GO

These fields provide a shortcut for assigning rappers to a sequence. Set the starting and ending rapper number and press <Enter> on **GO**. The HHP will automatically assign rappers to the POR group’s sequence.

Seq#

Shows the current sequence number (1-48). Pressing <+Incr> or <-Decr> on these fields will scroll the display to the next/previous set of sequence numbers.

Rap#

This field represents the rapper output number to fire when this sequence member is scheduled. The rapper numbers can be auto-assigned using the **Assign** option or by using the <+Incr> and <-Decr> keys. When a “gap” in the sequence is desired, a 0 can be entered. To complete the sequence, change the field below the last member to >end. Programmable from 0 to 1024.

Lift

If the rapper assigned for this sequence member is a DC Impact type device, enter the desired lift in inches. Otherwise, this field is ignored. Programmable from 0 to 16 inches in .5 inch steps.

Freq

If the rapper assigned for this sequence member is a Multi-Impact type device, enter the desired frequency in cycle per minute. Programmable from in 13 preset steps from 200 to 600 CPM. Valid values are 200, 212, 225, 240, 257, 278, 300, 330, 360, 390, 450, 510, and 600. Press the <+Incr> or <-Decr> key to scroll through the available settings and press <Enter> to accept the change.

Int

If the rapper assigned for this sequence member is a Vibrator or Multi-Impact type device, enter the desired intensity value in percentage. Programmable from 0 to 100%. Changes to the intensity less than 100% will result in ½ cycles of power applied at less than full conduction.

Duration

If the rapper assigned for this sequence member is a Vibrator, Multi-Impact, or Motor type device, enter the desired duration value in seconds. Programmable from 00:00:00 to 23:59:59. For DC Impact type devices, verify this value is 00:00:00 to prevent inaccurate results to the program timing check.

Anti-Coincidence Grouping

Each of the GRC System’s program groups operates with individual timers and sequences. In order to prevent rappers within the same precipitator lane to fire together, anti-coincidence groups (ACG) must be configured. The GRC System supports up to 4 ACG’s for each rapper. The figure below shows an example of a typical precipitator’s anti-coincidence group configuration.

| Monitor
Setup | SignOff
POR | Program
S-Rap | S-CPU | T-Shoot
Help |
|--------------------------|----------------|------------------|--------------|-----------------|
| S-CPU: 1 | | | | |
| <<ACG Groups by Rapper>> | | | | |
| ACG | Rap# | 1st
Entry | 2nd
Entry | 3rd
Entry |
| Timers | 1 | 1 | 2 | 0 |
| Reset: 0 | 2 | 0 | 0 | 0 |
| Pr91: 20 | 3 | 2 | 0 | 0 |
| Pr92: 0 | 4 | 2 | 0 | 0 |
| Pr93: 0 | 5 | 1 | 0 | 0 |
| Pr94: 0 | 6 | 1 | 0 | 0 |
| Pr95: 0 | 7 | 2 | 0 | 0 |
| CLEAR-ACG | 8 | 2 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| | | | | MENU |
| | | | | ALARMS |

Figure 36 - Typical Anti-coincidence Grouping

While the system is operating, the ACG FIFO’s (First In First Out) can be viewed from the **MONITOR** window by selecting **ACG FIFO**. The indication of “***” next to an anti-coincidence group represents an overflow. This occurs when system timing exceeds the capabilities of the GRC System. See figure below:

| Monitor
Setup | SignOff
POR | Program
S-Rap | ACG
S-CPU | T-Shoot
Help |
|------------------|----------------|------------------|--------------|-----------------|
| S-CPU: 1 | | | | |
| ACG# | Timer | FIFO | | |
| *** | 1 | 1 | 2 | 0 |
| 0 | 2 | 1 | 2 | 0 |
| 0 | 3 | 1 | 2 | 0 |
| 0 | 4 | 1 | 2 | 0 |
| 0 | 5 | 1 | 2 | 0 |
| 0 | 6 | 1 | 2 | 0 |
| 0 | 7 | 1 | 2 | 0 |
| 0 | 8 | 1 | 2 | 0 |
| 35 | 0 | 0 | 0 | 0 |
| | | | | ALARMS |

Figure 37 - Anti-Coincidence Window

S-CPU

Shows the address of the currently selected S-CPU module.

ACG Timers

When the S-CPU detects a conflict between rappers of the same ACG, it will delay the higher number device by the preset ***ACG Time***. Typically, this is configured as the amount of time it takes for fly ash to completely pass through the precipitator. A value of 0 disables the ACG algorithm. Programmable from 0 to 99 seconds. The ACG time can be set for each of the 5 possible rapper programs saved into the Scpu memory. The ***ACG Time*** for each program, ***Prg1***, ***Prg2***, ***Prg3***, ***Prg4***, and ***Prg5*** can be changed individually or together as a group by modifying the ***Reset*** parameter.

Rap#

Shows the current rapper number (1 – 1024). Pressing <+Incr> or <-Decr> on these fields will scroll the display to the next/previous set of rapper numbers.

ACG1-4

The four fields to the right of the ***Rap#*** represent the anti-coincidence group assignments. The GRC System supports up to 64 ACG's. Each rapper can be in up to four ACG groups.

Clear-ACG

Selecting this function resets all of the four ACG assignments (4096) to "0". Pressing <Enter> will open a dialog box: "Confirm ACG delete." "Press enter again to delete". When selecting this function a second dialog box appears informing the user that pressing enter a second time will reset all 4096 ACG assignments to "0". Pressing any <arrow> key at this point will prevent the "***clearing***" of the ACG assignments and places you back in the ACG screen.

Chapter 5: Troubleshooting

Quick determination of rapper controller system problems could prevent the unfortunate shutdown of the precipitator. The GRC System provides several tools to assist technicians in determining the cause of these problems. With a few simple keystrokes, a complete picture of the system can be retrieved. The following section describes each of these unique GRC features.

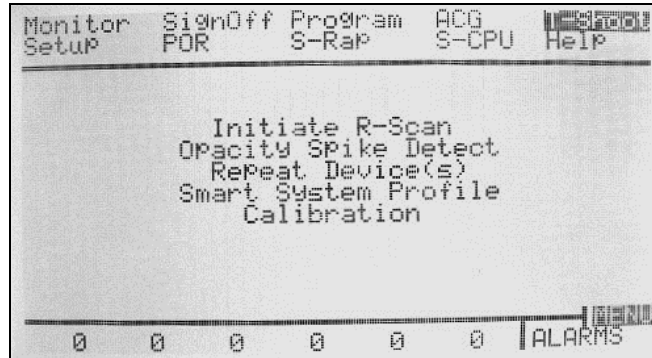


Figure 38 - Troubleshooting Window

Initiate R-SCAN

Pressing <Enter> on this field will open the R-Scan window and begin to gather information about the current status of each S-Rap's 16 outputs. See **R-Scan** window shown for more information.

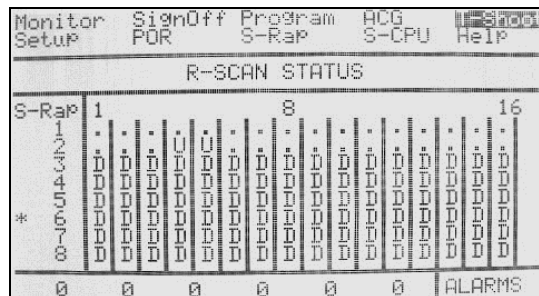


Figure 39 - R-Scan Window

R-Scan is another of NWL unique GRC system features. This window allows operators to get operating status for each of the outputs within seconds. When R-Scan is initiated, the HHP will instruct each S-Rap module to quickly sample each output and return the status.

The status of each output will be displayed as a single character (see table below).

| Alarm | Description |
|-------|--------------------------|
| . | Device OK |
| O | Failed overcurrent test |
| U | Failed undercurrent test |
| D | Device disabled |
| H | Failed half-waving test |
| S | Suspect device |

Opacity Spike Detection

Pressing <Enter> on this field will open the window that displays the rapper currently suspected of causing opacity spikes. Press <Enter> again to return to the **Troubleshooting** menu.

Using the opacity spike detect list, operators can fine tune rapper operating programs to minimize re-entrainment caused by specific rappers (see Opacity Spike section in the Monitor chapter). Verify the ***Flow Delay*** and ***Opacity Spike*** values are configured in the **S-CPU** window for proper operation.

Repeat Device(s)

Pressing <Enter> on this field will open the window for *repeating* or firing rappers. Either a single rapper or a range of rappers can be fired with preset settings.

The **Repeat Devices** window is a useful tool for technicians when checking the operating status of the GRC System. It can be used to fire a single device or multiple devices. If the operator leaves the window before stopping the repeat mode, the HHP will automatically turn off the repeat mode.

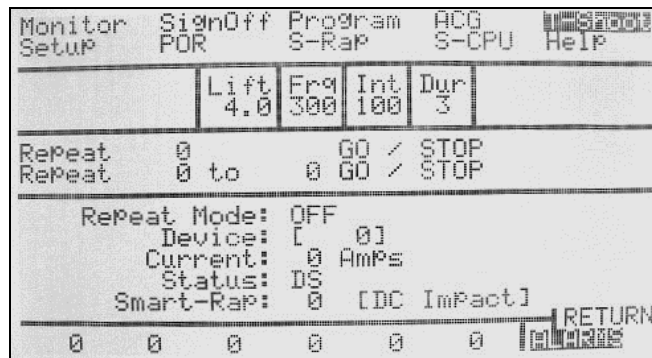


Figure 40 - Repeat Device Window

Lift

This value is used for repeating or firing DC Impact type devices when repeat mode is enabled. Programmable from 0 to 16 inches in .5 inch steps.

Frq

This value is used for repeating Multi-Impact type devices when repeat mode is enabled. Programmable in 13 preset steps from 200 to 600 CPM. Valid values are 200, 212, 225, 240, 257, 278, 300, 330, 360, 390, 450, 510, and 600. Press the <+Incr> or <-Decr> key to scroll through the available settings and press <Enter> to accept the change.

Int

This value is used for repeating Vibrator and Multi-Impact type devices. Programmable from 0 to 100%.

Dur

This value is used for repeating Vibrator, Multi-Impact, or Motor type devices. Programmable from 0 to 59 seconds.

Repeat

This field is used for repeating or firing a single device. Select the device number you wish to energize and use the **GO** field to start repeating. Programmable from 0 to 1024.

Repeat .. to ..

These fields are used for assigning a range of devices you wish to repeat or fire. Set the start and stop device number and select **GO** to start energizing devices. The HHP will automatically step through the devices. After firing the last device, the HHP will restart at the first device in the list. Programmable from 0 to 1024.

GO

Pressing <Enter> on either of these fields will start the associated repeat single device or repeat range of devices.

Feedback Gain

Press <+Incr> or <-Decr> to calibrate the lift for DC Impact type rappers.

STOP

Pressing <Enter> on either of these fields will stop the associated repeat mode.

Repeat Mode

This field shows the current status of the repeat mode – *On* or *Off*.

Device

This field shows the last device being fired in repeat mode.

Current

This field represents the average current (in amperes) of the last device fired.

Status

This field shows the operating status of the last device fired. Devices that fail on an alarm condition in repeat mode will not be removed from normal program firing.

Smart-Rap

This field shows the address of the S-Rap module that contains the last device fired.

Smart System Profile

Within a few seconds, operators can get a “picture” of the operating status of each of the S-Rap modules. The HHP will poll each device and display the status in the fields described below.

| S-Rap | Type | Ver | Comm | CalStat |
|-------|-----------|-------|------|---------|
| 1 | DC Impact | v2.00 | OK | Normal |
| 2 | DC Impact | v2.00 | OK | Normal |
| 3 | | | Dis | |
| 4 | | | Dis | |
| 5 | | | Dis | |
| 6 | | | Dis | |
| 7 | | | Dis | |
| 8 | | | Dis | |

10 0 0 0 0 0 | ALARMS

Figure 41 - Smart System Profile Window

S-Rap

Shows the address of the associated S-Rap module.

Type

This field shows the current “type” configuration of the associated S-Rap module. Valid types are “DC Impact”, “AC Vib(rator)”, “AC/DC Mot(or)”, “Multi-Imp(act)”, “DC Vib(rator)”, and “POR Outp(ut)”.

Comm

This field indicates whether the associated S-Rap module is communicating with the HHP.

Version

Software version of each S-RAP in the system will be displayed in this column.

Cal. Stat

Calibration Status of each S-RAP board will be displayed in this column. Calibration Status can have the following modes:

Normal, Cal, and Failed.

Normal mode means that the S-RAP board successfully completed Calibration.

Cal mode means that the Calibration is in progress for a particular S-RAP board.

Failed mode means that the Calibration failed.

Calibration

This feature will be used for **DC Impact devices** only.

Calibration feature needs to be used if the actual Lift value measured by the User differs from the programmed Lift value (due to excessive wiring length or firing non-Research Cottrell type of rappers). After Calibration is performed the lift accuracy will be significantly improved.

Calibration screen is shown below:

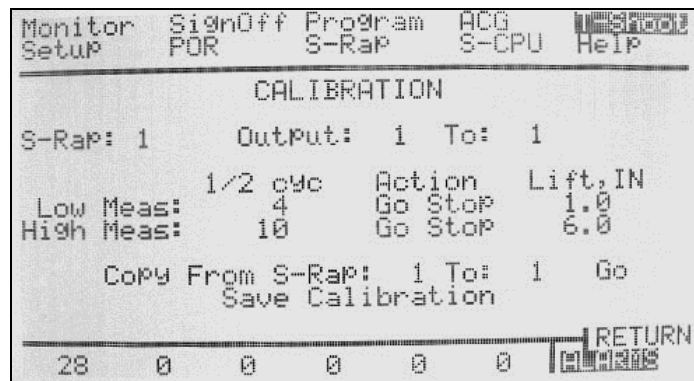


Figure 42 - Calibration Window

SRAP:

The User will specify which S-RAP board needs to be calibrated.

Output...to...

User will specify the range of the outputs that need to be fired to calibrate the S-RAP.

Low Meas/1/2 cyc:

User will enter the Low number of ½ cycles to fire the calibrated rapper. The recommended value is 5. The minimal value is 4.

Low Meas/Action:

User will start/stop the firing of calibrated rapper for Low number of ½ cycles.

Low Meas/Lift, in:

User will measure the Lift value (in) of the Calibrated rapper that fires for **Low** number of half-cycles and enter it into HHP.

High Meas/1/2 cyc:

User will enter the High number of ½ cycles to fire the calibrated rapper. The recommended value is 10.

High Meas/Action:

User will start/stop the firing of calibrated rapper for High number of ½ cycles.

High Meas/Lift, in:

User will measure the Lift value (in) of the Calibrated rapper that fires for **High** number of half-cycles and enter it into HHP.

Copy from SRAP...to... GO

User will specify the range of S-RAPs to which the Calibration data will be copied. After the range is specified User will press GO to initiate the copying of the data.

Save Calibration

Before this new data can be used by the S-RAP board, it must be saved to Flash memory.

By initiating this option User will save the Calibration data into the flash memory of the S-RAP board (s). The data will be saved to all the S-RAP boards that it was copied to.

After this option is selected HHP will prompt the User with the message: “**Burning flash...Please, wait: 2min 30sec**” This is the approximate time it takes for the flash burn. After the message disappears the User will check if the flash burn was successful. To do that the User will select **Smart System Profile** option from **Troubleshoot** Menu. **Cal. Stat** should indicate **Normal** if the flash burn was successful.

After Calibration is completed the S-RAP board needs to be configured to use Calibration Lift Table that was created during the calibration process.

Please, refer to **Ch6. GRC Configuration Summary**. Section **Selecting the Lift Table**.

REMEMBER: Power must be cycled to the S-RAP board in order for the S-RAP software to read new switch settings.

Changing Boards

Below is the procedure for replacing the SCPU and the SRAP boards in the GRC.

SCPU:

It should be noted that the SCPU board contains the memory where all of the rapping programs are stored. When replacing this board, the new board will not contain those programs. It is very important that you save the user programs, ACG data, and system configuration to the SD card prior to changing the board. Scroll down to the Sub Menu option in the SCPU screen and press <Enter>. Scroll down to the SD-CARD FUNCTIONS and press <Enter>. Back up the user programs, ACG data and configuration to the SD card.

De-energize the circuit breaker on the GRC cabinet. Loosen the screws on the bar that hold the boards in the cage captive and remove the SCPU board. Set the rotary switch of the new replacement board to the same serial address position as the old

board. Slide the new board into the cage, insuring that the edge connectors are properly seated in the backplane. Place the SD card from the old board into the new board.

Energize the cabinet circuit breaker. Return to the SD-Card Function screen and Load the user programs, ACG data, and configuration from the SD card back into the SCPU memory.

The board exchange is now complete.

SRAP:

Prior to replacing the SRAP board, scroll to the SRAP screen and record the parameter settings in the Rapper Setup screen for the specific SRAP board number being replaced.

De-energize the circuit breaker on the GRC cabinet. Loosen the screws that hold the boards in the cage captive and remove the SRAP board. Set the dip switches S1 through S10 of the replacement board to the same settings as the old board. Slide the new board into the cage, insuring that the edge connectors are properly seated in the backplane.

Energize the cabinet circuit breaker. Re-enter all of the parameters that you recorded from the old board. If you are operating off of the default lift table, then the board exchange is complete.

If you are operating off of a user created calibration table, you may either re-calibrate the SRAP board that was just exchanged by following the calibration procedure outlined in this User Guide, or you can copy the calibration from another SRAP board.

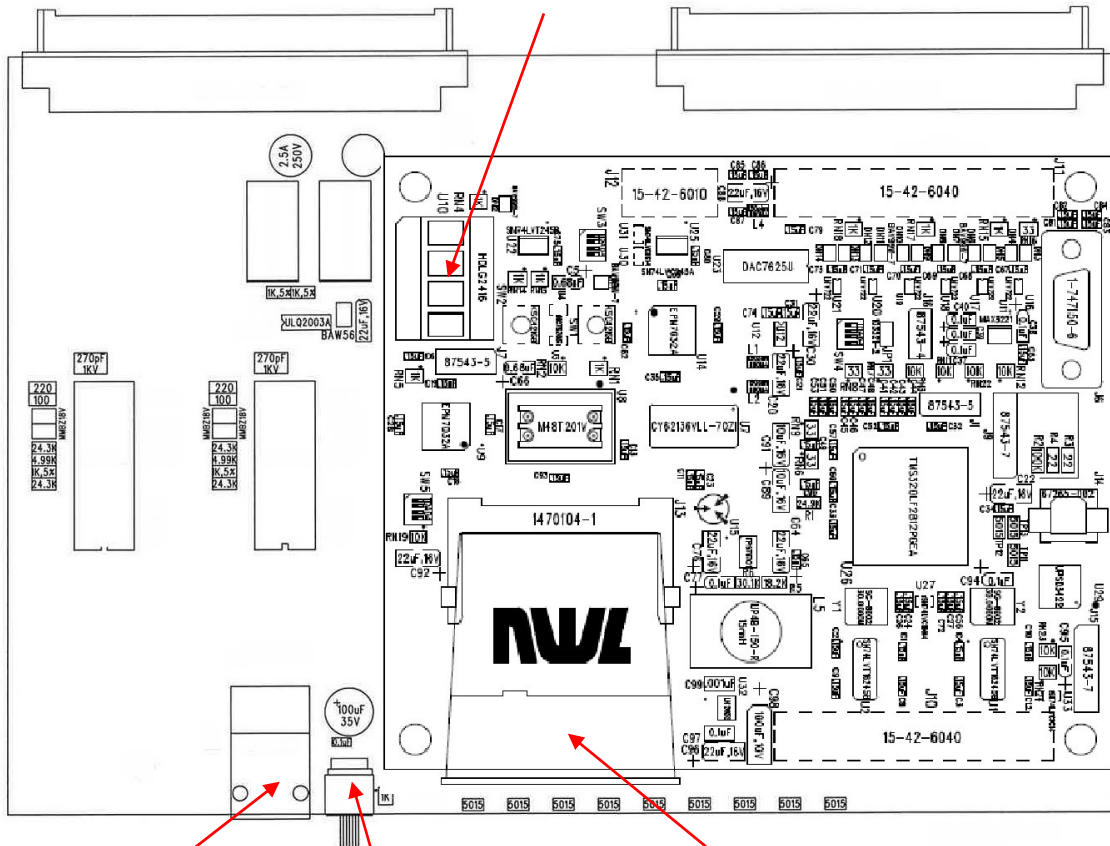
To copy the calibration table from another board, go to the Calibration screen under the Troubleshooting menu of the HHP display. Scroll down to the area of the screen that shows “Copy from SRAP: ___ To: ___ GO”. Enter the SRAP # that you want to copy the calibration table from and the SRAP# of the new board you are copying to. Scroll over to the GO and press the ENTER button on the HHP. The table is now copied to the new board. But before you can use it, you must first save it to the flash memory. To do this, scroll down until the “Save Calibration” is highlighted and press the ENTER button again

on the HHP. The process will begin and a message will be displayed indicating the status. Once the flash is burned, the rapper controller can be energized.

Chapter 6: Configuration Summary

Smart-CPU

4 Character LED Display



RJ45 Jacks

Rotary Selector Switch

Optional Fieldbus Module

Network Port

Local Port

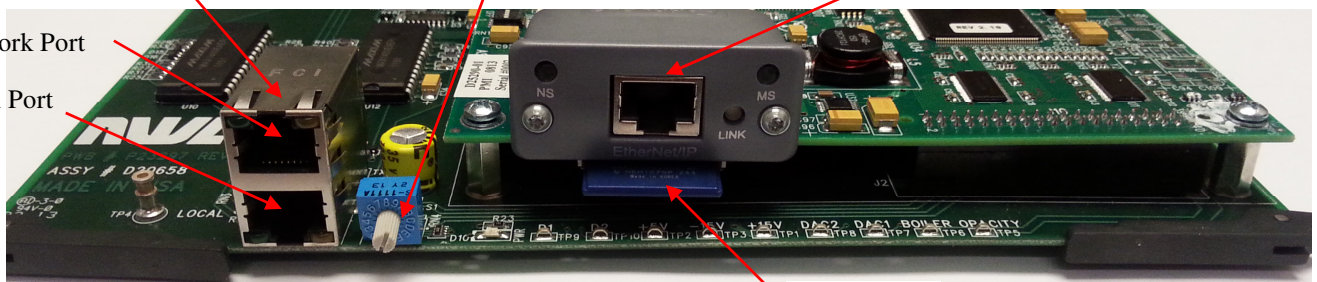


Figure 43 - Smart-CPU Board Layout

Board Address

The S-CPU modules requires a board address using the following Rotary Switch settings:

Board Address – Rotary Switch Positions

| Switch Position | Board Address |
|-----------------|---------------|
| 0 or 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| : | : |
| f | 15 |

Smart-Rap

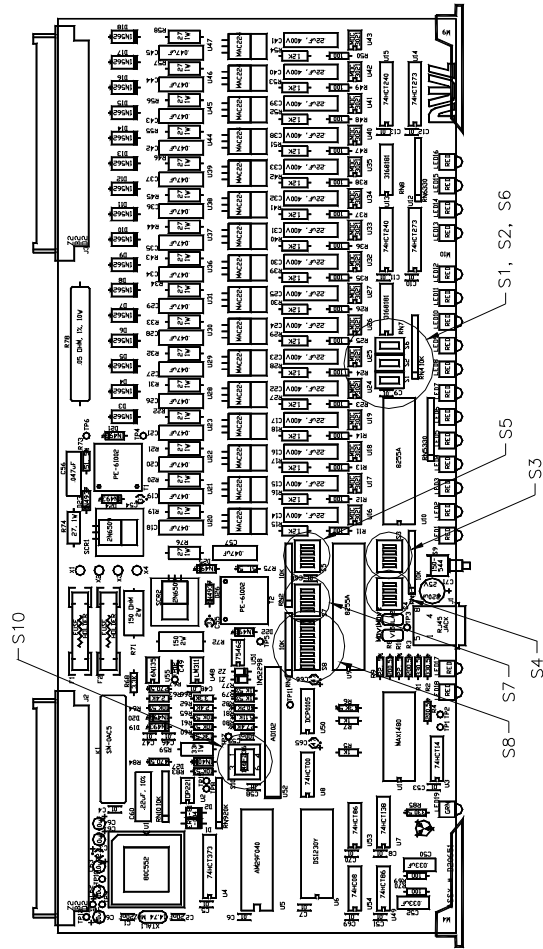


Figure 44 - Smart-Rap Board Layout

Board Address and Rapper outputs range

The S-Rap modules require a board address. It can be configured using DIP Switch 8. The range of rapper outputs is assigned to a particular S-Rap address.

Table below links a particular S-Rap address to its corresponding rapper output range and DIP Switch 8 configuration.

Note: S-Rap board addresses 1...64 are binary 0...63

| S-RAP board address | Rapper outputs range | Switch 8 position | | | | | | | |
|---------------------|----------------------|-------------------|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 1-16 | x | x | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 17-32 | x | x | 0 | 0 | 0 | 0 | 0 | 1 |
| 3 | 33-48 | x | x | 0 | 0 | 0 | 0 | 1 | 0 |
| 4 | 49-64 | x | x | 0 | 0 | 0 | 0 | 1 | 1 |
| 5 | 65-80 | x | x | 0 | 0 | 0 | 1 | 0 | 0 |
| 6 | 81-96 | x | x | 0 | 0 | 0 | 1 | 0 | 1 |
| 7 | 97-112 | x | x | 0 | 0 | 0 | 1 | 1 | 0 |
| 8 | 113-128 | x | x | 0 | 0 | 0 | 1 | 1 | 1 |
| 9 | 129-144 | x | x | 0 | 0 | 1 | 0 | 0 | 0 |
| 10 | 145-160 | x | x | 0 | 0 | 1 | 0 | 0 | 1 |
| 11 | 161-176 | x | x | 0 | 0 | 1 | 0 | 1 | 0 |
| 12 | 177-192 | x | x | 0 | 0 | 1 | 0 | 1 | 1 |
| 13 | 193-208 | x | x | 0 | 0 | 1 | 1 | 0 | 0 |
| 14 | 209-224 | x | x | 0 | 0 | 1 | 1 | 0 | 1 |
| 15 | 225-240 | x | x | 0 | 0 | 1 | 1 | 1 | 0 |
| 16 | 241-256 | x | x | 0 | 0 | 1 | 1 | 1 | 1 |
| 17 | 257-272 | x | x | 0 | 1 | 0 | 0 | 0 | 0 |
| 18 | 273-288 | x | x | 0 | 1 | 0 | 0 | 0 | 1 |
| 19 | 289-304 | x | x | 0 | 1 | 0 | 0 | 1 | 0 |
| 20 | 305-320 | x | x | 0 | 1 | 0 | 0 | 1 | 1 |
| 21 | 321-336 | x | x | 0 | 1 | 0 | 1 | 0 | 0 |
| 22 | 337-352 | x | x | 0 | 1 | 0 | 1 | 0 | 1 |
| 23 | 353-368 | x | x | 0 | 1 | 0 | 1 | 1 | 0 |
| 24 | 369-384 | x | x | 0 | 1 | 0 | 1 | 1 | 1 |

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| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|----|-----------|---|---|---|---|---|---|---|---|
| 25 | 385-400 | x | x | 0 | 1 | 1 | 0 | 0 | 0 |
| 26 | 401-416 | x | x | 0 | 1 | 1 | 0 | 0 | 1 |
| 27 | 417-432 | x | x | 0 | 1 | 1 | 0 | 1 | 0 |
| 28 | 433-448 | x | x | 0 | 1 | 1 | 0 | 1 | 1 |
| 29 | 449-464 | x | x | 0 | 1 | 1 | 1 | 0 | 0 |
| 30 | 465-480 | x | x | 0 | 1 | 1 | 1 | 0 | 1 |
| 31 | 481-496 | x | x | 0 | 1 | 1 | 1 | 1 | 0 |
| 32 | 497-512 | x | x | 0 | 1 | 1 | 1 | 1 | 1 |
| 33 | 513-528 | x | x | 1 | 0 | 0 | 0 | 0 | 0 |
| 34 | 529-544 | x | x | 1 | 0 | 0 | 0 | 0 | 1 |
| 35 | 545-560 | x | x | 1 | 0 | 0 | 0 | 1 | 0 |
| 36 | 561-576 | x | x | 1 | 0 | 0 | 0 | 1 | 1 |
| 37 | 577-592 | x | x | 1 | 0 | 0 | 1 | 0 | 0 |
| 38 | 593-608 | x | x | 1 | 0 | 0 | 1 | 0 | 1 |
| 39 | 609-624 | x | x | 1 | 0 | 0 | 1 | 1 | 0 |
| 40 | 625-640 | x | x | 1 | 0 | 0 | 1 | 1 | 1 |
| 41 | 641-656 | x | x | 1 | 0 | 1 | 0 | 0 | 0 |
| 42 | 657-672 | x | x | 1 | 0 | 1 | 0 | 0 | 1 |
| 43 | 673-688 | x | x | 1 | 0 | 1 | 0 | 1 | 0 |
| 44 | 689-704 | x | x | 1 | 0 | 1 | 0 | 1 | 1 |
| 45 | 705-720 | x | x | 1 | 0 | 1 | 1 | 0 | 0 |
| 46 | 721-736 | x | x | 1 | 0 | 1 | 1 | 0 | 1 |
| 47 | 737-752 | x | x | 1 | 0 | 1 | 1 | 1 | 0 |
| 48 | 753-768 | x | x | 1 | 0 | 1 | 1 | 1 | 1 |
| 49 | 769-784 | x | x | 1 | 1 | 0 | 0 | 0 | 0 |
| 50 | 785-800 | x | x | 1 | 1 | 0 | 0 | 0 | 1 |
| 51 | 801-816 | x | x | 1 | 1 | 0 | 0 | 1 | 0 |
| 52 | 817-832 | x | x | 1 | 1 | 0 | 0 | 1 | 1 |
| 53 | 833-848 | x | x | 1 | 1 | 0 | 1 | 0 | 0 |
| 54 | 849-864 | x | x | 1 | 1 | 0 | 1 | 0 | 1 |
| 55 | 865-880 | x | x | 1 | 1 | 0 | 1 | 1 | 0 |
| 56 | 881-896 | x | x | 1 | 1 | 0 | 1 | 1 | 1 |
| 57 | 897-912 | x | x | 1 | 1 | 1 | 0 | 0 | 0 |
| 58 | 913-928 | x | x | 1 | 1 | 1 | 0 | 0 | 1 |
| 59 | 929-944 | x | x | 1 | 1 | 1 | 0 | 1 | 0 |
| 60 | 945-960 | x | x | 1 | 1 | 1 | 0 | 1 | 1 |
| 61 | 961-976 | x | x | 1 | 1 | 1 | 1 | 0 | 0 |
| 62 | 977-992 | x | x | 1 | 1 | 1 | 1 | 0 | 1 |
| 63 | 993-1008 | x | x | 1 | 1 | 1 | 1 | 1 | 0 |
| 64 | 1009-1024 | x | x | 1 | 1 | 1 | 1 | 1 | 1 |

Lift Table Select

Lift Table is used for DC Impact type devices only. There are two Lift Tables: Default Lift Table and Calibration Lift Table. S-RAP can be configured to use a certain Lift Table. This is done by asserting position 1 of the Switch 8.

| Switch Setting | Lift Table |
|-----------------|-------------|
| 0 x x x x x x x | Default |
| 1 x x x x x x x | Calibration |

Stand-Alone Operation

The S-Rap module can be configured to operate in “Stand-Alone Mode” (without a S-CPU). The following DIP switches are used for configuring stand-alone operation and the associated parameters.

Switch 1 - Stand-Alone Operation

| Switch Setting | Description |
|----------------|-------------|
| 0 | Disabled |
| 1 | Enabled |

Switch 2 - Use Stand-Alone DIPs or Internal Register Values

| Switch Setting | Description |
|----------------|-------------|
| 0 | DIPs |
| 1 | Registers |

Switches 3, 4, 5 - Initial Wait, Cycle, & Wait Time (x 5 multiplier)

| Switch Setting | Description |
|----------------|-------------|
| 0 0 0 0 | 0 minutes |
| 0 0 0 1 | 5 minutes |
| 0 0 1 0 | 10 minutes |
| 0 0 1 1 | 15 minutes |
| : | : |
| 1 1 1 0 | 70 minutes |
| 1 1 1 1 | 75 minutes |

Note: For *cycle time only*, a setting of 0 seconds represents a 16 second cycle time.

Switch 6 - Device Fire Settings

| Switch Setting | DC Impact | AC/DC Vibrator & DC Multi-Impact | AC/DC Motor |
|----------------|---------------|----------------------------------|---------------------|
| | Lift (inches) | Duration (seconds) | Duration (minutes) |
| 0 | 4 | 2 | 5 |
| 1 | 8 | 4 | Fire All Continuous |

Stand-Alone Operation Defaults

DC Impact Number of Times in Sequence = 1
 AC Vibrator Intensity = 100%
 DC Vibrator Intensity = 100%
 DC Multi-Impact Intensity = 100%, Frequency = 300 CPM
 AC/DC Motor Intensity = 100%

Device Type

The device type setting is used for determining specific methods of energizing devices. The following DIP switches must be setup for each S-Rap module before operation:

Switch 7 - Device Type

| Switch Setting | Description |
|----------------|-----------------|
| 0 0 0 | 120 V Migi |
| 0 0 1 | AC Vibrator |
| 0 1 0 | AC/DC Motor |
| 0 1 1 | DC Multi-Impact |
| 1 0 0 | DC Vibrator |
| 1 0 1 | T/R POR Outputs |
| 1 1 0 | 240 V Migi |

Stand-Alone using Internal Registers

The S-Rap module can also be configured using a HHP or PC to setup registers for the parameters listed below. These values will be used for Smart System rapping and Stand-Alone rapping if Switch 2 is set to 1 for “Registers”.

- Lift (1 - 16 inches) for DC Impact
- Intensity (5 - 100%) for AC/DC Vibrators and DC Multi-Impact
- Frequency (200 - 600 CPM) for DC Multi-Impact
- Duration (00:00:01 to 23:59:59 (continuous)) for AC & DC Vibrators, DC Multi-Impact, and AC/DC Motors
- Overcurrent and Undercurrent (amperes) settings for all types
- Enable/Disable status for all types
- Alarm relay logic (NO/NC)

Gain Switch

This switch will be set according to the load current range. If current range is from 0 to 10 Amps then the most accurate current measurement will be achieved with Gain Switch set to HIGH position. It could be set to LOW position, but the accuracy of the current measurement will be lower. If current range is greater than 0 to 10 Amps then the switch must be set to LOW position.

Switch S10 – Gain Switch

| Gain | How to set |
|-------------|-----------------------------|
| Low | Switch moved toward U5 chip |
| High | Switch moved away from U5 |

System Installation Notes

Connecting RS485 cable between the GRC panels

If the User desires to have a common RS485 communication line between GRC panels the following procedure should be followed:

- 1) Turn OFF the system Power.
- 2) Jumper a shielded communication cable between 2TB-1 inputs of the GRC panels of interest.
- 3) Jumper a shielded communication cable between 2TB-2 inputs of the GRC panels of interest.
- 4) Jumper a shielded communication cable between 2TB-3 inputs of the GRC panels of interest.

Connecting I2C line between GRC panels

I2C line must be common to the GRC panels that are controlled by a single S-CPU card located on one of the panels of interest. For example, GRC needs to control 22 S-RAPs. One panel can contain only one Card Cage that, in turn, can have 11 S-RAPs. Therefore, 2 panels are needed for the system.

S-RAPs 1 through 11 will contain outputs 1-176;
S-RAPs 12 through 22 will contain outputs 177-352.

In order for this system to operate I2C line must be common to both panels. To connect I2C lines the following steps should be taken:

- 1) Turn OFF the system Power.
- 2) Jumper TB4-1 terminals of the **Backplanes** located on GRC panels of interest.
- 3) Jumper TB4-2 terminals of the **Backplanes** located on GRC panels of interest.
- 4) Jumper TB4-3 terminals of the **Backplanes** located on GRC panels of interest.

Glossary of Terms

ACG

Anti-Coincidence Groups – A collection or group of assigned rappers to prevent rapping along the gas-flow of the precipitator. ACG's are used to minimize re-entrainment.

DIP Switch

Dual Inline Package – Printed circuit board level switches used for configuration.

ESP

Electrostatic Precipitator – Pollution control device that utilizes electrostatic charges for fly-ash collection.

FIFO

First In First Out – Term used in the technology industry to represent a list where the first device entered into the list will be the first device removed.

Flash Memory

High-speed non-volatile memory used for storage on computer, electronic controls, etc.

Fly-ash

Output of burned coal from the plant's boiler that enters the precipitator for collection.

GRC

Graphic Rapper Controller – NWL's next generation rapper controller that uses a graphical display.

HHP

Hand Held Programmer – NWL's GRC System programming device.

NVRAM

Non-volatile Random Access Memory – Memory used on computers, electronic controls, etc. that will retain the contents in the event of power loss.

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POR

Power Off Rapping – A technique used for more effective collection plate cleaning where the power is removed or reduced from a field before rapping occurs.

Rapper

Generic name for a device that “raps” a precipitator collection plate or electrode wire for cleaning purposes.

Re-entrainment

Fly ash that re-enters that gas stream after being collected. Typically caused from excessive rapping.

Rip/Rap

NWL’s unique method for minimizing re-entrainment where rappers are fired with multiple impacts with increasing energy.

S-CPU

NWL’s Smart-CPU module responsible for scheduling rapper activity.

S-Rap

NWL’s Smart-Rap module responsible for energizing rapper devices and monitoring for alarm conditions.

Appendix 1 – Fieldbus Data Exchange Map

NWL S-CPU Network Data Exchange Map - Rev. 0.4

Date: 6/13/2014

| Web
Idx # | Parameter | Bit Assignments | Data
Type | Instance # | Min
Value | Max
Value | Default
Value | Modbus | Modbus | PROFIBUS | PROFIBUS | Notes |
|--|-----------------------------|---------------------------------------|--------------|------------|--------------|--------------|------------------|---|----------------------------------|------------------------------|-----------------------------|---------------------------------------|
| | | | | | | | | Register #
(Anybus-CC
and Net Port) | Register #
(Net Port
only) | DP/V1
Acyclic - Slot
| DP/V1
Acyclic -
Index | |
| Process READ Data (Data Read from NWL Controller) | | | | | | | | | | | | |
| 1 | Controller Status | | UINT16 | 1 | | | | 30001 | | 0 | 0 | |
| | | Bit 15 - POR Mode MSB | | | | | | | | | | 0=Off, 1=Local, 2=Remote |
| | | Bit 14 - POR Mode LSB | | | | | | | | | | |
| | | Bit 13 - Spare | | | | | | | | | | |
| | | Bit 12 - Spare | | | | | | | | | | |
| | | Bit 11 - Spare | | | | | | | | | | |
| | | Bit 10 - Spare | | | | | | | | | | |
| | | Bit 9 - Spare | | | | | | | | | | |
| | | Bit 8 - Auto Program Select Enabled | | | | | | | | | | |
| | | Bit 7 - Program Restart Mode Enabled | | | | | | | | | | |
| | | Bit 6 - Local Remote Input State | | | | | | | | | | |
| | | Bit 5 - Remote Program On Input State | | | | | | | | | | |
| | | Bit 4 - POR Program On | | | | | | | | | | |
| | | Bit 3 - S-RAP Comm Error(s) | | | | | | | | | | |
| | | Bit 2 - S-RAP Alarm(s) | | | | | | | | | | |
| | | Bit 1 - Program On | | | | | | | | | | |
| | | Bit 0 - 1 Sec Heartbeat toggle | | | | | | | | | | |
| 2 | Active Operating Program | | UINT16 | 2 | 0 | 5 | | 30002 | | 0 | 1 | |
| 3 | Remote Software Select | | UINT16 | 3 | 0 | 2 | | 30003 | | 0 | 2 | 0=Disable, 1=Discrete, 2=Network |
| 4 | Active Rapper 1 | | UINT16 | 4 | 0 | 1024 | | 30004 | | 0 | 3 | 0=No activity, 1...1024=Device Number |
| 5 | Active Rapper 2 | | UINT16 | 5 | 0 | 1024 | | 30005 | | 0 | 4 | 0=No activity, 1...1024=Device Number |
| 6 | Active Rapper 3 | | UINT16 | 6 | 0 | 1024 | | 30006 | | 0 | 5 | 0=No activity, 1...1024=Device Number |
| 7 | Active Rapper 4 | | UINT16 | 7 | 0 | 1024 | | 30007 | | 0 | 6 | 0=No activity, 1...1024=Device Number |
| 8 | Active Rapper 5 | | UINT16 | 8 | 0 | 1024 | | 30008 | | 0 | 7 | 0=No activity, 1...1024=Device Number |
| 9 | Active Rapper 6 | | UINT16 | 9 | 0 | 1024 | | 30009 | | 0 | 8 | 0=No activity, 1...1024=Device Number |
| 10 | Average Opacity | | UINT16 | 10 | 0 | 999 | | 30010 | | 0 | 9 | |
| 11 | Average Boiler Load | | UINT16 | 11 | 0 | 9999 | | 30011 | | 0 | 10 | |
| 12 | SRAP1-SRAP16 Alarms | | UINT16 | 12 | | | | 30012 | | 0 | 11 | |
| | | Bit 15 - SRAP16 Alarmed | | | | | | | | | | |
| | | ... | | | | | | | | | | |
| | | Bit 0 - SRAP1 Alarmed | | | | | | | | | | |
| 13 | SRAP17-SRAP32 Alarms | | UINT16 | 13 | | | | 30013 | | 0 | 12 | |
| 14 | SRAP33-SRAP48 Alarms | | UINT16 | 14 | | | | 30014 | | 0 | 13 | |
| 15 | SRAP49-SRAP64 Alarms | | UINT16 | 15 | | | | 30015 | | 0 | 14 | |
| 16 | SRAP1-SRAP16 Comm Failures | | UINT16 | 16 | | | | 30016 | | 0 | 15 | |
| | | Bit 15 - SRAP16 Comm Fail | | | | | | | | | | |
| | | ... | | | | | | | | | | |
| | | Bit 0 - SRAP1 Comm Fail | | | | | | | | | | |
| 17 | SRAP17-SRAP32 Comm Failures | | UINT16 | 17 | | | | 30017 | | 0 | 16 | |
| 18 | SRAP33-SRAP48 Comm Failures | | UINT16 | 18 | | | | 30018 | | 0 | 17 | |
| 19 | SRAP49-SRAP64 Comm Failures | | UINT16 | 19 | | | | 30019 | | 0 | 18 | |

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| <u>Web</u>
<u>Idx #</u> | <u>Parameter</u> | <u>Bit Assignments</u> | <u>Data Type</u> | <u>Data Instance #</u> | <u>Min Value</u> | <u>Max Value</u> | <u>Default Value</u> | <u>Modbus Register #</u>
<u>(Anybus-CC and Net Port)</u> | <u>Modbus Register #</u>
<u>(Net Port only)</u> | <u>PROFIBUS DP/V1</u>
<u>Acyclic - Slot #</u> | <u>PROFIBUS DP/V1</u>
<u>Acyclic - Index</u> | <u>Notes</u> |
|--|-------------------------------|------------------------|------------------|------------------------|------------------|------------------|----------------------|---|--|--|---|--------------------------|
| Process WRITE Data (Data Written to NWL Controller) | | | | | | | | | | | | |
| 20 | Operating/POR Program: On/Off | | UINT16 | 100 | 0 | 1 | 0 | 40628 | 40001 | 0 | 99 | 0=Off, 1=On |
| 21 | Active Operating Program | | UINT16 | 101 | 1 | 5 | 1 | 40629 | 40002 | 0 | 100 | |
| 22 | POR Mode | | UINT16 | 102 | 0 | 2 | 0 | 40630 | 40003 | 0 | 101 | 0=Off, 1=Local, 2=Remote |

Application Data Instances (ADIs) Accessible via Acyclic Messaging Only

| | | | | | | | | | | | | |
|----|--|--|--------|-----|---|------|------|-------|-------|---|-----|--|
| 23 | Software Version ID | | UINT16 | 103 | 0 | 9999 | R/O | 40631 | 40004 | 0 | 102 | |
| 24 | Program Restart Mode | | UINT16 | 104 | 0 | 1 | 0 | 40632 | 40005 | 0 | 103 | 0=Continue, 1=Restart |
| 25 | Alarm Relay Logic | | UINT16 | 105 | 0 | 1 | 0 | 40633 | 40006 | 0 | 104 | 0=Normally Open, 1=Normally Closed |
| 26 | # of Alarms Before Activating Relay | | UINT16 | 106 | 1 | 99 | 1 | 40634 | 40007 | 0 | 105 | |
| 27 | Boiler Load Full Scale | | UINT16 | 107 | 0 | 9999 | 1000 | 40635 | 40008 | 0 | 106 | |
| 28 | System Clock Set - Month | | UINT16 | 108 | 1 | 12 | 1 | 40636 | 40009 | 0 | 107 | System clock is updated when "Seconds" registers is written. |
| 29 | System Clock Set - Day | | UINT16 | 109 | 1 | 31 | 1 | 40637 | 40010 | 0 | 108 | |
| 30 | System Clock Set - Year | | UINT16 | 110 | 0 | 99 | 13 | 40638 | 40011 | 0 | 109 | |
| 31 | System Clock Set - Hour | | UINT16 | 111 | 0 | 23 | 0 | 40639 | 40012 | 0 | 110 | |
| 32 | System Clock Set - Min | | UINT16 | 112 | 0 | 59 | 0 | 40640 | 40013 | 0 | 111 | |
| 33 | System Clock Set - Sec | | UINT16 | 113 | 0 | 59 | 0 | 40641 | 40014 | 0 | 112 | |
| 34 | Auto-Program Select On/Off Switch | | UINT16 | 114 | 0 | 1 | 0 | 40642 | 40015 | 0 | 113 | 0=Auto-Program Select disabled |
| 35 | Auto-Program by Load - Step 1 Min Load | | UINT16 | 115 | 0 | 9999 | 0 | 40643 | 40016 | 0 | 114 | |
| 36 | Auto-Program by Load - Step 1 Max Load | | UINT16 | 116 | 0 | 9999 | 0 | 40644 | 40017 | 0 | 115 | |
| 37 | Auto-Program by Load - Step 1 Program # | | UINT16 | 117 | 0 | 5 | 0 | 40645 | 40018 | 0 | 116 | |
| 38 | Auto-Program by Load - Step 2 Min Load | | UINT16 | 118 | 0 | 9999 | 0 | 40646 | 40019 | 0 | 117 | |
| 39 | Auto-Program by Load - Step 2 Max Load | | UINT16 | 119 | 0 | 9999 | 0 | 40647 | 40020 | 0 | 118 | |
| 40 | Auto-Program by Load - Step 2 Program # | | UINT16 | 120 | 0 | 5 | 0 | 40648 | 40021 | 0 | 119 | |
| 41 | Auto-Program by Load - Step 3 Min Load | | UINT16 | 121 | 0 | 9999 | 0 | 40649 | 40022 | 0 | 120 | |
| 42 | Auto-Program by Load - Step 3 Max Load | | UINT16 | 122 | 0 | 9999 | 0 | 40650 | 40023 | 0 | 121 | |
| 43 | Auto-Program by Load - Step 3 Program # | | UINT16 | 123 | 0 | 5 | 0 | 40651 | 40024 | 0 | 122 | |
| 44 | Auto-Program by Time - Step 1 Min Time Hours | | UINT16 | 124 | 0 | 23 | 0 | 40652 | 40025 | 0 | 123 | |
| 45 | Auto-Program by Time - Step 1 Min Time Minutes | | UINT16 | 125 | 0 | 59 | 0 | 40653 | 40026 | 0 | 124 | |
| 46 | Auto-Program by Time - Step 1 Min Time Seconds | | UINT16 | 126 | 0 | 59 | 0 | 40654 | 40027 | 0 | 125 | |
| 47 | Auto-Program by Time - Step 1 Max Time Hours | | UINT16 | 127 | 0 | 23 | 0 | 40655 | 40028 | 0 | 126 | |
| 48 | Auto-Program by Time - Step 1 Max Time Minutes | | UINT16 | 128 | 0 | 59 | 0 | 40656 | 40029 | 0 | 127 | |
| 49 | Auto-Program by Time - Step 1 Max Time Seconds | | UINT16 | 129 | 0 | 59 | 0 | 40657 | 40030 | 0 | 128 | |
| 50 | Auto-Program by Time - Step 1 Program # | | UINT16 | 130 | 0 | 5 | 0 | 40658 | 40031 | 0 | 129 | |

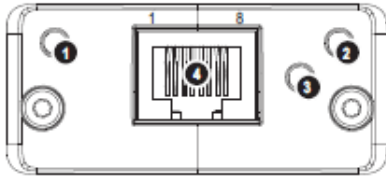
NWL ENVIRONMENTAL TECHNOLOGIES

| Web
Idx # | Parameter | Bit Assignments | Data Type | Data Instance # | Min Value | Max Value | Default Value | Modbus | Modbus | PROFIBUS | PROFIBUS | Notes |
|--------------|--|-----------------|-----------|-----------------|-----------|-----------|---------------|---|----------------------------------|------------------------------|-----------------------------|---|
| | | | | | | | | Register #
(Anybus-CC
and Net Port) | Register #
(Net Port
only) | DP/V1
Acyclic - Slot
| DP/V1
Acyclic -
Index | |
| 51 | Auto-Program by Time - Step 2 Min Time Hours | | UINT16 | 131 | 0 | 23 | 0 | 40659 | 40032 | 0 | 130 | |
| 52 | Auto-Program by Time - Step 2 Min Time Minutes | | UINT16 | 132 | 0 | 59 | 0 | 40660 | 40033 | 0 | 131 | |
| 53 | Auto-Program by Time - Step 2 Min Time Seconds | | UINT16 | 133 | 0 | 59 | 0 | 40661 | 40034 | 0 | 132 | |
| 54 | Auto-Program by Time - Step 2 Max Time Hours | | UINT16 | 134 | 0 | 23 | 0 | 40662 | 40035 | 0 | 133 | |
| 55 | Auto-Program by Time - Step 2 Max Time Minutes | | UINT16 | 135 | 0 | 59 | 0 | 40663 | 40036 | 0 | 134 | |
| 56 | Auto-Program by Time - Step 2 Max Time Seconds | | UINT16 | 136 | 0 | 59 | 0 | 40664 | 40037 | 0 | 135 | |
| 57 | Auto-Program by Time - Step 2 Program # | | UINT16 | 137 | 0 | 5 | 0 | 40665 | 40038 | 0 | 136 | |
| 58 | Auto-Program by Time - Step 3 Min Time Hours | | UINT16 | 138 | 0 | 23 | 0 | 40666 | 40039 | 0 | 137 | |
| 59 | Auto-Program by Time - Step 3 Min Time Minutes | | UINT16 | 139 | 0 | 59 | 0 | 40667 | 40040 | 0 | 138 | |
| 60 | Auto-Program by Time - Step 3 Min Time Seconds | | UINT16 | 140 | 0 | 59 | 0 | 40668 | 40041 | 0 | 139 | |
| 61 | Auto-Program by Time - Step 3 Max Time Hours | | UINT16 | 141 | 0 | 23 | 0 | 40669 | 40042 | 0 | 140 | |
| 62 | Auto-Program by Time - Step 3 Max Time Minutes | | UINT16 | 142 | 0 | 59 | 0 | 40670 | 40043 | 0 | 141 | |
| 63 | Auto-Program by Time - Step 3 Max Time Seconds | | UINT16 | 143 | 0 | 59 | 0 | 40671 | 40044 | 0 | 142 | |
| 64 | Auto-Program by Time - Step 3 Program # | | UINT16 | 144 | 0 | 5 | 0 | 40672 | 40045 | 0 | 143 | |
| 65 | Auto-Program Default Program | | UINT16 | 145 | 0 | 5 | 0 | 40673 | 40046 | 0 | 144 | |
| 66 | Global Anti-Coincidence Time Set | | UINT16 | 146 | 0 | 99 | 0 | 40674 | 40047 | 0 | 145 | Sets all programs' ACG timers to sent value |
| 67 | Anti-Coincidence Time for Program 1 | | UINT16 | 147 | 0 | 99 | 0 | 40675 | 40048 | 0 | 146 | |
| 68 | Anti-Coincidence Time for Program 2 | | UINT16 | 148 | 0 | 99 | 0 | 40676 | 40049 | 0 | 147 | |
| 69 | Anti-Coincidence Time for Program 3 | | UINT16 | 149 | 0 | 99 | 0 | 40677 | 40050 | 0 | 148 | |
| 70 | Anti-Coincidence Time for Program 4 | | UINT16 | 150 | 0 | 99 | 0 | 40678 | 40051 | 0 | 149 | |
| 71 | Anti-Coincidence Time for Program 5 | | UINT16 | 151 | 0 | 99 | 0 | 40679 | 40052 | 0 | 150 | |
| 72 | Clear Output Alarms | | UINT16 | 152 | 1 | 9999 | 0 | 40680 | 40053 | 0 | 151 | Write output number to this register to clear alarms (e.g., write 5 to clear output 5 alarms).
Write 9999 to clear all active alarms. |

| <u>Web</u>
<u>Idx #</u> | <u>Parameter</u> | <u>Bit Assignments</u> | <u>Data Type</u> | <u>Data Instance #</u> | <u>Min Value</u> | <u>Max Value</u> | <u>Default Value</u> | <u>Modbus Register # (Anybus-CC and Net Port)</u> | <u>Modbus Register # (Net Port only)</u> | <u>PROFIBUS DP/V1 Acyclic - Slot #</u> | <u>PROFIBUS DP/V1 Acyclic - Index</u> | <u>Notes</u> |
|----------------------------|----------------------------------|--------------------------------|------------------|------------------------|------------------|------------------|----------------------|---|--|--|---------------------------------------|--|
| 73 | Output Status: Devices 1-4 | | UINT16 | 153 | 0 | 65535 | R/O | 40681 | 40054 | 0 | 152 | Each output status is represented by 4 bits in these registers, as follows:
0=Output Disabled
1=Output OK (no errors)
2=Undercurrent
3=Overcurrent
4=Half-wave
5=Suspect UC
6=Suspect OC
7=Suspect Half-wave |
| | | Bits 15...12 - Output 4 Status | | | | | | | | | | |
| | | Bits 11...8 - Output 3 Status | | | | | | | | | | |
| | | Bits 7...4 - Output 2 Status | | | | | | | | | | |
| | | Bits 3...0 - Output 1 Status | | | | | | | | | | |
| 74 | Output Status: Devices 5-8 | | UINT16 | 154 | 0 | 65535 | R/O | 40682 | 40055 | 0 | 153 | |
| 75 | Output Status: Devices 9-12 | | UINT16 | 155 | 0 | 65535 | R/O | 40683 | 40056 | 0 | 154 | |
| ... | | | | | | | | | | | | |
| 174 | Output Status: Devices 405-408 | | UINT16 | 254 | 0 | 65535 | R/O | 40782 | 40155 | 0 | 253 | |
| 175 | Output Status: Devices 409-412 | | UINT16 | 255 | 0 | 65535 | R/O | 40783 | 40156 | 0 | 254 | |
| 176 | Output Status: Devices 413-416 | | UINT16 | 256 | 0 | 65535 | R/O | 40784 | 40157 | 1 | 0 | |
| 177 | Output Status: Devices 417-420 | | UINT16 | 257 | 0 | 65535 | R/O | 40785 | 40158 | 1 | 1 | |
| ... | | | | | | | | | | | | |
| 328 | Output Status: Devices 1020-1024 | | UINT16 | 408 | 0 | 65535 | R/O | 40936 | 40309 | 1 | 152 | |

Appendix 2 – Fieldbus Module Additional Information

For Fieldbus modules that utilize a Ethernet style RJ45 jack (Ethernet IP, Modbus TCP, ProfiNet, etc.) :

| | | |
|---|--------------------|--|
| # | Item |  |
| 1 | Network Status LED | |
| 2 | Module Status LED | |
| 3 | Link/Activity | |
| 4 | Ethernet Interface | |

Network Status LED

Note: A test sequence is performed on this LED during startup.

| LED State | Description |
|-----------------|---|
| Off | No power or no IP address |
| Green | On-line, one or more connections established (CIP Class 1 or 3) |
| Green, flashing | On-line, no connections established |
| Red | Duplicate IP address, FATAL error |
| Red, flashing | One or more connections timed out (CIP Class 1 or 3) |

Module Status LED

Note: A test sequence is performed on this LED during startup.

| LED State | Description |
|-----------------|---|
| Off | No power |
| Green | Controlled by a Scanner in Run state |
| Green, flashing | Not configured, or Scanner in Idle state |
| Red | Major fault (EXCEPTION-state, FATAL error etc.) |
| Red, flashing | Recoverable fault(s) |

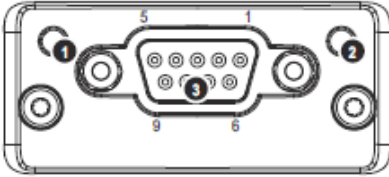
LINK/Activity LED

| LED State | Description |
|-------------------|----------------------|
| Off | No link, no activity |
| Green | Link established |
| Green, flickering | Activity |

Ethernet Interface

The Ethernet interface supports 10/100Mbit, full or half duplex operation.

For Fieldbus modules that utilize a 9 pin D connector (Modbus RTU, Profibus DPV1, etc.) :

| | | |
|---|-------------------|--|
| # | Item |  |
| 1 | Communication LED | |
| 2 | Device Status LED | |
| 3 | Modbus Interface | |

Communication LED

| LED State | Description |
|-----------|---------------------------------|
| Off | No power - or - no traffic |
| Yellow | Frame reception or transmission |
| Red | A fatal error has occurred |

Device Status LED

| LED State | Description |
|-------------------|---|
| Off | Initializing - or - no power |
| Green | Module initialized, no error |
| Red | Internal error - or - major unrecoverable fault |
| Red, single flash | Communication fault or configuration error
Case 1: Invalid settings in Network Configuration Object.
Case 2: Settings in Network Configuration Object has been changed during runtime (i.e. the settings does not match the currently used configuration) |
| Red, double flash | Application diagnostics available |

Modbus Interface

The Modbus interface is galvanically isolated, and provides both RS-232 and RS-485.

| Pin | Direction | Signal | Comment |
|---------|---------------------|--------|--|
| Housing | - | PE | Protective Earth |
| 1 | - | GND | Bus polarization, ground (isolated) |
| 2 | Output ^a | 5V | Bus polarization power +5V DC (isolated) |
| 3 | Input | PMC | Connect to pin #2 for RS-232 operation.
Leave unconnected for RS-485 operation. |
| 4 | - | - | - |
| 5 | Bidirectional | B-Line | RS-485 B-Line |
| 6 | - | - | - |
| 7 | Input | Rx | RS-232 Data Receive |
| 8 | Output | Tx | RS-232 Data Transmit |
| 9 | Bidirectional | A-Line | RS-485 A-Line |

a. Any current drawn from this pin will affect the total power consumption. See also "Power Consumption" on page 32.

For DeviceNet Fieldbus Module :

| # | Item |
|---|----------------------|
| 1 | Network Status LED |
| 2 | Module status LED |
| 3 | DeviceNet Connector |
| 4 | M12 Female Connector |
| 5 | M12 Male Connector |

Network Status

| State | Indication |
|-----------------------|--|
| Off | Not online / No power |
| Green | On-line, one or more connections are established |
| Flashing Green (1 Hz) | On-line, no connections established |
| Red | Critical link failure |
| Flashing Red (1 Hz) | One or more connections timed-out |
| Alternating Red/Green | Self test |

Module Status

| State | Indication |
|-----------------------|---|
| Off | No power |
| Green | Operating in normal condition |
| Flashing Green (1 Hz) | Missing or incomplete configuration, device needs commissioning |
| Red | Unrecoverable Fault(s) |
| Flashing Red (1 Hz) | Recoverable Fault(s) |
| Alternating Red/Green | Self test |

DeviceNet Connector

This connector provides DeviceNet connectivity.

| Pin | Signal | Description |
|-----|--------|--|
| 1 | V- | Negative bus supply voltage ^a |
| 2 | CAN_L | CAN low bus line |
| 3 | SHIELD | Cable shield |
| 4 | CAN_H | CAN high bus line |
| 5 | V+ | Positive bus supply voltage ^a |

M12 Connectors, Code A

The female M12 connector is used when modules are used in a daisy-chain topology.

| Pin | Name | Description |
|-----|-------|---|
| 1 | Drain | Shield |
| 2 | V+ | Positive voltage bus power. 11 - 25 VDC |
| 3 | V- | Ground bus power |
| 4 | CAN_H | CAN high |
| 5 | CAN_L | CAN low |

Additional information on the fieldbus modules can be obtained from the manufacturer at www.anybus.com

Appendix 3 – DSP Board Four Character LED Display Messages

Message Types

The 4-character display messages are classified as either "short" (4 characters or less) or "long" (more than 4 characters) messages.

The short messages are displayed for 2 seconds without scrolling. The long messages are scrolled once (with 250 ms per character scrolling rate).

When multiple event messages are pending in display message queue (see "Events" section below), the display sequence is accelerated as follows: short messages are only shown for 1 second, and long messages are scrolled twice as fast (125 ms per character rate). The maximum queue size is 4 messages, and if events occur quickly, the oldest ones will be "kicked out" from the queue (i.e., they will never be displayed).

Normal Operation

During normal operation, the 4-character display on the DSP board cycles through the following messages:

| <i>Message</i> | <i>Description</i> |
|---|---|
| "Program: X" | Shows current operating program number, or "idle" if operating program is off. |
| "S-RAP: ok"
"S-RAP: alarmed"
"S-RAP: comm fail"
"S-RAP: alm/comm fail" | Current status of S-RAP cards in the system. "alarmed" means that at least one S-RAP card has an output in alarmed state. "comm fail" means that at least one S-RAP card is not communicating with S-CPU. |
| "Opacity: xx.x%" | Displays opacity measurement (moving average). This is the value reported via RS485. A "faster" average is used for opacity spike detection. |
| "Boiler Load: x" | Displays boiler load measurement (moving average). This is the value reported via RS485. |

Additionally, the following messages will be shown continuously when S-CPU is performing a time-consuming operation:

| <i>Message</i> | <i>Description</i> |
|--------------------|--|
| "busy" | S-CPU is writing or reading files on the SD card. |
| "Programming Mode" | Operating programs are being read or written by Handheld Programmer. |

Events

At any time if an event occurs that needs to be displayed to the user, the normal display sequence described above will be interrupted and the event message will be displayed immediately.

Event messages:

| <i>Message</i> | <i>Description</i> |
|----------------------|--|
| "S-CPU Vx.xx" | S-CPU firmware version. Displayed after power-up. |
| "Default settings" | Default S-CPU settings are loaded, either because NVRAM check failed after power-up, or requested by user. |
| "Warm" | "Warm" reset occurred (as opposed to a "cold" reset due to a power cycle). |
| "Program ON" | Operating program is turned on via RS485, fieldbus, or discrete input. |
| "Program OFF" | Operating program is turned off via RS485, fieldbus, or discrete input. |
| "No SD card" | Displayed when an SD card operation is requested by user, but SD card is not present. |
| "SD config saved" | S-CPU configuration has been written to SD card. |
| "SD config restored" | S-CPU configuration has been read from SD card and applied. |
| "SD programs saved" | S-CPU programs have been saved to SD card. |
| "SD programs loaded" | S-CPU programs have been read from SD card into S-CPU's non-volatile memory. |
| "Saved ACG config" | Anti-Coincidence Group (ACG) configuration has been saved to SD card. |
| "Loaded ACG config" | Anti-Coincidence Group (ACG) configuration has been read from SD card into S-CPU's non-volatile memory. |

14 Mar 2014