SunGuide™:

Ramp Metering Firmware

Cabinet Users Guide

SunGuide-RMF-CUG-1.0.0

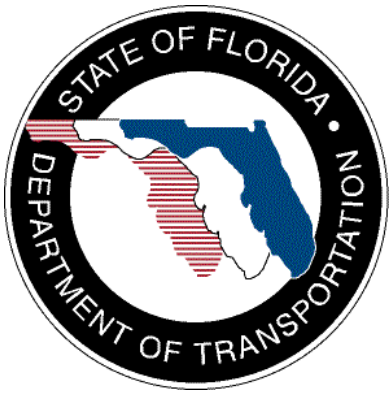

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Table of Contents

List of Figures

List of Acronyms

ACIA.....Asynchronous Communications Interface Adapter
I/O .....Input/Output
LED.....Light Emitting Diode
RMF .....Ramp Metering Firmware
TOD .....Time of Day

Revision History

Revision	Date	Changes
1.0.0-Draft	March 17, 2008	Initial Release

1. Operation

1.1 Power Up Display

Immediately after the RMF is reset or powered up, a series of diagnostics are executed to verify the functionality of the front panel displays. Each of the six 7-segments LEDs are cycled through each possible display value and each of the call lights is turned on in sequence. The display and call lights are then blanked before entering base mode display.

1.2 Base Display Modes

The base display modes are the front panel display modes for normal operation of the RMF. Each of the three ramps controlled by the RMF has a base mode display. On startup, the default display is the base display mode for ramp one. To switch to the base display for another ramp, the number of the ramp (1, 2 or 3) is selected by pressing that key on the keypad. In the base mode displays, the call lights and LEDs display information regarding the state of the system as described in the following sections.

1.2.1 Base Display Mode - Call Lights

In the base mode display for each ramp, the call lights indicate the RMF status information as defined in Table 3.2.

Table 3.1 - Base Mode Call Light Functionality

Light #	Name	Function
0	Metering	Indicates that metering is active.
1	Signal Red	Indicates the state of the red signal light for the selected ramp.
2	Signal Yellow	Indicates the state of the yellow signal light for the selected ramp.
3	Signal Green	Indicates the state of the green signal light for the selected ramp.
4	Central Control	Indicates that metering (start/stop) is controlled by the host.
5	Local Control	Indicates that metering (start/stop) is controlled via the time of day tables.
6	Telemetry	Indicates that host communication is active.
7	Echo	Indicates the state of a specified detector or digital input.
8	Conflict	Indicates a conflict with two signal lights active simultaneously.
9	Failure	Indicates that a detector failure has occurred.

1.2.2 Base Display Mode - LEDs

In the base mode display for each ramp, the LEDs indicate the RMF status information as defined in Table 3.2 and Table 3.3.

Table 3.2 - Base Mode LED functionality

LED	Function
Phase	Displays the currently selected ramp (1, 2 or 3).
Interval	Displays the metering status (0 - F). Refer to Table 3.3.
Timing	Displays the seconds remaining in the current metering cycle.

Table 3.3 - Metering Status Definitions

Metering Value	Definition
0	Not metering
1	Local metering
2	Local metering, queue adjustment
3	Local metering, advance queue override
4	Bottleneck
5	Bottleneck, queue adjustment
6	Bottleneck, advance queue override
7	Prediction
8	Prediction, queue adjustment
9	Prediction, advance queue override
A	Time of day
B	Time of day, queue adjustment
C	Time of day, advance queue override
D	Pre-empt
E	Communication status
F	Fuzzy meter control

1.3 Keypad Display Modes

The keypad can be used to view or modify the operational parameters of the RM firmware. When the keypad is used for this purpose, the base display modes are disabled and the call lights and LEDs are used to display information relevant to the keypad operation performed. The keypad has six different modes of operation:

- Date and time viewing/modification; accessed via the **8** key
- Global parameter viewing/modification; accessed via the **C** key
- TOD table parameter viewing/modification; accessed via the **9** key
- Ramp meter parameters viewing/modification; accessed via the **F** key
- General memory viewing; accessed via the **E** key
- Reset mode operation; accessed via the **A** key

Note that in the keypad display modes, various key sequences are used to change the state of the display for the data being viewed or modified. The **B** key is used to return the previous mode or state without altering data. Pressing the **B** key three times consecutively will return to the base display mode from any of the keypad display modes.

1.3.1 Keypad Display Mode – Date and Time

To view or modify the date/time, the date/time mode is selected by pressing the **8** key on the keypad from any of the base display modes. This will cause all of the LEDs to go blank and call

light 8 to flash indicating date/time mode active. Once the **8** key has been pressed, the **0** key is pressed to view/modify the current time, or the **1** key is pressed to view/modify the current date.

8+**0** displays the current hour, minute, second and day of the week. The Phase LED is set to **0** to indicate time display mode. The hour (00-23) and minute (00-59) are displayed in the Timing LEDs. The one's digit of the second is displayed in the Interval LED. The ten's digit is not displayed. The day of the week is displayed using call lights 1 through 7 with Sunday starting at 1 and Saturday ending at 7.

To modify the time, the hour (00-23) is entered, followed by the minute (00-59), the one's digit of the second (0-9) and finally the day of the week (1-7). When the first key is pressed, the high order digit of the hour is displayed in the left-most Timing LED and the remaining LEDs are changed to **C** to indicate that the time is being modified. As additional keys are pressed, the LEDs are changed to the value entered. Note that invalid values entered for day of the week (less than 1 or greater than 7) are ignored by the system. At any time during modification of the time, the **B** key can be pressed to return to the base display mode. When the final entry (the day of the week) has been made, the **E** key is pressed to enter the new time.

If the time entered is valid, the new time is saved and the LEDs flash to indicate that the save was successful. The **B** key can then be pressed to return to the base display mode. If the time is invalid, the time is not saved and **E** is displayed in the Interval and Timing LEDs to indicate the error. In this event, the **B** key is pressed to return to the time display from which the time can again be modified or the **B** key can be pressed again to return to the base display mode.

8+**1** displays the current date. The Phase LED is set to **1** to indicate date display mode. The day of the month (01-31) and the year (00-99) are displayed in the Timing LEDs. The month (1-12) is displayed as a single hexadecimal value (1-C) in the Interval LED.

To modify the date, the day (01-31) is entered, followed by the year (00-99) and finally the month (1-C). When the first key is pressed, the high order digit of the day is displayed in the left-most Timing LED and the remaining LEDs are changed to **C** to indicate that the date is being modified. As additional keys are pressed, the associated LEDs are changed to the value entered. At any time during modification of the date (other than entering the month), the **B** key can be pressed to return to the base display mode. When the final entry (the month) has been made, the **E** key is pressed to enter the new date.

If the date entered is valid, the new date is saved and the LEDs flash to indicate that the save was successful. The **B** key can then be pressed to return to the base display mode. If the date is invalid, the date is not saved and **E** is displayed in the Interval and Timing LEDs to indicate the error. In this case, the **B** key is pressed to return to the date display from which the date can again be modified or the **B** key can be pressed again to return to the base display mode.

1.3.2 Keypad Display Mode – Global Parameters

To view or modify the global parameters, the global parameter mode is selected by pressing the **C** key on the keypad from any of the base display modes. This will cause all of the LEDs and the call lights to go blank. Two additional keys are then pressed to specify the first column (0-F) and then the row (0-F) of the global parameter on the global parameter memory page (referred to as the C memory page). Refer to Appendix B – Memory Maps for a description of the contents of the C memory page. Refer to Appendix A – Default Firmware Parameters for the default values of the global parameters.

Once the column and row values have been entered, the column number is displayed in the Phase LED, the row number is displayed in the Interval LED, **C** is displayed in the left-most digit of the Timing LEDs (to indicate global parameter mode) and the value (base 10) of the global parameter at that address is displayed in the other three Timing LEDs. For example, **C**+**0**+**1** displays the value at column 0, row 1 of the C page. This is the firmware Program Number and the value displayed should be 170.

To select a different parameter within the global parameters page, the memory page navigation keys, **A**, **C**, **D** and **F** can be used to move to a different memory location within the page. These keys function as shown in Figure 3.1.

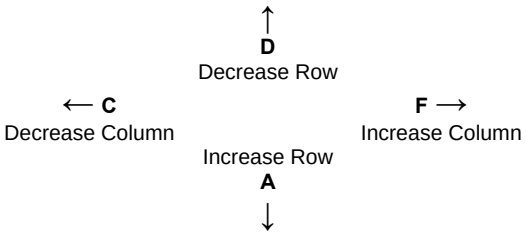

Figure 3.1 - Memory Page Navigation Keys

To modify the value of a parameter, the new value (base 10) is entered starting with the most significant digit. As values are entered, they are displayed in the least significant digit of the Timing LEDs and with the existing values shifted from right to left. At any time during modification of the parameter value, the **B** key can be pressed to return to the base display mode. When the parameter modification is complete, the **E** key is pressed to enter the new value.

If the parameter value entered is valid (no greater than 255), the new value is saved and the Timing LEDs flash to indicate that the save was successful. The **B** key can then be pressed to return to the base display mode, or the navigation keys can be used to select another parameter.

If the parameter value is invalid, the value is not saved and **E** is displayed in the Timing LEDs to indicate the error. In this case, the **B** key is pressed to return to the parameter display. The value can then again be modified, the navigation keys can be used to select another parameter, or the **B** key can be pressed again to return to the base display mode.

1.3.3 Keypad Display Mode – Time of Day Table

To view or modify the TOD table, the TOD table mode is selected by pressing the **9** key on the keypad from any of the base display modes. This will cause all of the LEDs to go blank and call light 9 to flash indicating TOD table mode active.

Once the **9** key has been pressed, the number of the TOD table entry (01-32) is entered. If the TOD entry number is valid (greater than 00 and less than 33), the number is briefly flashed in the Phase/Interval LEDs and then the TOD entry values are displayed as described below. For example, **9**+**0**+**1** displays TOD table entry 1.

For TOD entries, the start time (hour and minute) is displayed in the Timing LEDs, the metering rate is displayed in the Phase/Interval LEDs as a hexadecimal value, and the active days of the week are displayed using call lights 1 through 7, starting at 1 (Sunday) and ending at 7 (Saturday). Refer to Appendix B – Memory Maps for a description of the contents of the TOD

Table memory page. Refer to Appendix A – Default Firmware Parameters for the default values of the time of day table entries.

To select a different TOD entry, the TOD navigation keys **A** and **D** can be used to move to the next or previous entry in the table. These keys function as shown in Figure 3.2. Each time that a different entry is selected, the TOD entry number is briefly flashed in the Phase/Interval LEDs and then the TOD entry values are displayed. Also, at any time that the TOD values are displayed, the TOD entry number for those values can be viewed by pressing the **F** key, which causes the TOD entry number to be briefly flashed in the Phase/Interval LEDs.

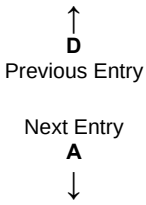

Figure 3.2 - Time of Day Table Navigation Keys

To modify the TOD entry, the hour (00-23) is entered, followed by the minute (00-59), the metering rate (00 – FF) and finally the days of the week (1-7). When the first key is pressed, the high order digit of the hour is displayed in the left-most Timing LED and all remaining LEDs are changed to **C** to indicate that the TOD entry is being modified. As additional keys are pressed, the associated LEDs are changed to the value entered. When modifying the days of the week, each key press toggles the state of the associated call light, allowing for specification of multiple days of the week. At any time during modification of the TOD entry (other than entering the metering rate), the **B** key can be pressed to return to the base display mode. Once modification of the TOD entry is complete, the **E** key is pressed to enter the new values.

If the TOD entry is valid (the hour and minute are valid), the TOD entry is saved and the LEDs flash to indicate that the save was successful. The **B** key can then be pressed to return to the base display mode, or the navigation keys can be used to select another entry.

If the entry is invalid, the entry is not saved and **E** is displayed in the Timing LEDs to indicate the error. In this case, the **B** key is pressed to return to the TOD entry display. The TOD entry can then again be modified, the navigation keys can be used to select another parameter, or the **B** key can be pressed again to return to the base display mode.

1.3.4 Keypad Display Mode – Ramp Meter Parameters

To view or modify the ramp meter parameters, the ramp meter parameter mode is selected by pressing the **F** key on the keypad from any of the base display modes. This will cause all of the LEDs and the call lights to go blank.

Once the **F** key has been pressed, the ramp number (1-3) is entered to select the F memory page for the parameters, followed by the column and then the row of the desired parameter. An **F** is displayed in the left-most Timing LED to indicate ramp meter parameter mode, the ramp number is displayed using call lights 1-3, and the column and row are displayed in the Phase/Interval LEDs. For example, **F**+**1**+**1**+**1** displays the parameter for ramp 1 at column 1, row 1, which is the Multilane Split parameter.

Note that using the **F** Key mode, only the modifiable ramp lane parameters are accessible on the ramp lane parameter pages. These parameters reside in memory at ramp lane page indices 0x10 through 0x2B. These are depicted in row/column format in Table 3.4.

Table 3.4 - Valid Ramp Lane Parameter Addresses

Ramp	Column	Rows
1, 2 or 3	1	0-F
1, 2 or 3	2	0-B

If the ramp page, column and row are valid, the value of the parameter at that address is displayed (in base 10) in the lower 3 Timing LEDs; otherwise **E** is displayed in the Phase/Interval LEDs to indicate the address error. The **B** key is then pressed to return to the base display mode. Refer to Appendix B – Memory Maps for a description of the contents of the ramp lane parameter pages. Refer to Appendix A – Default Firmware Parameters for the default values of the ramp lane parameters.

To select a different parameter within the selected ramp meter parameters page, the memory page navigation keys, **A**, **C**, **D** and **F** can be used to move to a different memory location within the ramp meter parameters page. These keys function as shown in Figure 3.1.

To modify the value of a parameter, the new value (base 10) is entered starting with the most significant digit. As values are entered, they are displayed in the least significant digit of the Timing LEDs and with the existing values shifted from right to left. At any time during modification of the parameter value, the **B** key can be pressed to return to the base display mode. When the parameter modification is complete, the **E** key is pressed to enter the new value.

If the parameter value entered is valid, the new value is saved and the Timing LEDs flash to indicate that the save was successful. The **B** key can then be pressed to return to the base display mode, or the navigation keys can be used to select another parameter.

If the parameter value is invalid, the value is not saved and **E** is displayed in the Timing LEDs to indicate the error. In this case, the **B** key is pressed to return to the parameter display. The value can then again be modified, the navigation keys can be used to select another parameter, or the **B** key can be pressed again to return to the base display mode.

1.3.5 Keypad Display Mode – General Memory Access

The RAM used by the ramp meter firmware is located at addresses 0x0000 through 0x7FFF. Part of this RAM is used to store user modifiable parameters as described in Sections 1.3.2, 1.3.3 and 1.3.4. Other sections of the RAM are reserved for memory mapped I/O and also for parameters that are used by the system but are not user modifiable.

The E memory pages at addresses 0x7600 – 0x7A00 are used to store system parameters that are not modifiable by the user. The contents of these memory pages are documented in Appendix B. While the values of these parameters are not modifiable, they can be viewed using the keypad E page memory access mode.

In order to view the contents of an E memory page, the E page number must first be stored to the E Page Entry in the C memory page which is at column 0, row E (see Appendix A). This is done as described in Section 1.3.2. Since each E memory page contains 255 bytes (0xFF), the E page number is the value (in base 10) of the two high order hexadecimal digits of the E page memory

address. For example, the E page number for the E memory page at address 0x7600 is 118 (0x76 hexadecimal). Also, note that the page number for each memory page is shown above the table for that page in Appendix B.

Once the E page number has been specified, the E page memory access mode is selected by pressing the **E** key on the keypad from any of the base display modes. This will cause all of the LEDs and the call lights to go blank. Two additional keys are then pressed to specify first the column (0-F) and then the row (0-F) of the E page memory location.

Once the column and row values have been entered, the column number is displayed in the Phase LED, the row number is displayed in the Interval LED, **E** is displayed in the left-most digit of the Timing LEDs (to indicate E page access mode) and the value (base 10) of the data at that address is displayed in the other three Timing LEDs. For example, if E page 118 is currently selected (118 stored to the E Page Entry in the C Page), then the key sequence **E**+**1**+**0** will display the data value at memory page address 0x7600, column 1, row 0, which is the ramp 1 meter rate.

Note that the value of the data displayed in the timing LEDs is updated in real time, so that if the value of the data changes while it is being viewed, the timing LEDs are automatically updated to display the change.

This mode allows only for viewing memory values, not for modification. To select a different memory value for viewing, the memory page navigation keys, **A**, **C**, **D** and **F** can be used to move to a different memory location within the currently selected E page. These keys function as shown in Figure 3.1. To exit the E page memory access mode, the **B** key is pressed to return to the base display mode.

1.3.6 Keypad Display Mode – Reset Functions

The RMF system supports three types of resets, which can be invoked by the host computer or via the keypad. These include:

- Detector Reset – Resets the loop detectors.
- Comm Reset – Resets the ACIA interface to the host computer.
- Software Reset – Restarts execution of the RMF firmware.

The reset mode is selected pressing the **A** key on the keypad from any of the base display modes. This will cause all of the LEDs and the call lights to go blank. The reset type is then specified, **1** for Detector Reset, **2** for Comm Reset, or **3** for Software Reset. **A** is displayed in the Phase LED to indicate reset mode and the reset type is displayed in the interval LED. At any point during entry of reset mode values, the **B** key can be pressed to return to the base display mode. Once the reset mode and type have been specified, the **E** key is pressed to execute the reset. For example, the key sequence **A**+**1**+**E** will reset the loop detectors.

For the Detector and Comm Resets, **dddd** is then flashed in the Timing LEDs to indicate that the reset was done. For the Software Reset, the RMF will restart execution and the Power Up display described in Section 0.2 will be initiated.

1.4 Special Keypad and Display Modes

1.4.1 Detector Echo and Input Echo

The RMF system provides for echoing the state of a specified detector or C1 connector input to a dedicated call light, call light 7 (refer to Table 3.2).

Detector echo is enabled by entering the number of the detector (1-40) to be monitored in the C Page memory address 0x0C08 (refer to the C Page memory map in Appendix B). This is done via the keypad global parameter modification procedure as described in Section 1.3.2.

Input echo is enabled by entering the number of the C1 connector input (39-82) to be monitored in the C Page memory address 0x0C09 (refer to the C Page memory map in Appendix B). This is done via the keypad global parameter modification procedure as described in Section 1.3.2.

Note that if non-zero values are entered for both detector echo and input echo, detector echo will take precedence. If zero values are entered for both, the echo functionality is disabled.

1.4.2 Memory Reset

The RMF system provides for clearing (resetting to 0) all memory in the address range of 0x0000 to 0x04FF (the system parameters, the ramp lane parameters, and the global parameters). This is done by powering up the controller with the Stop Time switch ON and any key pressed on the keypad.

WARNING: This action will clear the drop address for the controller causing communications with the host computer to be disabled. The Controller Drop Address is stored at column 0, row 0 of the C (global parameters) memory page. Refer to Section 1.3.2 for instructions on assigning the drop address.

1.4.3 Fatal Error Detection

In the event that the RMF system detects a fatal error, it will enter a safe mode in which the signal lights are all turned off and no metering is done. The Timing LEDs will flash **EEEE** to indicate that the controller is in this fatal error state. The controller will remain in this state until it is power cycled or the RMF firmware is restarted by turning the Stop Time switch ON and pressing any key on the keypad.

1.4.4 Display Blanking Feature

In the event that there is no keypad activity for a period of 30 minutes, the phase/interval LEDs, timing LEDs and call lights are blanked (turned off) to preserve the lamps. In this mode, the normal ramp metering functions continue, but the display is not updated. To restore the display to an active state, any key on the keypad is pressed. The single key press will only activate the display; it will not initiate any keypad function.

Table 5: C-Page

0400	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	Drop Address	Det 1 Loop Func Code	Det 17 Loop Func Code	Det 33 Loop Func Code	ST 3 Upstream Detector	ST 7 Upstream Detector	UpperVol3	Bin1 Length	FilterTh Rev							
1	Program Number	Det 2 Loop Func Code	Det 18 Loop Func Code	Det 34 Loop Func Code	ST 3 Dnstream Detector	ST 7 Dnstream Detector	Occupancy4	Bin2 Length	Cars per Green							
2	Version Number	Det 3 Loop Func Code	Det 19 Loop Func Code	Det 35 Loop Func Code	ST 3 Distance	ST 7 Distance	LowerVol4	Bin3 Length	Ignore CurrMon							
3	Release Number	Det 4 Loop Func Code	Det 20 Loop Func Code	Det 36 Loop Func Code	ST 3 Eff Loop Length	ST 7 Eff Loop Length	UpperVol4	Ramp DetOn								
4		Det 5 Loop Func Code	Det 21 Loop Func Code	Det 37 Loop Func Code	ST 4 Upstream Detector	ST 8 Upstream Detector	Data Switch	Ramp DetOff								
5		Det 6 Loop Func Code	Det 22 Loop Func Code	Det 38 Loop Func Code	ST 4 Dnstream Detector	ST 8 Dnstream Detector	# Active Loops	Mainline DetOn								
6		Det 7 Loop Func Code	Det 23 Loop Func Code	Det 39 Loop Func Code	ST 4 Distance	ST 8 Distance	# Metered Lanes	Mainline DetOff								
7		Det 8 Loop Func Code	Det 24 Loop Func Code	Det 40 Loop Func Code	ST 4 Eff Loop Length	ST 8 Eff Loop Length	# Speed Traps	HOV DetOn								
8	Detector Echo	Det 9 Loop Func Code	Det 25 Loop Func Code	ST 1 Upstream Detector	ST 5 Upstream Detector	Occupancy1	Control Switch	HOV DetOff								
9	Input Echo	Det 10 Loop Func Code	Det 26 Loop Func Code	ST 1 Dnstream Detector	ST 5 Dnstream Detector	LowerVol1	Police Switch	Rev DetOn								
A		Det 11 Loop Func Code	Det 27 Loop Func Code	ST 1 Distance	ST 5 Distance	UpperVol1	Meter End Green	Rev DetOff								
B		Det 12 Loop Func Code	Det 28 Loop Func Code	ST 1 Eff Loop Length	ST 5 Eff Loop Length	Occupancy2	Demand End Gap	Start Yellow								
C		Det 13 Loop Func Code	Det 29 Loop Func Code	ST 2 Upstream Detector	ST 6 Upstream Detector	LowerVol2	Minimum Speed	Meter Off Display								
D		Det 14 Loop Func Code	Det 30 Loop Func Code	ST 2 Dnstream Detector	ST 6 Dnstream Detector	UpperVol2	Maximum Speed	FilterTh ML								
E	E Page Entry	Det 15 Loop Func Code	Det 31 Loop Func Code	ST 2 Distance	ST 6 Distance	Occupancy3	Minimum Length	FilterTh Ramp								
F		Det 16 Loop Func Code	Det 32 Loop Func Code	ST 2 Eff Loop Length	ST 6 Eff Loop Length	LowerVol3	Maximum Length	FilterTh HOV								