# FloBoss 500-Series Firmware

The FloBoss™ 500-Series firmware is the software programmed into the flash memory of the FloBoss 503 and FloBoss 504 Flow Manager product line. The firmware determines the functions that these units can perform and includes:

- Operating system, Input / Output (I/O) processing, logging, and user interface.
- American Gas Association (AGA) flow calculations.
- Logic and sequencing control via two user-defined Function Sequence Tables (FST).
- Power cycling control.
- Modbus protocol emulation (Slave mode only).
- Closed-loop Proportional, Integral, and Derivative (PID) control capabilities.
- Spontaneous-Report-by-Exception (SRBX) communication to a host computer.

The firmware makes extensive use of configuration parameters. Use ROCLINK™ 800 Configuration Software to configure the firmware.

## Operating System

The firmware provides a complete operating system for the FloBoss and supports:

- Task Execution.
- Real-Time Clock.
- Input / Output (I/O) Database.
- Historical Database.
- Event and Alarm Logs.
- User Interface.
- Communications.
- Security.

**Task Execution** – The operating system is structured around 12 tasks that are executed on a 100-millisecond cycle and tasks execute in a priority order. The tasks are: I/O scanning, PID control, communications, FST, liquid crystal display (LCD), history, battery, multi-variable sensor, (MVS), dual-variable sensor (DVS), meter input, meter instantaneous, meter recalculation, and monitor.

**Real-Time Clock** – The real-time clock can be set by for century, year, month, day, hour, minute, and second. The real-time clock provides time stamping of database values and event and alarm log entries. The clock calculates the day of the week and corrects for leap year.

**Input / Output Database** – The operating system supports the following input or output points including the built-in inputs, integral sensor inputs, and I/O channels from the optional I/O card. The firmware automatically determines the type and location of each I/O channel. A point in the database corresponds to each input and output. Each point includes configuration parameters for assigning values, statuses, or identifiers as appropriate.

The firmware scans each input, placing the values into the respective database point. These values are made available for display and historical archiving.

**Historical Database** – The historical database provides archiving of measured and calculated values for on-demand viewing or saving to a file. You can configure each point in the historical database to archive the current value, average value, totalized value, or accumulated value, or to archive values as determined by an FST. The four types of historical databases include: Min/Max, Minute, Hourly, and Daily (with configurable contract-day start).

Historical archives for hourly and daily databases comply with American Petroleum Institute (API) Chapter 21.1.

**Event and Alarm Logs** – The Event Log records the last 240 parameter changes and system events, such as power on and off cycles. The Alarm Log records the last 240 occurrences of alarms (set or clear). You can view, print, or save the logs to a disk file using ROCLINK 800 software.

**User Interface** – Access to data is made available through the LCD display on the FloBoss, as well as the Local Operator Interface (LOI) port. The display allows viewing of database values gathered and stored by the operating system. Use ROCLINK 800 software and the LOI port to view and edit values.

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**EMERSON**
Process Management

# Specification Sheet

**Communications** – The operating system uses its own specialized ROC (Remote Operations Controller) protocol to support serial communications and radio or telephone modem communications to local or remote devices, such as a host computer. The operating system also supports Modbus protocol. Auto-detection provides for automatically switching between the two protocols

**Security** – A maximum of 16 log-on identifiers (IDs) for operators may be stored in the operating system. A user access level corresponds with each ID. For the unit to communicate, the log-on ID sent to the ROCLINK 800 software must match one of the stored IDs. By default, the Local Operator Interface (LOI) port has this security enabled. You can configure the host port (Comm1) to enable the same security protection.

## Flow Calculations

The firmware calculates gas flow through an orifice meter (AGA3 calculation) when used in a FloBoss 503, and through a turbine meter (AGA7 calculation) when used in a FloBoss 504. The values for gas quality can be entered or live. Gas quality parameters include gas composition, heating value, and specific gravity.

The AGA3 calculations conform to methods in the American Gas Association Report No. 3, *Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.* Based on the second and third editions, the primary calculation method is 1992 AGA3. The 1992 calculation allows AGA8 super-compressibility methods (Detail, Gross 1, or Gross 2).

The AGA7 calculations conform to methods described in American Gas Association Report No. 7, *Measurement of Gas by Turbine Meters,* and uses the AGA8 method for determining the super compressibility factor.

The **FloBoss 504 uses the ISO 9951 calculations, with ISO 12213-2 super compressibility**. Data transmission fidelity and security Level A to E is met according to API Chapter 5 Section 5 and ISO 6551. Level A integrity, which uses two pulse signals and includes error correction, requires the use of a high-precision turbine (no more than one percent phase error between blades).

The AGA Reports utility, supplied with the ROCLINK 800 software, works with firmware to generate hourly and daily reports of a meter run. The utility creates fixed-format reports of the operational characteristics of the orifice or turbine meter run. The reports are available for display and saved as disk files that you can view or print.

## Power Cycling Control

Power cycling control is used with the optional EIA-232 (RS-232) serial communications card to provide power savings when communicating with a radio or cell phone.

Two modes of power control are possible: Second and Minute. In Second mode, the time base for the timers is in 100-millisecond increments and is primarily used with radios. In Minute mode, the time base for the timers is in 1-minute increments and is primarily used with cell phones.

Three cycling "zones" are provided in a 24-hour period, but zones can be disabled as desired. The EIA-232 (RS-232) card provides the switching mechanism.

## Modbus Protocol

The Modbus Protocol Emulation software is contained within the FloBoss firmware. The Modbus application allows the FloBoss to emulate the communications protocol used by Modbus devices. The Modbus software is based primarily on the description contained in the reference guide entitled "Modicon Modbus Protocol," found in publication PI-MBUS-300. The firmware includes an enhanced version of Modbus with EFM extensions.

The FloBoss is operated only as a Modbus "Slave" (polled) device. The FloBoss supports both ASCII and RTU modes of transmission.

## PID Control

The PID control applications firmware provides Proportional, Integral, and Derivative (PID) gain control for a FloBoss and enables the stable operation of up to three feedback control loops that employ a regulating device, such as a control valve.

The firmware sets up an independent PID algorithm (loop) in the FloBoss. The PID loop has its own user-defined input, output, and override capability. Typically, an optional FloBoss 500-Series I/O card supplies the inputs and outputs for a PID loop.

The typical use for PID control is to maintain a process variable at setpoint. If PID override control is configured, the primary loop is normally in control of the regulating device. When the change in output for the primary loop becomes less or greater than the change in output calculated for the secondary (override) loop, the override loop takes control of the regulating device. When the switchover conditions are no longer met, the primary loop regains control of the device.

## Spontaneous-Report-by-Exception Communication

Spontaneous-Report-By-Exception (SRBX) communication allows the FloBoss to monitor for alarm conditions and, upon detection of an alarm, automatically report the alarm to a host computer. The SRBX communication link communicates using a dial-up modem, radio, or serial line when the host is set up for receiving field-initiated calls.

## Function Sequence Table

The Function Sequence Table (FST) applications firmware provides analog and discrete sequencing control capability to the FloBoss. This programmable control defines the actions to be performed by the FloBoss using a series of functions. You use the FST editor, which is part of ROCLINK 800 software, to program the FST. FloBoss 500-Series units have two FSTs. Each FST executes ten instructions every 100 milliseconds.

**Functions** – The basic building block of an FST is the function. A sequence of steps organizes the functions to form a control algorithm. Each function step can consist of a label, a command (CMD), and arguments.

Labels identify functions and allow branching to specific steps within an FST.

You select the command, which is the heart of each function, from a library of mathematical, logical, and other commands. Names consisting of up to three characters or symbols identify the commands.

Arguments provide the means to access process I/O points and retrieve real-time values. A function may have zero, one, or two arguments.

As the sequence of functions execute, two storage locations store the results of one function and pass them along to the next. One storage location tracks analog or floating-point operations and another location tracks logical or discrete operations.

For each FST, ten additional global locations store intermediate values.

**FST Editor** – The FST editor program allows you to create a new FST, modify an existing FST, copy an FST to and from the FloBoss or disk, start and stop an FST, change runtime parameters in an FST, monitor an FST, and debug an FST.

The editor provides a workspace that accepts the entry of up to 4000 bytes (typically 200-300 functions) in each FST. You enter each function into the editor next to a step number. The modes of operation for the FST editor include Ready, Edit, Menu, Monitor, and Trace.

| STEP | LABEL | CMD | ARGUMENT 1 | ARGUMENT 2 |
|---|---|---|---|---|
| 000 | CKHIAL | VAL | @IOB9, TANK LEVEL,EU | |
| 001 | | >= | @IOB9, TANK LEVEL,HIAL | PUMPON |
| 002 | | GO | CKHIAL | |
| 003 | PUMPON | DO | @IOA5,PUMP1,STATUS | 1 |
| 004 | CKLOAL | VAL | @IOB9,TANK LEVEL,EU | |
| 005 | | <= | @IOB9,TANK LEVEL,LOAL | PMPOFF |
| 006 | | GO | CKLOAL | |
| 007 | PMPOFF | DO | @IOA5,PUMP1,STATUS | 0 |
| 008 | | END | | |

*Function Sequence Table Example*

## FloBoss 500-Series Firmware Specifications

### HISTORY DATABASE

15 history points, with archiving of hourly and daily values for 35 days, in accordance with API Chapter 21.1. Eight points are reserved and seven are user-configurable.

### FLOW CALCULATIONS

**Orifice:** AGA3 with 1992 method with AGA8 super compressibility methods (Detailed, Gross 1 and Gross 2).

**Turbine:** AGA7 with AGA8 super compressibility methods or ISO 9951 calculations with ISO 12213-2 super compressibility. Data transmission fidelity and security level A to E is met according to API Chapter 5 Section 5 and ISO 6551.

**Meter Runs:** One.

### FST COMMAND LIBRARY

**Logical:** NOT, AND, OR, Exclusive OR.

**Mathematical:** Add, Subtract, Multiply, Divide, Raise to a Power, Absolute Value, Exponent (base $e$), Integer Value, Base 10 Logarithm, Natural Logarithm, Square Root, and 3rd Order Polynomial.

**Comparison:** Test if Equal, Not Equal, Less Than, Less Than Or Equal, Greater Than, and Greater Than Or Equal.

**Time-Related:** Set Timer, Check Timer, Wait (Suspend), Day of Week, and Minutes Past Midnight.

**Control-Related:** Analog Output, Discrete Output, and Timed Discrete Output.

**Database:** Read from Historical Database, Write to Historical Database, Write Time to Historical Database.

**General:** Load Value into Results Register (RR), Store RR into Database, Go To Indicated Step, Write Message to Local Display Panel, End of FST, Log Alarm, Log Event.

### FUNCTION SEQUENCE TABLE

Two FSTs. Each limited to 4000 bytes total, typically 200 to 300 Steps.

### LOGGING

**Events:** 240 before rollover.

**Alarms:** 240 before rollover.

### PID CONTROL PARAMETERS

Configurable parameters for a Proportional, Integral, and Derivative (PID) loop include:

**Control Type:** Selects the "modes" in which the PID loop operates: auto mode, manual mode, primary control, override control, DO control, AO control, stop on reset, manual tracking, override high select, and override low select.

**Input Definition:** The input (process variable) assigned to the PID loop.

**Output Definition:** The output assigned to the PID loop.

**Setpoint:** Value to which the process variable is controlled.

**Setpoint EU/Min:** The maximum rate at which the setpoint is allowed to ramp to a new value.

**Loop Period:** The amount of time between PID calculations.

**PID Gains:** Proportional, Integral, and Derivative gains used by the loop for desired response.

**Scale Factor:** Ratio of output span to input (process variable) span. Determines direct or reverse action for the loop.

**Deadband:** Integral action is disabled when the process variable is within this "window" around the setpoint.

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