

FloBoss™ 500-Series Firmware

The FloBoss 500-Series firmware is the software programmed into the flash memory of the FloBoss 503, 504, and 553 Flow Manager product line. It determines the functions that these units can perform and includes:

- ◆ Operating system, I/O processing, logging, and user interface.
- ◆ AGA flow calculations.
- ◆ Logic and sequencing control via 2 user-defined Function Sequence Tables (FST).
- ◆ Power cycling control.
- ◆ Modbus protocol emulation (Slave mode only).
- ◆ Closed-loop PID control capabilities.
- ◆ Report-by-Exception communication to a host computer.

The firmware makes extensive use of configuration parameters, which are configured using ROCLINK™ Configuration Software (see Specification Sheet 4:RLFW).

Operating System

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

- ◆ Task Execution.
- ◆ Real-Time Clock.
- ◆ Input/Output 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. The tasks are executed in a priority order. The tasks are: I/O scanning, PID Control, Communications, FST, LCD, History, Battery, MVS, Meter Input, Meter Instantaneous, Meter Recalc., and Monitor.

Real-Time Clock – The real-time clock can be set by the user for century, year, month, day, hour, minute, and second. It is used to provide 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 number of input or output points supported by the operating system includes the built-in inputs, integral sensor inputs, and I/O channels from the optional I/O board. The firmware automatically determines the type and location of each I/O channel. Each input and output is assigned a point in the database; 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. Each point in the historical database can be configured to archive the current value, average value, totalized value, or accumulated value, or to archive values as determined by an FST. Four types of historical databases are maintained: Min/Max, Minute, Hourly, and Daily (with configurable contract-day start).

API Chapter 21.1 compliant historical archives are maintained for hourly and daily databases.

Event and Alarm Logs – The Event Log records the last 240 parameter changes and system events, such as power on/off cycles. The Alarm Log records the last 240 occurrences of alarms (set or clear). The logs can be viewed, saved to a disk file, or printed by using ROCLINK 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. With ROCLINK software, the LOI port allows values not only to be viewed, but edited as well.

Communications – The operating system uses its own specialized protocol (called ROC 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 (see Page 3). Auto-detection is provided for automatically switching between the two protocols.

Specification Sheet

Security – A maximum of 16 log-on identifiers (IDs) for operators may be stored in the operating system. Each ID is associated with a user access level. For the unit to communicate, the log-on ID supplied to the ROCLINK Configuration Software must match one of the stored IDs. The operator interface (LOI) port has this security enabled by default. The host port can be configured 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 or 553, 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 described in 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 (allows greater accuracy). The 1992 calculation allows AGA8 super-compressibility methods (Detail, Gross I, or Gross II).

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 **ISO 9951 calculations**, with ISO 12213-2 super-compressibility, are used by the FloBoss 504. 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 Configuration Software, works with firmware to generate hourly and daily reports of a meter run. The Reports utility creates fixed-format reports of the operational characteristics of the orifice or turbine meter run. It also makes the reports available for display and saves them as disk files that can be viewed or printed later.

Function Sequence Table

The Function Sequence Table (FST) applications firmware gives 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 (see example on page 3). An FST is developed using the FST Editor that is part of ROCLINK for Windows Configuration Software. Two FSTs are provided in the FloBoss 500-Series units.

Functions — The basic building block of an FST is the function. Functions are organized in a sequence of steps to form a control algorithm. As shown in the figure on the next page, each function step can consist of a label, a command (CMD), and arguments.

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

The command, which is the heart of each function, is selected from a library of mathematical, logical, and other commands (see Specifications table). Commands are identified by a name consisting of up to three characters or symbols.

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 is executed, two storage locations are used to store the results of one function and pass them along to the next. One storage location keeps track of analog or floating-point operations. Another register keeps track of logical or discrete operations.

For each FST, ten additional global registers are provided for storing intermediate values.

FST Editor — The FST Editor (part of the ROCLINK software) is a program that allows the user 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, and monitor and debug an FST.

Specification Sheet

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

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

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. An enhanced version of Modbus with EFM extensions is programmed into the firmware.

The FloBoss is operated only as a Modbus “Slave” (polled) device. It 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 (see the Specifications table for a list of parameters). Typically, the inputs and outputs for a PID loop are supplied by an optional 500-Series I/O Card.

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 (as selected by user) than the change in output calculated for the secondary (override) loop, then 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.

Report-by-Exception Communication

Spontaneous report-by-exception (RBX) communication allows the FloBoss to monitor for alarm conditions and, upon detection of an alarm, automatically report the alarm to a host computer. This can be performed over any kind of communication link — dial-up modem, radio, or serial line — as long as the host is set up for receiving field-initiated calls.

Specifications

HISTORY DATABASE

15 history points provided, with archiving of hourly and daily values for 35 days, in accordance with API Chapter 21.1. 8 points are reserved; 7 are user-configurable.

FLOW CALCULATIONS

Orifice: AGA3 with 1992 method with AGA8 supercompressibility methods (Detailed, Gross I and Gross II).

Turbine: AGA7 with AGA8 supercompressibility methods or ISO 9951 calculations with ISO 12213-2 supercompressibility. 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, 3rd Order Polynomial.

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

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

Control-Related: Analog Output, Discrete Output, 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.

FST

2 FSTs. Each limited to 4000 bytes total, typically 200-300 steps.

LOGGING

Events: 240 before rollover.

Alarms: 240 before rollover.

PID CONTROL PARAMETERS

Some of the parameters that can be configured for a PID loop are:

Control Type: Selects the “modes” in which the PID loop operates: auto/manual, primary/override, DO control/AO control, stop on reset, manual tracking, and override high/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. Also 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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