

MASTERFLEX[®]

MasterSense[®] **Communications** **Protocols** **Guide**

MASTERFLEX[®]

A-1299-1185 Ed.01

***EN809 manufactured by Masterflex LLC**

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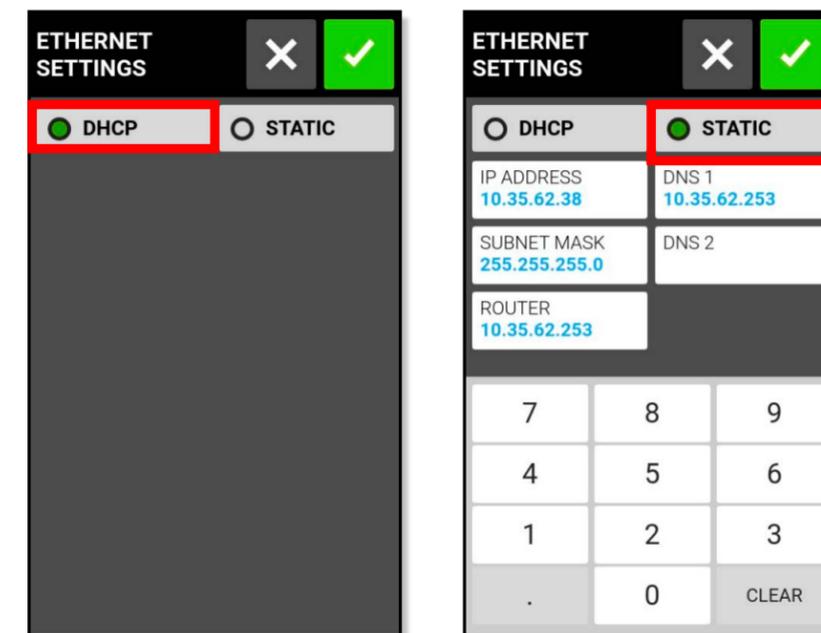
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EtherNet/IP

EtherNet/IP Mode

In EtherNet/IP mode the pump can be operated in Continuous, Volume, or Time modes. Pump-drives are equipped with EtherNet/IP for real-time control by a programmable logic controller (PLC). An electronic data sheet (EDS) command file is available for download by emailing Masterflex technical support at techsupport@masterflex.com.

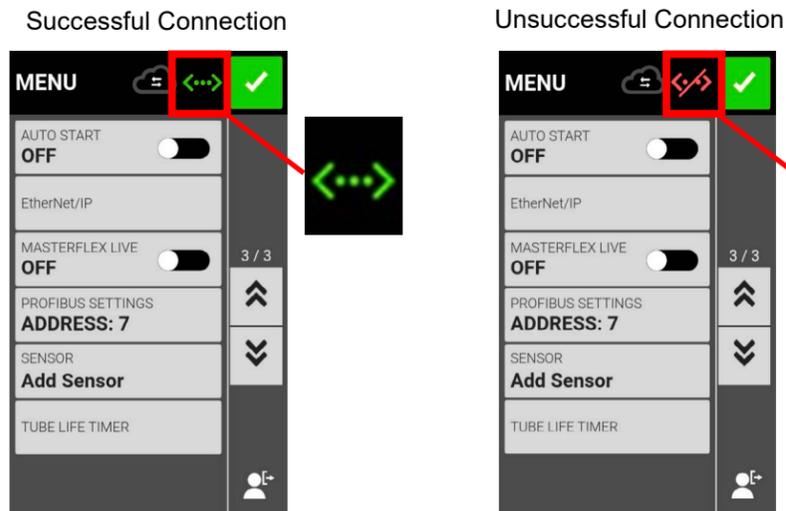
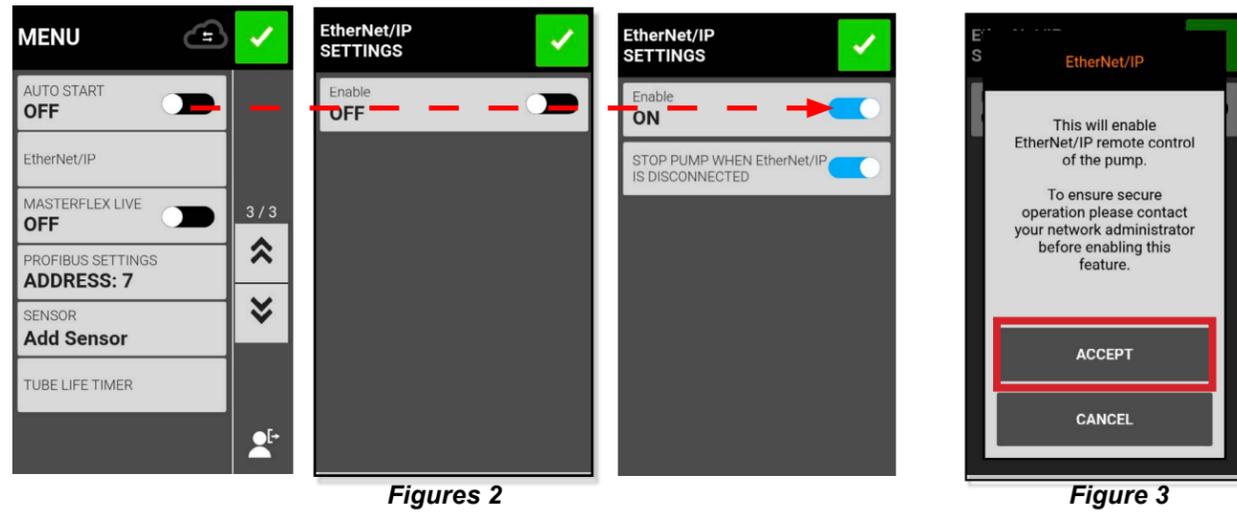
Verify that your pump-drive, PLC, along with an operator's computer are all connected to the same network. Also, verify the computer's IP address is within the subnet mask range of the PLC and the pump-drive. The default addressing method for the pump-drive is a dynamic host configuration protocol (DHCP), see Figures 1 below. A static IP address (see below) may be assigned through the EtherNet Settings menu.



Figures 1

Enabling EtherNet/IP Mode

- On the Menu touchscreen tap the EtherNet/IP switch moving it from OFF to ON (see Figures 2 below).
- The EtherNet message screen displays, tap its “Accept” button (see Figure 3 below).



Once the EtherNet/IP has been enabled and configured (see Figure 4 below), an operator can view the pump-drive from a programmable logic controller (PLC). To enable remote control, configure the pump-drive from a PLC using the bit “Pump1:O.Toggle_Remote_Local_Control_1_to_0.”

NOTE: The bit changes state from Local to Remote on a 1-to-0 transition. Once enabled, the EtherNet/IP banner will appear at the top of the pump-drive touchscreen (see Figure 4 below).

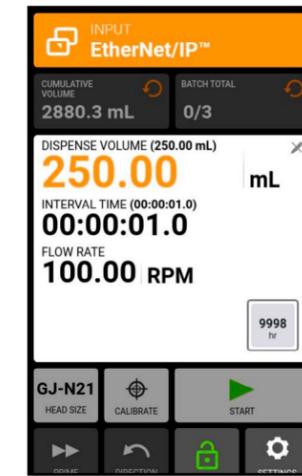


Figure 4

EtherNet/IP Input Data

Input Data: 56 Bytes of Input Data from Pump to Master

Bytes	Data Type	Description
0—3	32-bit INT	<u>Pump Status</u> Bit 0: Status OK Bit 1: Pump Running Bit 2: Dispense Running Bit 3: Tube Uncalibrated Bit 4: Head Open Bit 5: Reserved Bit 6: Flow Direction CCW Bit 7: Remote Control Bit 8—31: Reserved
4	BYTE	Dispense Mode
5	BYTE	Tube Size
6	BYTE	Flow Units
7	BYTE	Reserved Pad
8—11	FLOAT	Cumulative Volume
12—15	FLOAT	Remaining Dispense Volume
16—19	FLOAT	Remaining Dispense On Seconds
20—23	FLOAT	Remaining Dispense Off Seconds
24—27	32-bit INT	Batch Count Current
28—31	32-bit INT	Batch Count Total
32—35	FLOAT	Minimum Flow Rate
36 - 39	FLOAT	Current Flow Rate
40—43	FLOAT	Maximum Flow Rate
44—45	16-bit INT	Remaining Dispense On Time Days
46	BYTE	Remaining Dispense On Time Hours
47	BYTE	Remaining Dispense On Time Minutes
48	BYTE	Remaining Dispense On Time Seconds
49	BYTE	Remaining Dispense On Time Tenths
50—51	16-bit INT	Remaining Dispense Off Time Days
52	BYTE	Remaining Dispense Off Time Hours
53	BYTE	Remaining Dispense Off Time Minutes
54	BYTE	Remaining Dispense Off Time Seconds
55	BYTE	Remaining Dispense Off Time Tenths

EtherNet/IP Output Data

Output Data: 28 Bytes of Output Data from Pump to Master

Bytes	Data Type	Description
0	BYTE	<u>Pump Control</u> Bit 0: Run/Pause (1 = RUN; 0 = PAUSE) Bit 1: Stop and Reset Dispense (1 to 0 transition) Bit 2: Toggle Remote/Local Control (1 to 0 transition) Bit 3: Clear Cumulative Volume (1 to 0 transition) Bit 4: Reserved Bit 5: Reserved Bit 6: Set Flow Direction CCW (1 = CCW, 0 = CW) Bit 7: Reserved
1	BYTE	Reserved Pad
2	BYTE	Reserved Pad
3	BYTE	Reserved Pad
4	BYTE	Set Dispense Mode (0 = CONT, 1 = TIME, 2 = VOL)
5	BYTE	Reserved Pad
6	BYTE	Set Flow Units (see Table 3)
7	BYTE	Reserved pad
8 - 11	FLOAT	Set Flow Rate
12 - 15	FLOAT	Set Dispense Volume
16 - 19	FLOAT	Set Dispense On Seconds
20 - 23	FLOAT	Set Dispense Off Seconds
24 - 27	32-bit INT	Set Batch Count Total (0 = infinite)

Profibus

Profibus

In Profibus mode the pump-drive will operate remotely in Continuous, Volume, or Time mode.

Profibus Mode

Verify an operator computer and the PLC are both connected to the same network switch. Also, verify the pump can send/receive ping commands from the computer. In addition, verify the process control is running and connected to the network.

Connect the 9-PIN Profibus cable to the pump-drive's side connector, or to the Profibus connector which is either on the Profibus module or on a process controller itself.

Profibus Settings



NOTE: Verify the pump-drive is connected to a PLC and is in Profibus mode.

Selecting Profibus Settings

1. Tap SETTINGS.
2. The MENU screen displays (see Figure 5 below).
3. Scroll down to touchscreen **page 3/3** and access PROFIBUS SETTINGS.
4. Once a field is selected enter the PROFIBUS SETTINGS screen (see Figure 6 below). Enter the Profibus address as a value in between 1 and 126 on the touchscreen keypad. (The default Profibus address is 7.)
5. Verify the pump-drive and the PLC user interface are configured for the same address; confirm by pressing the **green** Confirm checkmark at the top of the screen (see below).

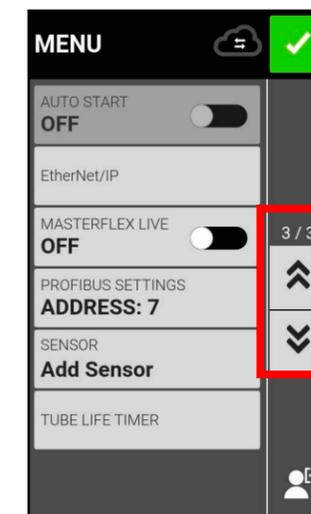


Figure 5

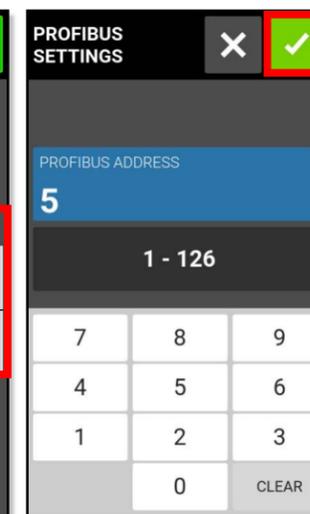


Figure 6

Profibus Data

The MASTERFLEX pump-drive operates as a DP-V0 Slave.

GSD File: CPMP0FF8.GSD

ID Number: 0FF8 HEX

Default Slave Address: 7

Cyclic Input Data: 56 bytes

Cyclic Output Data: 28 bytes

Table 1 below lists the 56 bytes of cyclic input data, from pump to master.

Table 1

Cyclic Input (pump → master, 56 bytes)		
Data	Size in Bytes	Data Type
Pump Status	4	unsigned integer
Dispense Mode	1	unsigned integer
Tube Size	1	unsigned integer
Flow Units	1	unsigned integer
Padding (not used)	1	unsigned integer
Cumulative Volume	4	decimal floating-point
Remaining Dispense Volume	4	decimal floating-point
Remaining Dispense On Seconds	4	decimal floating-point
Remaining Dispense Off Seconds	4	decimal floating-point
Current Batch Count	4	unsigned integer
Total Batch Count	4	unsigned integer
Minimum Flow Rate	4	decimal floating-point
Current Flow Rate	4	decimal floating-point
Maximum Flow Rate	4	decimal floating-point
Remaining Dispense On Days	2	unsigned integer
Remaining Dispense On Hours	1	unsigned integer
Remaining Dispense On Minutes	1	unsigned integer
Remaining Dispense On Seconds	1	unsigned integer
Remaining Dispense On Tenths	1	unsigned integer
Remaining Dispense Off Days	2	unsigned integer
Remaining Dispense Off Hours	1	unsigned integer
Remaining Dispense Off Minutes	1	unsigned integer
Remaining Dispense Off Seconds	1	unsigned integer
Remaining Dispense Off Tenths	1	unsigned integer

Profibus Data (Cont.)

NOTE: Converting multi-byte data correctly will depend on the byte order configuration of the master. The 4-byte decimal floating-point values are represented in IEEE-754 floating point format. Pump Status, a 4-byte unsigned integer as shown in **Table 1** (previous page), indicates the pump's operation in separate bits. See **Table 2** below for the description of each bit in Pump Status.

Table 2

Pump Status	
Status OK	bit 0
Pump Running	bit 1
Dispense On	bit 2
Tube Uncalibrated	bit 3
Head Open	bit 4
Profibus Control	bit 5
Flow Direction CCW	bit 6
Remote Control	bit 7

Table 3 below lists the 28 bytes of cyclic output data, from master to pump.

Cyclic Input (pump → master, 28 bytes)		
Data	Size in Bytes	Data Type
Pump Control	4	unsigned integer
Set Dispense Mode	1	unsigned integer
Set Tube Size	1	unsigned integer
Set Flow Units	1	unsigned integer
Padding (not used)	1	unsigned integer
Set Flow Rate	4	decimal floating-point
Set Dispense Volume	4	decimal floating-point
Set Dispense On Seconds	4	decimal floating-point
Set Dispense Off Seconds	4	decimal floating-point
Set Total Batch Count	4	unsigned integer

Pump Control, a 4-byte unsigned integer as shown in **Table 3** above, controls the pump's operation in separate bits. See **Table 4** (below) for the description of each bit in Pump Control.

Table 4

Pump Control	
Run (1) Pause (0)	bit 0
Stop and Reset Dispense (1 to 0)	bit 1
Toggle Remote/Local Control (1 to 0)	bit 2
Clear Cumulative Volume (1 to 0)	bit 3
Set Flow Direction CCW (1=CCW, 0=CW)	bit 6

A transition on bit 2 of Pump Control will toggle between Local and Remote control of the pump-drive. For example, if the pump-drive is in Local mode, then a 1-to-0 transition will put the pump-drive into PROFIBUS Remote Control mode; only in this mode can any change in the cyclic output data influence the pump-drive and be reflected in the cyclic input data.

By setting Dispense mode, the operating mode can be one of the following:

- Continuous
- Time Dispense
- Volume Dispense

Set Tube Size and Set Flow Units are integer numbers, beginning with 1. Entered numbers corresponding to the pump-drive's Local menu list on the touchscreen interface. For example, if tube size is listed as "13" on the Local menu list, then "13" corresponds to a value "1" for tube size output value flow units in "gal/hr." The Local menu list then corresponds to a value of "9" for the Flow Units output value.

- Set Flow Rate is a decimal floating-point number. This value must be between the minimum flow rate and maximum flow rate values from the input data.
- Set Dispense Volume is the amount of volume that is dispensed in Volume Dispense mode.
- Set Dispense On Seconds is the amount of pump dispense time in Time Dispense mode.
- Set Dispense Off Seconds is used for both Time and Volume dispense modes, setting the amount of time the pump will pause between dispenses.

Serial Communications

Serial Communications Mode

Masterflex Touchscreen Serial Control, RS-232 V2.20.0 or Later

SerialComms Models

- Masterflex Ismatec® Reglo touchscreen pump systems.
- Masterflex MasterSense Pump Drives (MasterSense L/S®, I/P®, and B/T®).

Requirements

RS232 Serial communication is available via virtual com port utilizing the USB port on the back panel of the pump-drive. An adapter cable is required for communication (see Figure 1 below).

- If a host PC operating on Windows, Mac, or Linux is used to control the pump through serial communication, the Masterflex **MFLX78006-90** serial cable is needed (see Figure 1 below).
- If a microcontroller or PLC-based system that accepts UART TTL 3.3V signal is used to control the pump, the Masterflex **MFLX78006-91** serial cable is needed (see Figure 2 next page). Alternatively, a FTDI USB to UART TTL 3.3V cable can also be used; three wires—TXD, RXD, and GND—are needed.

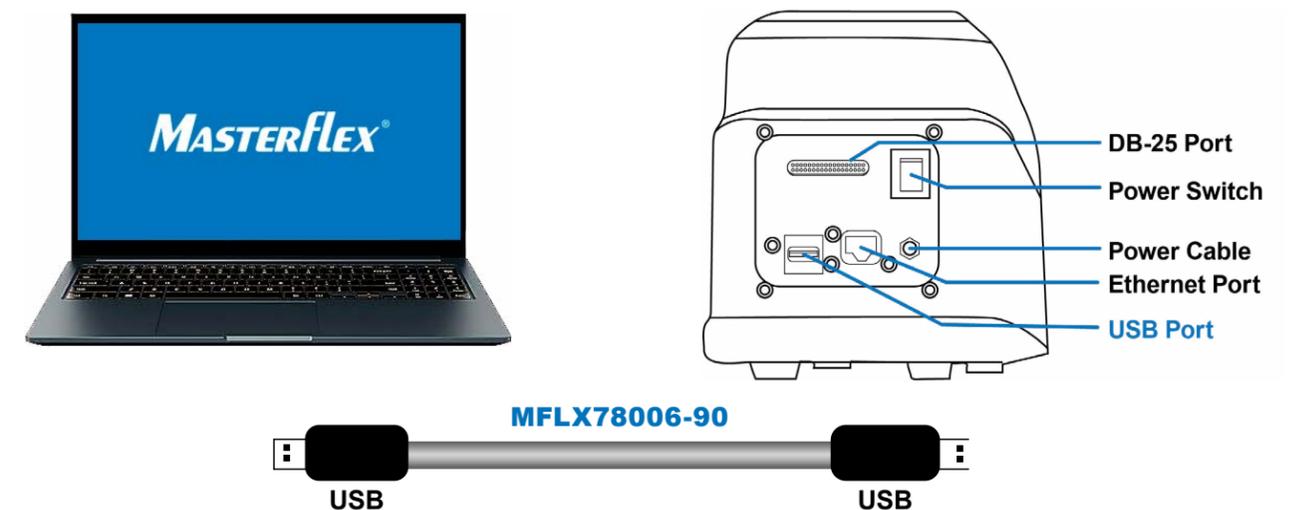


Figure 1. Adapter cable for PC Host interface for Pump Serial Communication control.

PC Host Interface

NOTE: The appearance of the drive back panels may vary from the illustration above. Nonetheless, the USB port is a common feature on all drives.

When a Windows PC is connected to the cable, a virtual **COMx** port is automatically assigned. The value of **X** will vary depending on the number of USB devices currently connected to the PC. For Mac or Linux systems connected to the cable, the corresponding port designation should be **/dev/ttyUSBx**, where the **'X'** value is determined by the number of connected USB devices.

Serial Communications Mode (Cont.)

Microcontroller or Process Controller (PLC, DCS) Interface

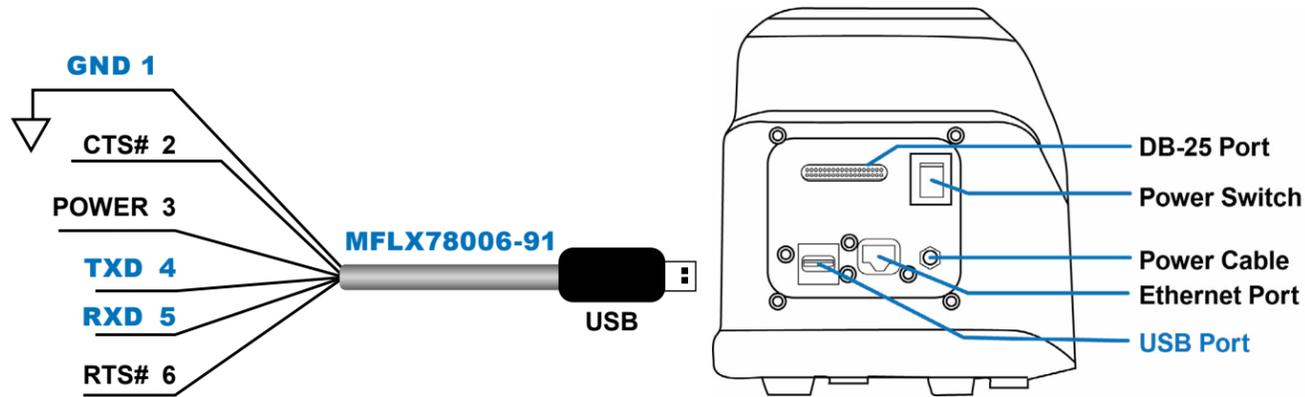


Figure 2: Microcontroller or PLC Host Interface for Pump Serial Control.

On the pump side, a USB connector is used. On the microcontroller or process controller side, only three out of six wires are needed; GND, TXD, and RXD. The CTS, RTS, and Power wires (see Figure 2 above) are not used.

To use this option, you will need to develop your own software tailored to your specific platform and programming language requirements.

Serial Communication Settings

- Baud Rate: 115200
- Bits: 8 bits
- Stopbits: 1
- Parity: no parity

Software Prerequisites

To effectively utilize this software requires a terminal program capable of transmitting and receiving serial commands. There are several options available depending on your operating system: for Windows users, popular programs like PuTTY or TeraTerm can be used. If you are using Linux® or iOS®, you can opt for terminal programs like Minicom®, iTerm®, or the built-in terminals. Alternatively, Masterflex offers an open-source Python® terminal program called masterflex-serial on GitHub®, freely available, it can serve as a valuable starting point for your project. Visit <https://github.com/masterflexbp/masterflex-serial>

Serial Communications Mode (Cont.)

Setting the Pump Address

Each command string begins with the pump address (1-8). It is factory-set to 1 and can be changed with the @ command.

Structure of the Commands

The address is followed by a character. Some commands have an additional parameter which always consists of 4 or 5 figures.

- **Command strings** are completed by a carriage return (ASCII 13) **13**. The pump confirms most of the commands with an asterisk (*). Yes/No inquiries are answered by + (yes) or - (no).
- **Multi-digit replies** are concluded by (CR) ASCII 13 and (LF) ASCII 10 **13 10**.
- **Incorrect command strings** are answered by #.
- **Numerical values** are confirmed as 3 to 5-digit figures. Four of the five digits are numerals, one digit is either a decimal point or a preceding blank space.

Once serial control is enabled by sending the command 1RE1 **13** (see reference on the next page), the “Input SerialComms” banner will appear at the top of the touchscreen display (see Figure 3 below).

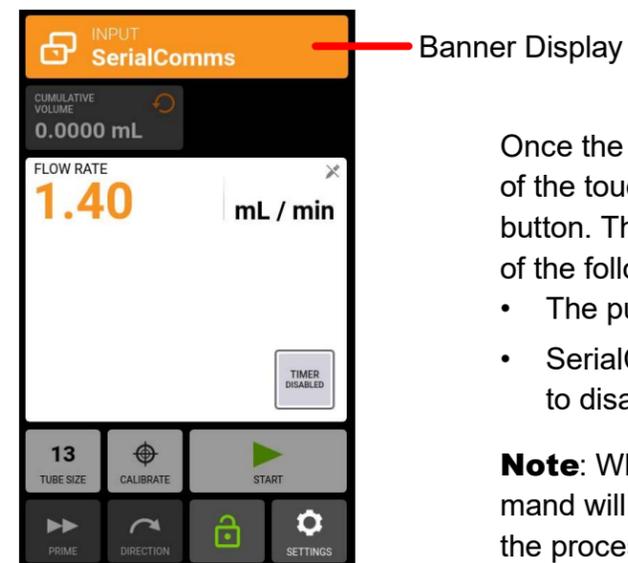


Figure 2: SerialComms Banner

Once the pump is in Serial Communication mode, most of the touchscreen is disabled except for the Start/Stop button. The pump will stay in SerialComms mode until one of the following events happens:

- The pump reboots.
- SerialComms client sends the command 1RE0 **13** to disable Serial Communication mode.

Note: When switching on the pump-drive the serial command will only respond after the system has fully loaded; the process may take several minutes.

Serial Communications Mode (Cont.)

Serial Interface Command Set, Software Release v2.20.0 and Later

General Information	Example	Response	Note
Each command string must begin with the pump address from 1 to 8, (factory set to 1) except for the set address command @.	1XXXX	⓫	
Aside from set address command, two types of supported commands are get and set . <ul style="list-style-type: none"> • get command will query for the current pump's parameters. • set command will set the pump to a certain operating condition. Each command string sent from the client side must be completed with the character ASCII (13, carriage return).	@ 3	⓫	*
<ul style="list-style-type: none"> • The response from the pump will be: <ul style="list-style-type: none"> ▪ * for valid set command. ▪ # for invalid set command. • ~ for valid command but not in serial mode • {value} + ⓫ ⓩ for get command. 			

NOTE: See page 24 for Serial Communications Commands details.

Serial Communications Mode (Cont.)



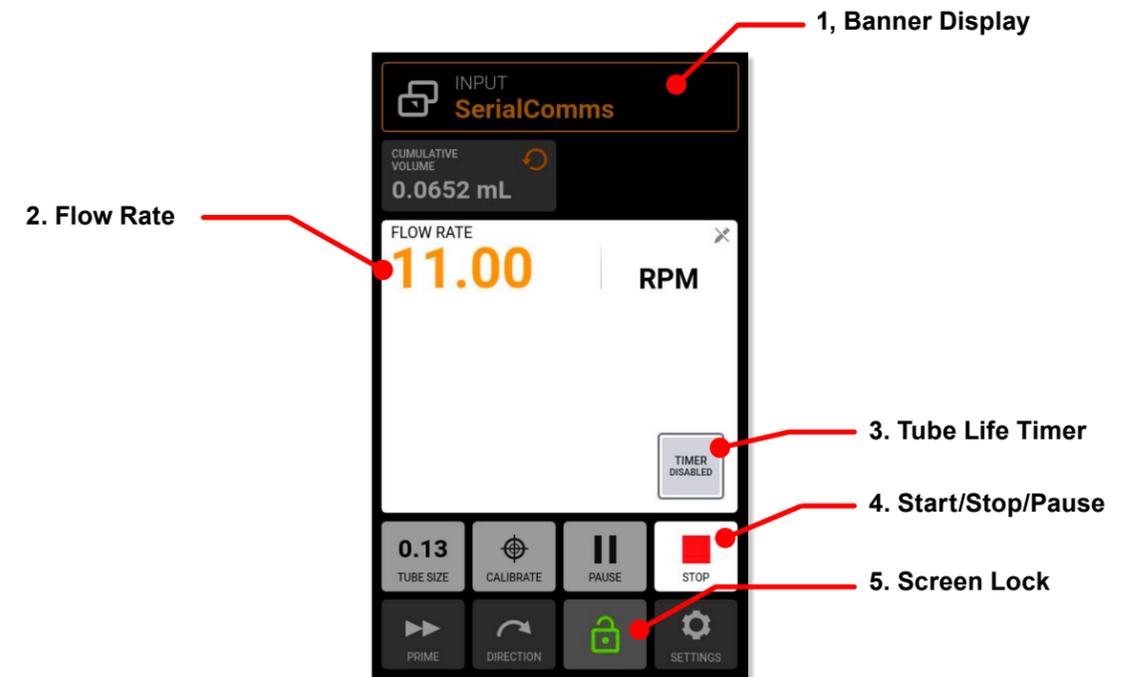
SerialComm Run Screen

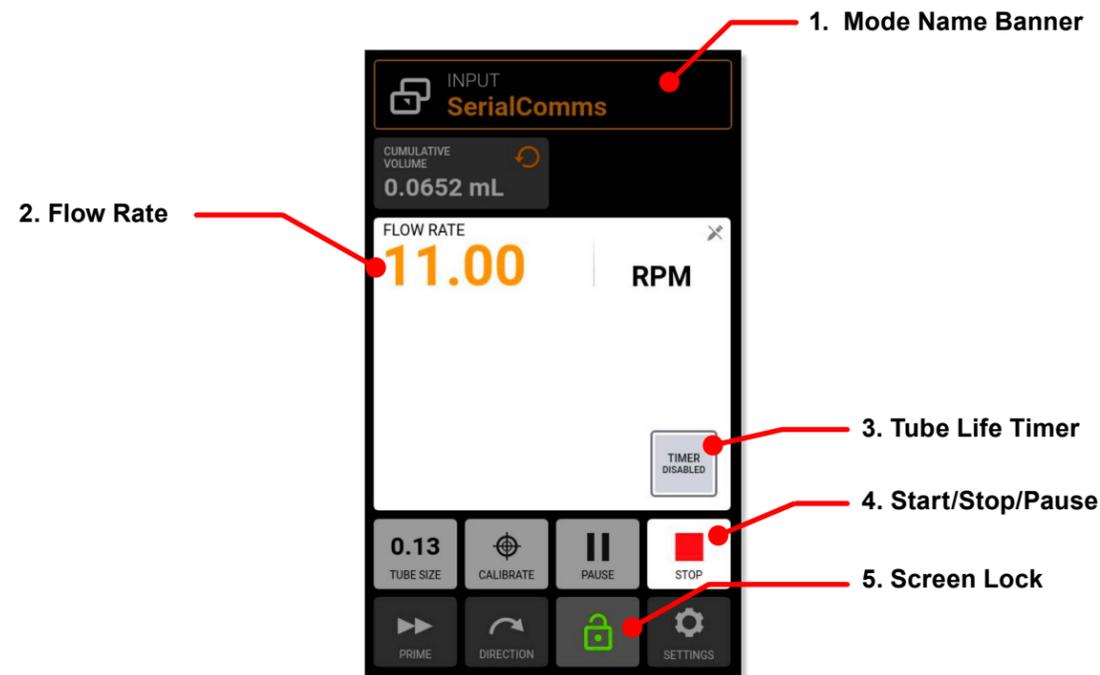
In Serial Communications Mode the pump can be operated in Continuous Mode. Masterflex Ismatec IPC pumps-drives are equipped with a USB-A port and a 9-pin RS232 DB-9 port for real-time control through serial commands using a computer (see above).

NOTE: A Masterflex MFLX78006-90 serial cable is required if using USB-A.

On the touchscreen the SerialComms Run screen displays during serial communications input operation (see below), as well as displays the currently selected settings from an external remote control device.

NOTE: Not all touchscreen options are available during Remote Mode operation.





1. **Mode Name Banner.** Displays currently selected input type.
2. **Flow Rate.** Displays current flow rate in an operator-selected unit of measurement.
3. **Tube Life Timer.** If enabled, Tube Life Timer displays a countdown timer that tracks operational life of the pump tubes. Tap to access the Tube Life Timer screen.
4. **Start/Stop/Pause.** During operation, the display will change from START to STOP.
5. **Screen Lock.** Locking the screen disables all touchscreen functions. To lock the screen: tap UNLOCKED—the icon changes to LOCKED. To unlock the screen tap LOCKED and then tap CONFIRM (not shown)—the icon changes to UNLOCKED.

Serial Communication Setup

General Preparation

- Download and install a suitable terminal application, such as PuTTY, onto the system controlling computer.
- Verify the pump-drive and computer are connected through either the USB port using a USB-A-to-USB-A serial cable. Or, for PC models, connected through the exclusive 9-pin DB-9 port using an RS232 DB-9 modem cable.
- Verify the computer is configured to send ASCII serial messages at a 115200 baud rate.

Setting the Pump-Drive Address

Each command string must begin with the pump-drive address (1-8). It is factory-set at 1 and can be changed using the address change command @ (see upcoming Serial Interface Command Table). The address will be stored permanently (even after the pump has been switched off). The assignment of the address enables an operator to control up to 8 pumps with one interface.

Enabling/Disabling Serial Communications Remote Mode

When not in Serial Communications Remote mode the pump will only respond to the address set (@) and Serial Remote mode enable commands (RE). To enter Serial Communications Remote Mode, the control device needs to send an enable command (see upcoming the Serial Interface Command Table upcoming page 26), this triggers the Serial Communications Mode on the SerialComms Run touchscreen display.

Serial Communications Mode (Cont.)

Serial Communications Commands

Command Structure

Example Command	1R20 ¹³
Command Structure	(Address) (Serial Command) (Command Parameter) (ASCII 13 Carriage Return)

The first character of the ASCII serial command string is the address, this is followed by the characters for the serial command (see the Serial Interface Command Table, next). Some commands have an additional parameter following the command character for setting values. The command string is completed by a carriage return (ASCII 13) ¹³ which initiates the processing of the command. The serial commands settings are at a 115200 baud rate, 8 bit, 1 stop bit, no parity.

Command acknowledgment:

- The pump confirms valid serial commands by returning an asterisk (*).
- Incorrect serial command strings will be returned with a hash mark (#).
- If the pump is not in Serial Communications mode the pump responds with tilde key (~); value + ¹³ ¹⁰ for getting command responses.

Serial Communications Mode (Cont.)

Serial Command Interface Table

Command	Function / Description	Example (NOTE: ¹³ is carriage return ASCII 13)	Response	Note
Serial Communications Setup				
@	- Set serial communications address for pump, from 1 to 8. The default serial address is 1. - Each pump must be allocated an individual address, this address is used as the first character in serial commands.	Set current address to 2: @2		
RE_	- Enable/Disable serial remote mode - Toggle serial communications remote mode, use 1 = enable and 0 = disable after the RE command	Enable: 1RE1 Disable: 1RE0		
Controlling the Pump				
H	Start Pump (Response (-) under command G, in case of error message).	1H	*	Valid
I	Stop pump dispensing.	1I ¹³	*	
J	Change pump revolution to clockwise direction.	1J ¹³	*	
K	Change pump revolution to counterclockwise direction.	1K ¹³	*	
RC	- Display current pump status. - Returns three integers (0,0,0); pump serial address, running status 1 = dispensing and 0 = not dispensing, pump direction 1 = counterclockwise and 0 = clockwise.	1RC ¹³	1, 0, 1 ¹³ ¹⁰	
Inquiring and Setting Parameters				
S	Get speed in % of max rotation speed.	1S ¹³	53.2 ¹³ ¹⁰	
S____(.)	- Set speed in % of max rotation speed. - To set a pump speed in percent, enter S followed by 5 digits that represent the percent to one decimal point, for example, 00500 is 50.0%.	1S00500 ¹³	*	XX.X%
R____(.)	- Set pump speed in RPM. - To set a pump speed RPM within the pump range, enter R followed by 3 or more digits that represent the RPM with two decimal points, for example, 10000 is 100.00.	1R030050 ¹³	*	Divide by 100 to get the 2 digit decimal => 300.50
R	Display pump speed in RPM.	1R ¹³	4000.12 ¹³ ¹⁰	

Continued

Serial Communications Mode (Cont.)

Serial Command Interface Table (Cont.)

RA	- Set flow unit index table 00-32. - To set a flow rate unit index add the two digit index after the RA command. To display the current index just enter RA. - See Flow Units Index Correlation Table below.	1RA00 ¹³	*	
RA	Display flow unit return unit index from 00 to 32.	1RA ¹³	01 ¹³ ¹⁰	
RB	Display current cumulative volume in revolutions.	1RB ¹³	4.983 rev ¹³ ¹⁰	
:	Display current cumulative volume.	1: ¹³	4.983 ml ¹³ ¹⁰	
W	Reset cumulative volume.	1W ¹³	*	

Flow Units Index Correlation Table

Masterflex MasterSense Flow Units							
Index	IP650	L/S100	L/S600	L/S250	B/T321	Gear6000	PistonQ1800
1	mL/min	mL/min	mL/min	mL/min	mL/min	mL/min	mL/min
2	mL/hr	mL/hr	mL/hr	mL/hr	L/min	mL/hr	mL/hr
3	L/min	L/min	L/min	L/min	L/min	L/min	L/min
4	L/hr	L/hr	L/hr	L/hr	L/hr	L/hr	L/hr
5	L/day	L/day	L/day	L/day	L/day	L/day	L/day
6	gal/min	µL/min	µL/min	µL/min	gal/min	µL/min	µL/min
7	gal/hr	µL/hr	µL/hr	µL/hr	gal/hr	µL/hr	µL/hr
8	gal/day	gal/min	gal/min	gal/min	gal/day	gal/min	gal/min
9	oz/min	gal/hr	gal/hr	gal/hr	cu m/hr	gal/hr	gal/hr
10	oz/hr	gal/hr	gal/day	gal/day	RPM	gal/day	gal/day
11	cu m/hr	oz/min	oz/min	oz/min	%	oz/min	oz/min
12	RPM	oz/hr	oz/hr	oz/hr		oz/hr	oz/hr
13	%	cu m/hr	cu m/hr	cu m/hr		cu m/hr	cu m/hr
14		RPM	RPM	RPM		RPM	RPM
15		%	%	%		%	%

Continued of next page

Flow Units Index Correlation Table (Cont.)

Masterflex MasterSense Flow Units						
Index	ISM160	ISM352	ISM352	ISM4000	ISM1800	IPC
1	mL/min	mL/min	mL/min	mL/min	mL/min	mL/min
2	mL/hr	mL/hr	mL/hr	mL/hr	mL/hr	mL/hr
3	L/day	L/day	L/day	L/day	L/day	L/day
4	oz/min	oz/min	oz/min	oz/min	oz/min	oz/min
5	oz/hr	oz/hr	oz/hr	oz/hr	oz/hr	oz/hr
6	µL/min	µL/min	µL/min	µL/min	µL/min	µL/min
7	µL/hr	µL/hr	µL/hr	µL/hr	µL/hr	µL/hr
8	RPM	RPM	RPM	RPM	RPM	RPM
9	%	%	%	%	%	%

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