Malema Inline Ultrasonic Flow meter

M-1500 PLUS

(Covered by U.S. Patent nos. 6055868 & 5974897)

Operating Instructions
and
Quick-Start Guide

(INTERIM)

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Introduction

The M-1500 PLUS consists of an inline flow sensor and externally mounted controller unit. The flow sensor is a straight-through PFA tube that uses ultrasonic sensing technology to measure the flow rate. There are no moving parts or mechanical seals. The M-1500 Plus is an ideal choice for use in the semiconductor industry for high purity applications.

The Controller electronics receives the raw flow rate signal from the sensor and provides flow rate information in terms of analog output, pulse output, frequency output, serial data and LCD display indication. The analog output, frequency output and pulse output are user-scalable.

Operating Principal

M-1500 PLUS (M-1500P) transit-time ultrasonic flow meters measure the difference in travel time between upstream and downstream signals. It consists of two ring shape   piezo-transducers that surround the tube with a fixed longitudinal spacing. The flow meter's electronic circuitry directs signals from one transducer to another and back through an upstream and a downstream measurement cycle; sound pulses of a few cycles in length are usually transmitted each way. If the liquid inside of the flow tube is moving, the sound pulse will travel faster when it is sent in the direction of liquid flow than it will when it is sent against the liquid flow. Thus the difference in the transit times in upstream Vs downstream directions, $(T_U - T_D)$ measured over the same acoustic signal path can be used to calculate the flow through the conduit. Because the cross-sectional area of the conduit is known, the product of that area and the measured velocity will provide a measure of volumetric flow. Such calculations are performed by the DSP based controller.

Storage and Handling

Storage conditions

Store the product under packed condition in an anti-static bag. The storage place shall be free from moisture, mechanical shock and vibration. The ambient temperature shall be between 0°C and 60°C and the humidity between 5% and 80% R.H. without condensation.

Unpacking and Product Inspection

On delivery, check the product for damage. Confirm that the model code on the label matches the specification in the purchase order.

Quick Start Instructions

Preliminary Checks:
1) Verify that the power supply is between 12 Vdc and 36 Vdc. Power consumption is 3.5 watts maximum, and the current requirement depends on the supplied voltage. At 12 volts the meter draws about 300 mA, at 36 volts it is about 100 mA. Allow for an initial current of double the operating current (for about 1 second).
2) Verify that the **'Sensor cable'** connector is properly plugged (locked) into the mating connector on the Controller.
3) Verify that the 'Interface cable' connector is properly connected to the High Density D-Sub connector (Refer to Pg.7 for **'I/O Cable'** details)
4) Ensure that the Sensor and Controller serial numbers match.

Procedure:
1) Install the flow sensor where you want to measure liquid flow rates. The sensor can be installed in either a vertical or horizontal direction. The preferred orientation is vertical, with the fluid entering at the bottom. The 'flow direction' arrow on the Sensor should point in the same direction as the actual flow direction.

2) Verify that the flow tube is full of stationary liquid.

3) When the power is turned on, the instrument will cycle through a series of start-up messages on the LCD screen while it does a self check.

4) Allow about 5 minutes of warm up time, and then momentarily press the 'ZERO' switch on the front panel. The flow meter will perform a **'Zero Calibration'**.
   The **'Zero Calibration'** process takes around 20 sec to complete with a sequence of LCD messages showing the actual operation progress in terms of % of task completed.
   The flow meter is now ready for making valid measurements.
   Attention: To read valid flow rates,' ZERO calibration' needs to be done whenever the fluid properties are different or the installation set-up is different than the one used for the previous 'ZERO Calibration'. Differences include concentration, temperature, and chemistry.
5) The flow meter gives a digital data output over a serial communication link. Any standard terminal program (e.g. Windows HyperTerminal Program) can be used to set up the serial communication with the flow meter.

   The Serial communication properties to be set-up for the Host Computer are as follows:
   Baud rate - 57600
   Data bits - 8
   Stop Bit - 1
   Parity - None
   Flow control – None

Specifications

Performance Specification

Flow Range*	4.0 to 600 mL/min
Accuracy**	± 2% of the reading for flow rates over 100 mL/min
	± 2 mL/min for flow rates under 100 mL/min

* Please contact the factory for special flow ranges
** Special calibration is available upon request

Functional Specification

Analog Output	Current	Isolated 4 - 20mA current output (Maximum load resistance of 500 Ω) (Under and over range capability 0 to 24mA)
	Voltage	Factory option: 0 to 6 V or 0 to 12 V
Pulse/Frequency Output		Isolated Open Collector (30 VDC, 10mA)
		Frequency of 1 KHz or 10KHz at 100% of full scale
Alarm Output		Configurable NO/NC, High/Low, Hysteresis
RS-232 Output		Many configurable options
Low Flow Cut-off		User settable
Power Supply		12 - 36 VDC
Power Consumption		3.5 W continuous (600 mA max on start-up)
Ambient Temperature		32 - 115 °F (0 - 46 °C)
Fluid Temperature		50 - 140 °F (10 - 60 °C)

Sensor Materials Specification

Cable Material	PTFE jacketed cabling
Cable Length	2 meters (standard)
Non-wetted Parts	FEP, Peek, PP, PTFE, PVDF, Viton A
Wetted Parts	High Purity PFA

Specifications (Continued)
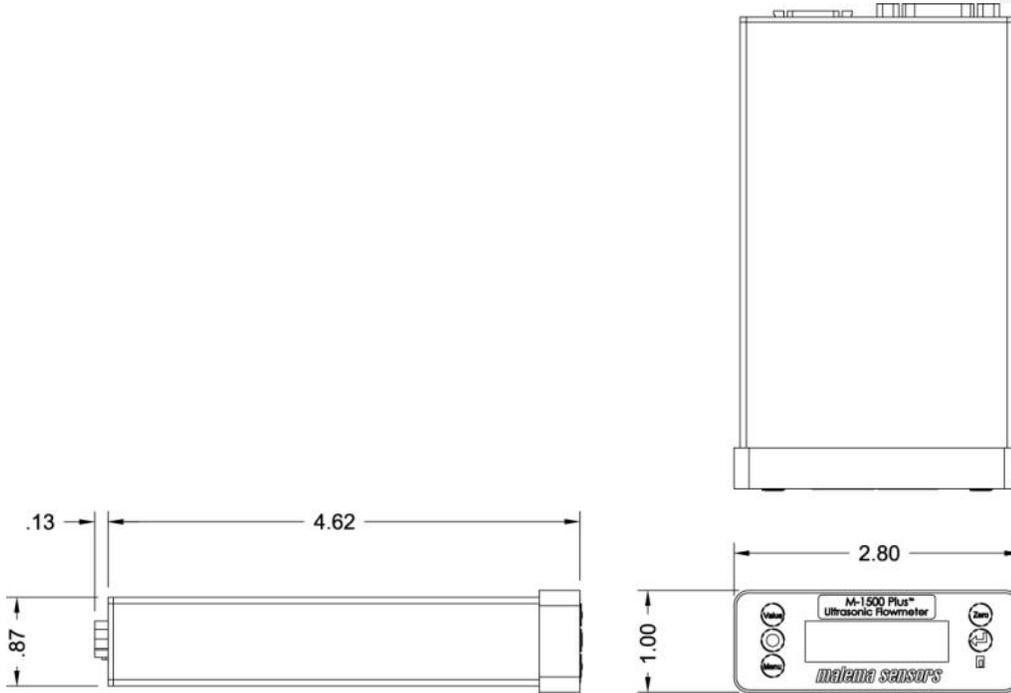
Controller Materials Specification

Enclosure Classification	IP20 (indoor use)
Mass	156 g (5.5 oz)
Materials	Anodized Aluminum, Plastic

# Dimensional Drawings

Sensor Dimension
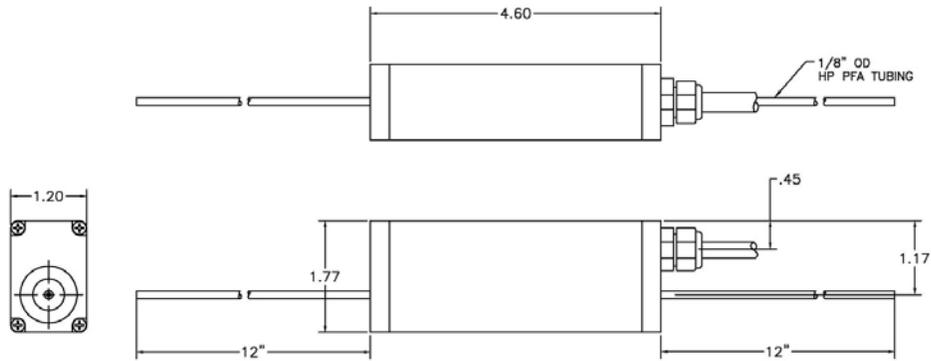
Controller Dimension

I/O Cable Details

M-1500P I/O CABLE HARNESS DETAILS

15 pin D-Sub	Description	Wire Color	Remarks
5	24Vdc (+)	Red	Power
10	Power Return (-)	Black	
1	Analog O/P (+)	Clear	Analog Output
6	Return (-)	Black	
3	Opto 1 (+)	Orange	
8	Opto 1 (-)	White	
4	Opto 0 (+)	Brown	
9	Opto 0 (-)	Yellow	Misc. I/O
2	Tot (+)	Red	
7	Tot (-)	Black	
11	Spare 1	Blue	
12	Spare 2	Green	
13	Gnd	White	
14	Rx	Red	Communication
15	Tx	Black	
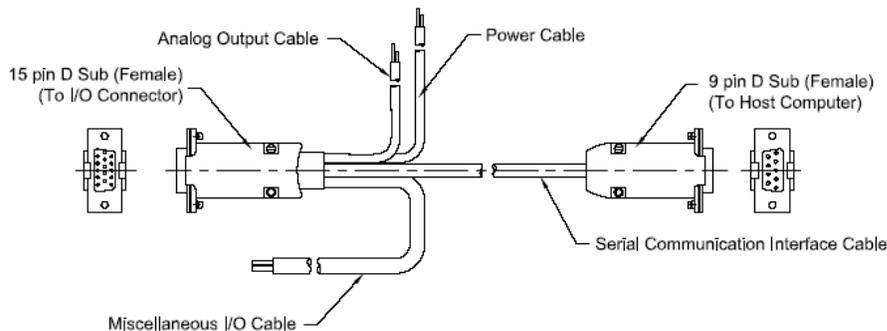
2 Core Shielded Cable: ANALOG OUTPUT (0% to 120% of Full Scale range)

Color Code	Current Loop	Voltage 6V	Voltage 12V	15 Pin D-sub
	Standard	Factory option	Factory option	
Clear	0 to 24 mA	0 to 6V (+)	0 to 12V (+)	1
Black	Analog Out Return (-)	Analog Out Return (-)	Analog Out Return (-)	6

2 Core Shielded Cable: POWER INPUT   (Range is 12V to 36V)

Color Code	Description	15 Pin D-sub
Red	24 (typ) Vdc (+)	5
Black	Power Return (-)	10

3 Core Shielded Cable : Serial Communications RS232 (Default is 57600, 8N1)

Color Code	Description	15 Pin D-sub	9 Pin D-sub
Black	Tx	15	2
Red	Rx	14	3
White	GND	13	5

I/O Cable Details (Continued)

8 Core Shielded Cable: Isolated Inputs and Outputs. All are 10 mA Max

Color Code	Description	Polarity	Direction	15 Pin D-sub
Red	Totalizer reset	+	Input	2
Black	Totalizer reset	–	Input	7
Orange	Pulse/Freq/Alarm 1	+	Output	3
White	Pulse/Freq/Alarm 1	–	Output	8
Brown	Pulse/Freq/Alarm 0	+	Output	4
Yellow	Pulse/Freq/Alarm 0	–	Output	9
Blue	Spare 1	n/a	n/a	11
Green	Spare 2	n/a	n/a	12

Note:
All the shields are connected to the 15 Pin D-sub Shell EXCEPT for ANALOG
OUTPUT cable

Console Interface Details

The main way to change the operational parameters of the M1500P flow meter is through the console interface. To use the console interface of the M1500P, you must set up the terminal emulation program with the correct serial port number, baud rate and protocol.

The default serial protocol is:
- 57600 Baud
- 1 start bit
- 8 Data bits
- 1 stop bit
- No parity

This is commonly written as "57600, 8N1".

Use the RS232 cable supplied with unit to connect to an RS232 PC port. If your computer has serial ports available, then M1500P can be connected directly.

Signal Name	M1500P pin on back of controller (15 pin)	M1500P pin on standard interface cable (9 pin)	Computer with 9 pin serial port	Computer with 25 pin serial port
TX	15 (TX)	2 (TX)	2 (RX)	2 (RX)
RX	14 (RX)	3 (RX)	3 (TX)	3 (TX)
GND	13 (GND)	5 (GND)	5 (GND)	7 (GND)

Note:
For computers without serial ports (or not enough ports), a common solution is to use a USB to serial port converter, and connect it to an available USB port.

The terminal emulation program

To communicate with the M1500P via the serial port (built in or USB) you need to run a terminal emulation program. Windows comes with such a program, named HyperTerm. In our experience, it is barely adequate. Three alternatives are suggested:
- TeraTerm which is free, and is available at

  - http://hp.vector.co.jp/authors/VA002416/teraterm.html
  - http://www.ayera.com/teraterm/
  - http://www.tucows.com/preview/195282

- CRT or SecureCRT from Van Dyke Software. A 30 day evaluation is available and it is not particularly expensive.

  - http://www.vandyke.com/products/crt/index.html

- Putty.exe which is free, and has no installation process.

  - http://www.chiark.greenend.org.uk/~sgtatham/putty

Console Interface Details (Continued)

Entering console mode:

If the serial port is connected to the M1500P, and the terminal emulation program is running and correctly configured, when the M1500P is turned on, a startup message and copyright notice should be seen.
If the M1500P is already running, typing the letter **"C"** (for console mode) should place the M1500P in to console mode, and a prompt of **"M1500P>"** should be seen.
Note:
   1) The Display will show 'No measurements'
                              'Serial control'
   2) The analog output will hold the last measurement value just before the user entered console mode.

Do not proceed with the rest of this section until the **"M1500P>"** has been seen.

The console interface provides access to **parameters** and **commands.**

Parameters have a current value, a saved value, and a default value (the factory default). If you just wanted to see the current value of the parameter, then just type the "enter" key to return to the "M1500P>" prompt. For many parameters, you can find out more about the parameter by typing a "?", which will inform you of the allowable values for the parameter.
If you want to change the value of the parameter, type a "=" followed by the new value for the parameter. When you have finished typing the new value, type the "enter" key (↵). The M1500P will respond by redisplaying the parameter name, and the updated value. Here is a complete example, with the characters typed by the user in bold.

            M1500P>**II**R [0.900] **= 0.993**↵
                        IIR[0.993]

Related item parameters are collections of related selections that make up a single parameter. These types of parameters are displayed as [----------------] (no items selected) or [ABCDEFGHIJKLMNOP] (all items selected), or any combination of '-' and letters to indicate which items are selected (each letter represents a different item). When this type of parameter is changed, all the selections must be typed, even if you are only adding or removing 1 item.

Commands instruct the M1500P to do something immediately, such as display the current list of parameter values, or save the current settings, or place the M1500P into a diagnostic mode. If a command requires any extra information, the values are separated from the command by commas ",". Some commands allow for the extra information to be optional.

Console Interface Details (Continued)

Remember:

1) Parameter and Command names may be entered in either lower or UPPER case. They will always display in upper case.
2) Each command sent to the Flow meter must be terminated by a carriage return (CR = 0x0d).
3) After modifying the new operating parameter value, initiate the SAVE command to permanently store this new value. If the SAVE command is not initiated, the change to the operating parameter will be lost when the flow meter is turned OFF.
4) For most commands and parameters, the M1500P comes with an "Auto complete" feature which keeps track of the name as you type it, and if you have typed sufficient characters to uniquely identify the command or parameter name, it will automatically finish typing the name for you.
5) For many parameters, you can find out more about the parameter by typing a "?", which will inform you of the allowable values for the parameter.

Command and Parameter Set Summary

Name	Type	Description
SAVE	Command	Saves parameter changes to flash memory.
RESTOR	Command	Restores all the parameters to their last saved value
DEFAUL	Command	the factory default settings for all user settable parameters
PDUMP	Command	Lists all current parameters with their values
QUIT	Command	Exits console mode
FR100	Parameter	Sets the Full scale rate of the analog output
LFCUT	Parameter	Sets a flow rate in CCM below which the units analog output and displays reads zero flow
KCOEF	Parameter	Sets the calibration constant of the Flow meter
IIR	Parameter	Sets the flow rate response time of the Flow meter
IVMODE	Parameter	Sets analog output range
OUT0	Parameter	Sets contact type of Alarm0 (Opto 0)
OUT1	Parameter	Sets contact type of Alarm1 (Opto 1)
ALARM0	Parameter	Sets Alarm0 output if OUT0 was selected as Alarm
ALARM1	Parameter	Sets Alarm1 output if OUT1 was selected as Alarm
PULSE	Parameter	Sets Opto 0 and Opto 1 output type

Note:
Press 'C' or 'c' to enter the console mode.

Command and Parameter Description

SAVE

This command saves all current parameter to internal Flash memory. The saved parameters are used when power is turned on.
Note:
If the user exits the console mode by executing the QUIT command and does not execute the SAVE command, any parameter changes since the last SAVE command will be lost when power is turned off. M1500P will start up with the last saved parameters from the Flash.

Example:

To execute SAVE command,

```
M1500P> SAVE<CR>
SAVING to FLASH
M1500P>
```

RESTOR

This command discards all parameter changes that have been made but not yet saved, and RESTORES all the parameters to their last saved value.

Example:

To restore parameters to their last saved value.

```
M1500P> RESTOR<CR>
Parameters restored from Flash
M1500P>
```

DEFAUL

This command restores the factory default settings for all user settable parameters. Any parameter values that have been changed/saved by a user will be restored to factory default values.

Example:

To restore the factory default parameters.

Note:
Please consult factory before executing this command.

Warning. This command reset the KCOEF parameter that is unique to each sensor. This value was set at the factory. Before entering this command, note the current value of KCOEF, and after the default command is given, restore KCOEF to its previous value. Then enter the save command.

```
M1500P> KCOEF [0.950] <CR>

M1500P> DEFAUL<CR>

M1500P> KCOEF [1.000]

M1500P> KCOEF [1.000] = 0.950 <CR>

M1500P> SAVE<CR>
SAVING to FLASH
M1500P>
```

PDUMP

This command displays all currently saved M1500 parameters including the firmware versions and the serial numbers of the flow meter.

Example:
To display all the saved parameters

```
M1500P> PDUMP<CR>
Controller Ver   FPGA Ver  Boot Ver       Alt Ver
V2.9.01E 1/8"       13     Loader V3.3.1  Alt V2.11
Controller SN 0001100-003  Transducer SN 0001100-003
Transducer type: 1/8"

AVE      IIR     FR100   KCOEF   LFCUT   SECMT   DIREC
50       0.996   600.0   0.9200  0.0     5       0

BAUD     CONAH   CONAP   CONTO   CONAC
57600    1       1       300     1

HEADER   SERU    CURU    LCDU    PRN2 (Output columns)
25       200     50      200     [A-------------P]

IVMODE                   PRN1 (Headings)         OPTOS
4-20mA   0% to 100%      [ABCDEFGHIJKLMNOP]      SIGNAL

PPVM     PPVU    FMFSF   PULSU   PULSE
1.00     ml      1000    200     [A---E-G----L----]

S001     S007    S008    S010    S011    S013
5        100     1       8000    10      20

S015     S016    S017    S027    S019
7800     2000    20      50      [ABCDEFG---------]

Alarm Channel  Type    Setpoint   Hysteresis  Contact Type
      0        High    100%          20%         Open
      1        High    100%          20%         Open

        HWOPT             CTRLB           CTRLM
[----------------] [AB-------------] [ABC-EF----------]

Measured IV at 4 mA    Measured IV at 20 mA
      2.016                  10.050
M1500P>
```

QUIT

This command is executed to exit console mode. This command checks the current parameter values against acceptable value ranges.

If the parameters are valid, M1500P exits the console mode (parameter setup mode) and returns to the measurement mode.

If the parameters are not valid, a message is displayed identifying parameter setting problems and the M1500P remains in the console mode.

The user should identify and resolve the parameters setting errors and again execute this command so as to go back to the measurement mode.

Example:

To executes the QUIT command,

```
M1500P> QUIT <CR>
No problems with parameters
        2:48    -0.0
        2:48    -0.1
        2:48    -0.1
```

FR100

This parameter allows the measured flow rate (CCM) to be scaled to a user specified maximum value (**F**ull scale **R**ange corresponding to **100**% flow, hence FR100).
The full scale value will scale the analog output to the specified current (or voltage) range as described in the **IVMODE** parameter setting. It will also scale the frequency output.

Parameter	Minimum value	Maximum value	Default value
FR100	1	1000	100

Example:
To change the Full scale range to 200 CCM.

```
M1500P> FR100 [600.0]=
M1500P> FR100 [600.0]=200<CR>
                    FR100 [200.0]
M1500P>
```

LFCUT

This parameter sets a flow rate in ml/min below which the device displays zero flow output.

The default value '0' disables this function. Flow rates that are less than the LFCUT value will also cause the analog output (current loop) and frequency outputs to indicate a flow rate of zero.

Parameter	Minimum value	Maximum value	Default value
LFCUT	0	Full scale value	0

Example:

To set flow rates between -2 ml/min and +2 ml/min to be reported as 0 ml/min.

```
M1500P> LFCUT [0.0]=
M1500P> LFCUT [0.0]=2
                    LFCUT [2.0]
```

KCOEF (Linearizer set to default)
)

This parameter is a linear scaling factor that is sensor and fluid specific.

Parameter	Minimum value	Maximum value	Default value
KCOEF	0.1000	10.0000	1.0000

Note:
To set this coefficient, the user needs to have an external reference method of
checking the actual flow rate such as weight scale (or graduated cylinder) and stop
watch.
The procedure to find KCOEF is as follows:

1.   Set KCOEF to 1.0
2.   Measure the actual flow rate with a steady flow rate using the external
      reference methods mentioned above.
3.   Divide the reference measurement value by the measurement value from the
      M1500P.
4.   Enter the result of the division as the new value of KCOEF.
5.   Repeat step #2 to confirm that the meter now reads correctly.

Example:
Set KCOEF to 1.0
Make a flow measurement. For example, the reference system shows 70 ml/min and
the meter shows 65 ml/min.
Calculate the scaling correction coefficient as follows: [70/65=1.077]

```
M1500P> KCOEF [1.0000]=
M1500P> KCOEF [1.0000]=1.077<CR>
                        KCOEF [1.077]
```

IIR

This parameter is used to change the flow response time.

Parameter	Minimum value	Maximum value	Default value
IIR	0.000	1.000	0.995

Response time values (in seconds) to a step change in the flow rate for typical IIR setting values are as follows.

IIR value	Time (Seconds) to reach 90% of changed flow rate	Time (Seconds) to reach 99% of changed flow rate
0.60	0.004	0.008
0.70	0.006	0.012
0.80	0.010	0.020
0.90	0.021	0.043
0.91	0.024	0.048
0.92	0.027	0.055
0.93	0.031	0.063
0.94	0.07	0.074
0.95	0.044	0.089
0.96	0.056	0.112
0.97	0.075	0.151
0.98	0.113	0.227
0.99	0.229	0.458

Example:
To set the IIR value to 0.9

```
M1500P> IIR [0.995]=
M1500P> IIR [0.995]=0.9<CR>
                    IIR [0.900]
M>1500P
```

IVMODE (For 'Current range' selection only)

This parameter is used to setup the 'Current range' of the isolated analog output as per the table options below.

The analog output is current source type.

Parameter	Option	Representing full scale flow rate	Default option
IVMODE	4 mA to 20 mA (A)	0% to 100%	A
	4 mA to 24 mA (B)	0% to 125% 20 mA is 100%	
	0 mA to 24 mA (C)	-25% to 125% 4mA is 0% 20 mA is 100%	
	0 mA to 24 mA (D)	0% to 120% 20ma = 100% 24ma = 120%	

Note:

For **'Voltage range'** selection -The user can externally connect an appropriate precision resistor across the analog output terminals to convert it to a voltage output depending on the required voltage output range. The maximum allowable load resistor is 500 Ohms.

e.g.

If the IVMODE is set to 4 to 20mA range and the user wants a 2-10Vdc voltage, connect a 500 Ohm precision resistor across the analog output terminal.

A 1% 499 Ohm resistor can be used as the error (compared to using a 500 Ohm resistor) is 0.2% which is less than the intrinsic accuracy of the meter.

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IVMODE (continued)

Example:

To change the Analog output range from 4-20mA (0 to 100%) to 0-24mA (0% to 120%)

M1500P> **IVMODE** [4-20mA   0% to 100%]=

Analog output.

Factory configured for Current Loop.

Available current loop options are

A) 4 to 20 mA   0% to 100% flow rate

B) 4 to 24 mA   0% to 125% flow rate, 20 mA is 100%

C) 0 to 24 mA -25% to 125% flow rate, 4mA is 0%,20 mA is 100%

D) 0 to 24 mA   0% to 120% flow rate, 20ma = 100%,24ma = 120%

M1500P> IVMODE [4-20mA   0% to 100%]=**D<CR>**

Analog output.

Factory configured for Current Loop.

Available current loop options are

A) 4 to 20 mA   0% to 100% flow rate

B) 4 to 24 mA   0% to 125% flow rate, 20 mA is 100%

C) 0 to 24 mA -25% to 125% flow rate, 4mA is 0%,20 mA is 100%

D) 0 to 24 mA   0% to 120% flow rate, 20ma = 100%,24ma = 120%

OUT0, OUT1

When **OPTO 0** or **OPTO 1** outputs are configured as 'ALARM' outputs, the OUT0 or OUT1 parameters select between NORMALLY OPEN and NORMALLY CLOSED contacts.

The Letter **'O'** is used for normally Open and the letter **'C'** for normally Closed.

Parameter	Minimum value	Maximum value	Default value
OUT0	O	C	O
OUT1	O	C	O

Note:
1) Refer to the **ALARM0** and **ALARM1** parameters for more configuration options for OPTO 0 and OPTO 1
2) The **OPTO 0** and **OPTO 1** outputs are 'Open collector' type outputs.
3) Refer to the **Appendix** A for the details on 'Open collector' output interfacing.
4) The **OUT0, OUT1** parameter settings have no effect when the output channels are configured as 'PULSE' output or 'FREQUENCY' output.

Example:
To SET OPTO 0 output contact to 'Normally Closed',

```
M1500P> OUT0 [O]=
Letter 'O' for normally open, 'C' for normally closed
M1500P> OUT0 [O]=C<CR>
                    OUT0 [C]
M1500P>
```

ALARM0, ALARM1

The M-1500P has two configurable 'Open collector' type outputs [OPTO 0 & OPTO 1]. The outputs can be configured as FREQUENCY, PULSE, or ALARM outputs.

If configured for 'ALARM' service, then ALARM0, ALARM1, OUT0 & OUT1 are the configuration parameters for the setting up the outputs.

The alarms attributes are as follows:

1) 'Normally Open' or 'Normally Closed' contacts [Refer to OUT0 and OUT1 parameter settings]

2) 'High' flow or 'Low' flow alarms.

3) The alarm 'Set Point' is a percentage of the full scale flow rate (FR100 parameter) and self clears based upon the measured flow rate.

4) Alarm 'Hysteresis' that is a percentage of the alarm Set Point

Parameter	Configure	Option	Default option
ALARM0	Type	HIGH (H)	H
		LOW (L)	
ALARM1	Type	HIGH (H)	L
		LOW (L)	

Parameter	Configure	Minimum value	Maximum value	Default value
ALARM0	Set Point	0	100	100
ALARM1	Set Point	0	100	100

Parameter	Configure	Minimum value	Maximum value	Default value
ALARM0	Hysteresis	0	100	20
ALARM1	Hysteresis	0	100	20

Note:

As soon as the user types ALARM0 or ALARM1 followed by **<CR>**, the display guides through other Alarm configuration options.

ALARM0, ALARM1 (continued)

Example:

To set OPTO 0 output alarm as:

Contact type -NORMALLY OPEN,

Type - LOW flow alarm

Set Point - 50% of the Full scale (600 CCM)

Hysteresis - 10% of the Set Point,

This setting will make the alarm to CLOSE when the flow rate falls below 300CCM and reset (OPEN) when the flow rate rises above (300 + (10% of 300))= 330 CCM

```
M1500P> ALARM0<CR>
Settings for Alarm Channel 0 are:
Alarm type is High
Alarm setpoint is 100% of max flow rate (600.0 ml/min):   600.0 ml/min
Hysteresis is 20% of setpoint. Alarm is cleared at:  480.0 ml/min
Contact type is Normally Open
Edit setup for Alarm channel 0
High or Low flow alarm (enter H or L or Q) >L<CR>
Set Point as a percentage of FR100 (integer only or Q) >50<CR>
Hysteresis as a percentage of Set Point (integer only or Q) >10<CR>
******************************************************************

Warning: You have set up alarm channel 0, but it is not enabled
Enable it by setting the PULSE parameter C (don't select A or B)
******************************************************************

Settings for Alarm Channel 0 are:
Alarm type is Low
Alarm setpoint is 50% of max flow rate(600.0 ml/min):300.0 ml/min
Hysteresis is 10% of setpoint. Alarm is cleared at:  330.0 ml/min
Contact type is Normally Open
M1500P>
```

PULSE

This parameter configures opto-isolated outputs **OPTO 0** and **OPTO 1**.
There are various configurations options that can be selected. These configuration options are displayed for reference as soon as the user executes the PULSE command followed by a **<CR>.**
Refer to the example for details.

Parameter	Configure	Option	Default option
PULSE	OPTO 0	Pulse Per Volume (A)	A
		Frequency (B)	
		Alarm (C)	
PULSE	OPTO 1	Pulse Per Volume (D)	E
		Frequency (E)	
		Alarm (F)	
PULSE	Pulse width	1ms (G)	G
		50ms (H)	
		100ms (None)	
PULSE	Pulse Duty Cycle	Pulse duty cycle 12.5% (I)	L
		Pulse duty cycle 25.0% (J)	
		Pulse duty cycle 37.5% (K)	
		Pulse duty cycle 50.0% (L)	
		Pulse duty cycle 62.5% (M)	
		Pulse duty cycle 75.5% (N)	
		Pulse duty cycle 87.5% (O)	

Note:

At most one of A,B, and C can be selected, at most one of D,E, and F can be selected, at most one of G and H can be selected, exactly one of I,J,K,L,M,N, and O must be selected

PULSE (continued)

Example:
To change Output 0 mode from 'Pulse Per Volume' (A option) to 'Frequency' (B option) and 'Pulse width' from 1ms (G option) to 50ms (H option) and to keep the rest of parameters same.

```
M1500P> PULSE [A---E-G----L----]=
Configure Opto-Isolated Outputs
A) Output 0 mode is Pulse Per Volume
B) Output 0 mode is Frequency
C) Output 0 mode is Alarm
D) Output 1 mode is Pulse Per Volume
E) Output 1 mode is Frequency
F) Output 1 mode is Alarm
G) Pulse width   1ms
H) Pulse width  50ms
I) Pulse duty cycle 12.5%
J) Pulse duty cycle 25.0%
K) Pulse duty cycle 37.5%
L) Pulse duty cycle 50.0%
M) Pulse duty cycle 62.5%
N) Pulse duty cycle 75.0%
O) Pulse duty cycle 87.5%
If no mode is selected for an output, it is off
If no pulse width is selected, then it is 100 ms
One of I through O must be selected
M1500P> PULSE [A---E-G----L----]=BEHL<CR>
               PULSE [-B--E--H---L----]
M1500P>
```

Troubleshooting Guide

Symptom	Action
The unit does not turn 'ON' when DC power is applied.	- Verify that the voltage at the power terminals is between 12Vdc and 36Vdc. - If the voltage is within the above range, consult factory for further investigation.
The unit displays: **'Cant Measure'** **'Empty Tube?'**	- Verify that the sensor cable is connected to the controller. - Verify that the flow tube is completely filled with fluid and the fluid is free of bubbles. - To get rid of any trapped bubbles, flush the flow tube with a high flow rate. - If the above conditions are satisfactory, consult factory for further investigation. - Verify that the 'Zero calibration' procedure was performed at least once for the specific fluid. - Verify that there are no trapped bubbles in the flow tube and the fluid itself does not have high concentration of bubbles.
The unit displays negative flow and the Analog output stays at lower limit of the output range when you are trying to flow liquid medium.	Verify that the actual Flow direction is in the same direction as the 'Arrow direction' on the unit.

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Symptom	Action
The unit displays Incorrect flow rate.	- Verify that the zero calibration was performed correctly (Refer to 'Procedure' under Quick start instruction section for details). - Verify that the fluid medium has not changed since the time the 'Zero calibration' was last done. - Verify that the physical properties of the fluid are not drastically different. If so it may require flow linearization. - Verify that the Calibration procedure (If implemented) was accurate.
The unit displays: **'Zero Cal Error 1'**	- 'Zero Calibration was done when the flow tube was either empty or with too many air bubbles. - Verify that the flow tube is full of liquid without any air bubbles and then perform 'Zero calibration' by momentarily pressing the 'Zero' button on the front panel.

Appendix A

Typical field wiring for Pulse, Frequency, or Alarm Output:

M-1500P Electronics | **External Wiring**
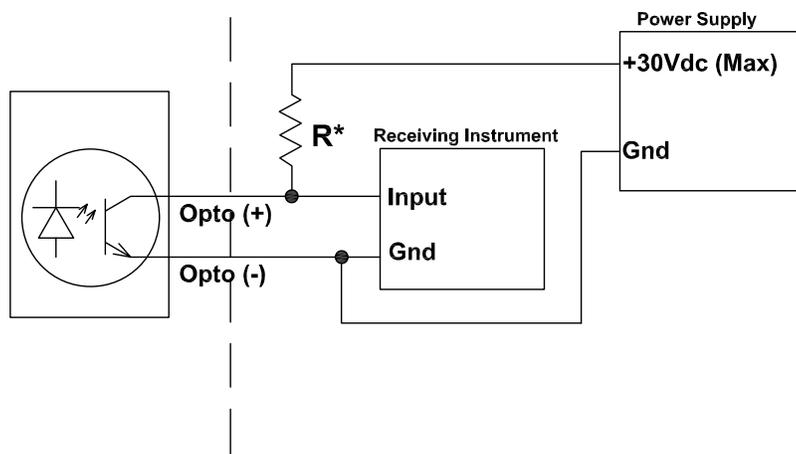
* An external series resistor (R) is recommended to limit the collector current below **10 mA**.

R can be calculated as follows:
R (K.Ohms) = Voltage applied to Opto(+) (Volts) / Max. Allowable collector current (mA)

Example:

1) If 12Vdc is applied to resistor, and 10mA is the maximum collector current
    limit, then
    R = 12/10
    R = 1.2 K ohms

2) Similarly, if 24Vdc is applied to resistor, and 10mA is the
    maximum collector current limit, then
    R = 24/10
    R = 2.4 K ohms

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WARRANTY PERIOD:
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Boca Raton,
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