SIEMENS

APPLICATION GUIDE

AG040305

Flow Application Configuration

Configuring the MultiRanger 200 to measure open channel flow

Objective: Specific parameter setting to configure the following primary measurement devices:

- exponential devices
- Palmer-Bowlus Flume
- H-Flume
- Universal Linear Flow Calculation
- Universal Curved Flow Calculation
- BS 3680/ISO 4359 Rectangular Flume
- BS 3680/ISO 1438/1 Thin Plate V-Notch Weir

Equipment: MultiRanger 200, transducer, IR Hand Held Programmer or Dolphin Plus software, and primary measurement device.

While every effort was made to verify the following information, no warranty of accuracy or usability is expressed or implied.

Overview:

This application guide is an addition to the instruction manual. Please review manual to ensure you are familiar with configuring the MultiRanger 200 using the IR Hand Held Programmer or the Dolphin Plus software tool.

Setting up the Common Parameters

These parameters are configured for all the open channel flow measuring applications supported by the MultiRanger 200.

Parameter	Parameter Index*	Value	Parameter and Value Definition **
P001	G	6	Selects Open Channel Flow measurement.
P002	G	1	Sets measured material to liquid.
P003	G	2	Sets maximum processing speed, or speed of response, to medium.
P004	G	102 (example)	Selects transducer (e.g. 102 = XPS 10) connected to MultiRanger 200.
P005	G	1 (example)	Sets units for head measurement (e.g 1 = meters).
P006	G	Empty Distance	Sets the distance from zero point of measurement (many times bottom of the weir or channel) to the sensor surface. Head is measured with reference to this zero point
P007	G	Span of Head measurement	Sets the range of head measurement. Often equal to the maximum head.
P801	G	Range Extension	Permits the liquid level to go below the zero point to the amount set here without indicating an LOE condition (pre-set is 20% of span).

* **G** means 'global.' If f you have dual channel unit then the index is either **1** or **2** . For both, select **00.**

** Here we have chosen one value. Other choices can be selected from the manual as needed.

Siemens Milltronics Process Instruments Inc.

1954 Technology Drive, P.O. Box 4225, Peterborough, ON Canada K9J 7B1
Tel: (705) 745-2431 Fax: (705) 741-0466 www.siemens-milltronics.com
Email: techpubs@siemens-milltronics.com

Selecting the Primary Measuring Device (P600)

The MultiRanger 200 supports the following primary measuring devices to calculate the flow rate based on either the Absolute method or Ratiometric method. The design standards of these devices are programmed in the MultiRanger 200, and it applies the correct standard formula to calculate the flow.

If you do not have a primary device, or your primary devices are not included in this list, selecting *Universal Linear Flow Calculation* or *Universal Curved Flow Calculation* enables the MultiRanger 200 to calculate the flow rate based on Ratiometric method.

Parameter	Parameter Index	Value
P600	G (dual channel **1** or **2**, if both enter **00**)	Choose from 0 through to 7

Select one value from the following list of primary measuring devices and methods per channel application.

Value	Description of Selected Value	Flow Calculation Method
0	Flow calculation is off and no flow rate or total flow will be calculated	None
1	Exponential devices	Ratiometric
2	Palmer-Bowlus Flume	Ratiometric
3	H-Flume	Ratiometric
4	Universal Linear Flow Calculation	Ratiometric
5	Universal Curved Flow Calculation	Ratiometric
6	BS-3680/ISO 4359 Rectangular Flume	Absolute
7	BS-3680/ISO 1438/1 Thin Plate V-notch Weir	Absolute

Configuring for the Selected Measurement Devices

The following sections present the calculations required to set the parameter values necessary to configure the applications according to the measuring device.

Section 1.0 Exponential Device (P600 = 1)

Single exponent devices supported by MultiRanger 200:

Standard Weirs	Flumes	Other
• V-notch or triangular • Rectangular or Suppressed • Trapezoidal or Cipolleti	• Parshall • Leopold Lagco • Cut Throat	• any other single exponent primary measuring device, whose exponent value is known.

Section 1.1 Exponential Device Flow Calculation Equation

MultiRanger 200 calculates flow rate (Q) based on Ratiometric calculation method using the following exponential equation:

$$Q = Q_{max}(H/H_{max})^X$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units (liters/sec. or gallons/min. etc.).
Q_{max}	Maximum flow (at maximum head H_{max}) as configured in P604. Its value is user provided, and is shown as a standalone number with no units indicated. User must know measurement units used. For example, if maximum flow is 1000 LPS then P604 = 1000 and P606 = seconds
H_{max}	Maximum Head H_{max} as configured in P603. Its value is provided by the user. Generally the same value as span configured in P007. The units are defined in P005.
x	Exponent as configured in P601. Its value is provided by the user. If the value is taken from the MultiRanger 200 manual, it should be verified by the user or with the manufacturer documentation.
H	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.

Section 1.2 Exponential Device Flow Configuration Table

Set parameters P601, P603, P604, and P606 to calculated values.

Parameter #	Description	Configuration Status
P600	Set to **1** (exponential device)	Must be configured.
P601	Enter the value of exponent **x**	Must be configured.
P603	Enter the value of $H_{max.}$	Must be configured.
P604	Enter the value of $Q_{max.}$	Must be configured.
P606	Time units	Must be configured.
P605	Zero Head Off-set	Optional, configure only when the actual zero is above channel bottom.
P607	Flow rate decimal	Optional, configured to display the flow rate (**Q**). Factory set to **2.**
P620	Low flow cut-off	Optional, set to avoid totalizing at flows below this set level.
P621	Auto zero head calibration	Optional, configure only if head displayed has constant off-set.

Section 2.0 Palmer-Bowlus Flume (P600 = 2)

Section 2.1 Palmer-Bowlus Flume Flow Calculation Equation

MultiRanger 200 calculates flow rate (Q) based on Ratiometric calculation method using the following equation;

$$Q = Q_{max} \times f(H/H_{max})/f(H_{max}/D)$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units used (liters/sec. or gallons/min. etc.).
Q_{max}	Maximum flow (at maximum head H_{max}) as configured in P604. Its value is user provided, and is shown as a standalone number with no units indicated. User must know measurement units used. For example, if maximum flow is 1000 LPS then P604 = 1000 and P606 = seconds
H_{max}	Maximum Head H_{max} as configured in P603. Its value is provided by the user. Generally the same value as span configured in P007. The units are defined in P005.
H	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.
D	Flume width as configured in P602 in the units defined in P005. This Information will be available from the user or by referring to the flume manufacturer's published discharge tables (e.g. for 30" Palmer Bowlus Flume from Plasti-Fab set P602 to **30** and P005 to **inches**).

Section 2.2 Palmer-Bowlus Flume Configuration Table

Parameter #	Description	Configuration Priority
P600	Set to **2** (Palmer-Bowlus Flume).	Must be configured.
P602	Enter the value **D**, the listed flume width.	Must be configured.
P603	Enter the value of **H_{max}**.	Must be configured.
P604	Enter the value of **Q_{max}**.	Must be configured.
P605	Zero Head Off-set. The flume is installed inside the pipe and its zero reference is above the zero reference of the pipe, where transducer monitors the head.	Must be configured.
P606	Time units	Must be configured.
P607	Flow rate decimal	Optional, configured to display the flow rate (**Q**). Factory set to **2.**
P620	Low flow cut-off	Optional, to avoid totalizing at flows below this set level.
P621	Auto zero head calibration	Optional, configured if displayed head has constant off-set.

Section 3.0: H-Flume (P600)

Section 3.1 H-Flume Flow Rate Calculation Equation

MultiRanger 200 calculates flow rate (Q) based on Ratiometric calculation method using the following equation:

$$Q = Q_{max} \times f(H/ H_{max})/f(H_{max}/ D)$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units used (liters/sec. or gallons/min. etc.).
Q_{max}	Maximum flow (at maximum head H_{max}) as configured in P604. Its value is user provided, and is shown as a standalone number with no units indicated. User must know measurement units used. For example, if maximum flow is 1000 LPS then P604 = 1000 and P606 = seconds
H_{max}	Maximum Head H_{max} as configured in P603. Its value is provided by the user. Generally the same value as span configured in P007. The units are defined in P005.
H	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.
D	Flume height as configured in P602 in the units defined in P005. This Information will be available from the user or by referring to the flume manufacturer's published discharge tables (e.g. for 1.5 ft. H-Flume set P602 to **1.5** and P005 to **feet**).

Section 3.2 H-Flume Configuration Table

Parameter #	Description	Configuration Priority
P600	Set to **3** (H-Flume device)	Must be configured.
P602	Enter the value **D**, the maximum height for the flume.	Must be configured.
P603	Enter the value of **$H_{max.}$**	Must be configured.
P604	Enter the value of **$Q_{max.}$**	Must be configured.
P605	Zero Head Off-set	Configured only when the actual zero is above channel zero.
P606	Time units.	Must be configured.
P607	Flow rate decimal	Optional, configured to display the flow rate (**Q**). Factory set to **2.**
P620	Low flow cut-off	Optional, to avoid totalizing at flows below this set level.
P621	Auto zero head calibration	Optional, configured if displayed head has constant off-set.

Section 4.0 Universal Linear Flow Calculation (P600 = 4)

The MultiRanger 200 uses polynomial function routines to generate a linear curve fitting between the discrete data points (also called break points) entered by the user. A maximum of 32 data points each for head and corresponding flow discharge in the secondary indices of P610 (Head breakpoints) and P611 (Flow breakpoints) can be defined. With maximum head value defined in P603 and corresponding maximum flow value defined in P604, a total of 33 discrete points are available to the MultiRanger 200 for flow rate calculation. Use as many data points as possible where flow variations are maximum for increased accuracy.

Section 4.1 Universal Linear Flow Calculation Equation

The MultiRanger 200 calculates flow rate (Q) based on Ratiometric calculation method using the following equation:

$$Q = Q_{max} \times f(H)/f(H_{max})$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units used (liters/sec. or gallons/min. etc.).
Q_{max}	Maximum flow (at maximum head H_{max}) as configured in P604. Its value is user provided, and is shown as a standalone number with no units indicated. User must know measurement units used. For example, if maximum flow is 1000 LPS then P604 = 1000 and P606 = seconds.
H_{max}	Maximum Head H_{max} as configured in P603. Its value is provided by the user. Generally the same value as span configured in P007. The units are defined in P005.
H	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.
f(H)	Calculated by MultiRanger 200 using polynomial function.

Section 4.2 Universal Linear Flow Calculation Configuration Table

Parameter #	Description	Configuration Priority
P600	Set to **4** (universal linear flow calculation)	Must be configured.
P603	Enter the value of **$H_{max.}$**	Must be configured.
P604	Enter the value of **$Q_{max.}$**	Must be configured.
P606	Time units	Must be configured.
P610 (Secondary Indices 1 – 32 max)	Sequentially enter from lowest head value in break point 1 (generally 0) and gradually increase up to maximum 32 head break points. The units are as set in P005.	Must be configured.
P611 (Secondary Indices 1 – 32 max)	Sequentially enter corresponding flow values for above head break points. Start from lowest flow value in break point 1 (generally 0) and gradually increase up to maximum 32 flow break points. The time units are as set in P606.	Must be configured.
P605	Zero head off-set	Optional, configure only when the actual zero is above channel zero.
P607	Flow rate decimal	Optional, configured to display the flow rate (**Q**). Factory set to **2**

Parameter #	Description	Configuration Priority
P620	Low flow cut-off	Optional, to avoid totalizing at flows below this set level
P621	Auto zero head calibration	Optional, configured if displayed head has constant off-set

Section 5.0 Universal Curved Flow Calculation (P600 = 5)

The MultiRanger calculates the flow rate using the same method as the linear flow calculations. It differs by applying a curved fitting between the discrete points.

Section 5.1 Universal Curved Flow Calculation Equation

The MultiRanger 200 calculates flow rate (Q) based on Ratiometric calculation method using the following equation:

$$Q = Q_{max} \times f(H)/f(H_{max})$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units used (liters/sec. or gallons/min. etc.).
Q_{max}	Maximum flow (at maximum head H_{max}) as configured in P604. Its value is user provided, and is shown as a standalone number with no units indicated. User must know measurement units used. For example, if maximum flow is 1000 LPS then P604 = 1000 and P606 = seconds.
H_{max}	Maximum Head H_{max} as configured in P603. Its value is provided by the user. Generally the same value as span configured in P007. The units are defined in P005.
H	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.
f(H)	Calculated by MultiRanger 200 using polynomial function

Section 5.2 Universal Curved Flow Calculation Configuration Table

Parameter #	Description	Configuration Priority
P600	Set to **5** (universal curved flow calculation)	Must be configured.
P603	Enter the value of $H_{max.}$	Must be configured.
P604	Enter the value of $Q_{max.}$	Must be configured.
P606	Time units	Must be configured.
P610 (Secondary Indices 1 – 32 max)	Enter sequentially from lowest head value in break point 1 (generally 0) and gradually increasing up to maximum 32 head break points. The units are as set in P005.	Must be configured.
P611 (Secondary Indices 1 – 32 max)	Sequentially enter corresponding flow values for above head break points starting form lowest flow value in break point 1 (generally 0) and gradually increasing up to maximum 32 flow break points. The time units are as set in P606.	Must be configured.
P605	Zero Head Off-set	Configured only when the actual zero is above channel zero

Parameter #	Description	Configuration Priority
P607	Flow rate decimal	Optional, configured to display the flow rate (**Q**). Factory set to **2**
P620	Low flow cut-off	Optional, to avoid totalizing at flows below this set level
P621	Auto zero head calibration	Optional, configured if displayed head has constant off-set

Section 6.0 BS-3680/ISO 4359 Rectangular Flume (P600 = 6)

For flowrate calculation, this method requires only the physical dimensions of the flume:

B	Approach channel width
b	Throat width
p	Hump height
L	Throat length

Section 6.1 BS-3680/ISO 4359 Rectangular Flume Flow Calculation Equation

The MultiRanger 200 calculates flow rate (Q) based on the Absolute calculation method confirming to BS 3680 Part 4C standard for Rectangular flumes and uses the following equation:

$$Q = (2/3)^{1.5} \times (g)^{0.5} \times Cv \times Cs \times Cd \times B \times (h)^{1.5}$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units used (liters/sec. or gallons/min. etc.).
g	Acceleration due to gravity
B	Throat width
h	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.
C_v	Velocity coefficient calculated by MultiRanger 200
C_s	Shape coefficient (= 1 here)
C_d	Discharge coefficient calculated by MultiRanger 200

Section 6.1 BS-3680/ISO 4359 Rectangular Flume Flow Calculation Table

	Description	Configuration Priority
P600	Set to **6** (BS 3680/ISO 4359 Rectangular Flume)	Must be configured.
P602 = (1 – 6)	Enter the values of B, b, p & L in indices 1 to 4 respectively. In indices 5 and 6 you can view calculated values of C_v and C_d respectively	Must be configured.
P605	Zero Head Off-set	Must be configured due to hump height of the flume.
P608	Flow rate units	Must be configured.
P607	Flow rate decimal is configured.	Optional, configured to display the flow rate (**Q**). Factory set to **2.**
P620	Low flow cut-off (Its optional), to avoid totalizing at flows below this set level.	Optional, to avoid totalizing at flows below this set level.
P621	Auto zero head calibration (its optional), configured if head displayed has constant off-set.	Optional, configured if displayed head has constant off-set.

Section 7.0 BS-3680/ISO 1438 Thin plate V notch (P600 = 7)

To calculate the flow rate this method requires only the angle of the weir notch (☐) in degrees.

Section 7.1 BS-3680/ISO 1438 Thin plate V Notch Flow Calculation

The MultiRanger 200 calculates flow rate (Q) based on Absolute calculation method confirming to BS 3680 Part 4A standard for thin plate weirs using the following equation:

$$Q = C_e \times (8/15) \times \tan(\square/2) \times (2g)^{0.5} \times (h)^{2.5}$$

Value Table	
Q	Flow rate calculated and displayed by MultiRanger 200. The units will not be displayed and user must know the measurement units used (liters/sec. or gallons/min. etc.).
☐	Weir notch angle in degrees
g	Acceleration due to gravity
C_e	Discharge coefficient and is a function of weir notch angle ☐.
h	Head measured by the ultrasonic head, or any other level measuring device, mounted upstream from the open channel measuring device. **IMPORTANT**: set in the same units selected in P005.

Section 7.1 BS3680/ISO 1438/1 V Notch Weir Configuration Table

Parameter number	Description to explain the value	Configuration Priority
P600	Set to 7 (BS 3680/ISO 1438/1 V Notch Weir)	Must be configured.
P602 = (1 & 2)	Enter the values of ☐ in degrees in index 1. In index 2, view the value of discharge coefficient C_e	Must be configured.
P603	Enter the value of maximum head in unit as set in P005.	Must be configured.
P605	Zero Head Off-set	Must be configured because the zero of the weir is above the channel zero.
P608	Flow rate units	Must be configured.
P607	Flow rate decimal	Optional, configured to display the flow rate (**Q**). Factory set to **2.**
P620	Low flow cut-off.	Optional, to avoid totalizing at flows below this set level.
P621	Auto zero head calibration	Optional, configured if displayed head has constant off-set.

Note: Both Primary devices BS 3680 / ISO 4359 Rectangular Flume and the BS 3680 / ISO 1438/1 Thin Plate V notch weir can also be configured for Ratiometric calculation in case the flow rate units are not supported in P608.