Flow Hunter III

Installation Manual

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ECHO Process Instrumentation, Inc.

Mail to: PO Box 800, Shalimar, FL 32579

Ship to: 70 6th Ave, Shalimar, FL 32579

Phone: 850.609.1300 Fax: 850.651.4777

Email: info@echopi.com Website**: www.echopi.com**

Contents

About this Manual

This manual provides important information about the installation, wiring, operation, and control of FLOW HUNTER III and its sensors; LXD-04. Please read this manual before installing or operating the product. In addition to operating the product, this manual is very important. Please keep it in a safe place for easy reference.

Please note that the contents of this manual are subject to change without prior notice if the product is modified, upgraded or improved.

Although we have checked all contents of this manual but there would be the possibility to remain errors. We welcome all suggestions for improvement.

Safety Guide Instruction

I. Safety Guide Instruction

1. Authorized Personnel

The installation and operation of the product must be carried out by licensed experts or qualified personnel. Please always wear protective equipment when operating the products.

2. Operation

Before operating the unit, please read this manual thoroughly. The manufacturer isn't responsible accidents caused by user's misuse or modification of the product without manufacture's permission. Conduct periodic inspection of the product.

3. Cautions

This manual provides all information you need to operate, maintain and troubleshoot the Flow Hunter III. Please follow the instructions. The manufacturer is not responsible in any way for the risk of an accident when user doesn't follow the instructions.

4. Product Inspection

When opening the product package box, look carefully to determine if the products or accessories have been damaged or contaminated. If the product has been damaged, it may not function properly.

5. Symbols

Caution:

If it is ignored, faults or malfunctions could be result.

Warning:

If it is ignored, injury to people and serious damage to the instrument could be result.

Electric Shock

If it is ignored, the product could be damaged by electric shock

Information:

It provides additional information.

Product Description
FLOW HUNTER III | LXD-04

II. PRODUCT

FLOW HUNTER III is an ultrasonic non-contacting flow meter for open channels. The measured level value is converted into the rate of flow in specific weirs or flumes, therefore the accurate level value is very important. LXD-P04 is an exclusive sensor for open channel flow and comes standard with a PVDF housing.

FLOW HUNTER III provides a variety of weirs and flume formulations so it can be used in different applications. The measured flow information is saved in the memory of FLOW HUNTER III and it can be downloaded by USB or transmitted by the digital communication such as RS232, RS485 or Modbus.

Application:

LXD-Series sensors are suitable for liquids level monitoring in all industries, particularly in the water and wastewater industry.

Weirs & Flumes

- Parshall Flume
- Suppressed Rectangular Weir
- Contracted Rectangular Weir
- V-Notch[Triangular] Weir
- Cipolletti Weir
- Leopold Lagco Flume
- Palmer Bowlus Flume
- H Flume
- Trapezoidal Flume
- DIY Table (X,Y values)

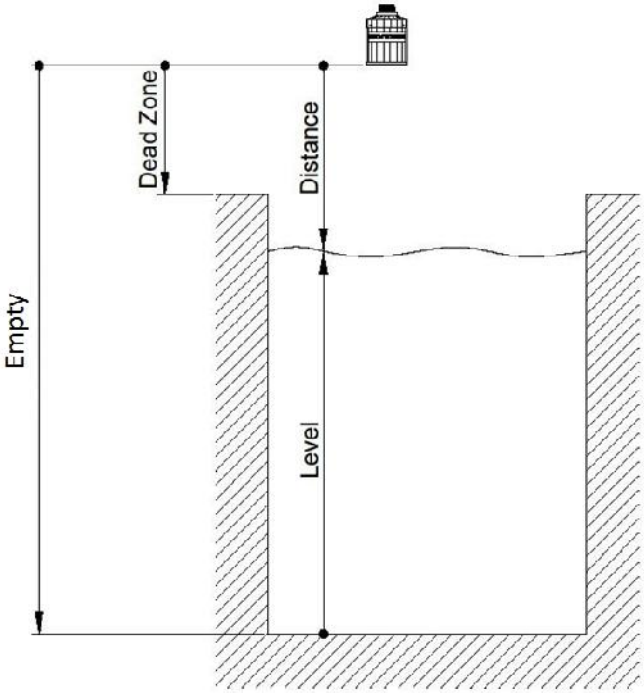
Compatible sensor is only LXD-04.

XDS-03 sensor is not compatible with the FLOW HUNTER III controller.

Depending on the sensor material, the application can be restricted. Before installing the sensor, please check the chemical compatibility chart.

1. Principle of operation

LXD Sensor transmits ultrasonic pulses to the measurement target. The pulses are reflected from the surface of the target and received back by the sensor. The running time is converted into distance and level. The measured level is then converted into flow rate according to the selected primary measurement device.



D=(C•T)/2

D: DISTANCE

C: SOUND VELOCITY

T: TIME OF FLIGHT

- Distance: from the sensor bottom to surface of the target
- Level: from the bottom of the weir or flume to the surface of the target
- Empty: from the sensor bottom to the bottom of the weir or flume

2. Specifications

FLOW HUNTER III (Controller)	
Measurement Method	Ultrasonic non-contacting
Measurement Range	0.0 – 4.0 meters (13.12 ft)
Accuracy	0.2% of F.S
Resolution	1mm
Damping Rate	0.1m/min - 100m/min adjustable
Data Logging Period	Maximum 672 days (1hr interval)
Output Analog	Two Analog 4~20mA, max 750Ω isolated
	3 Relays
	Digital RS232, RS485, Modbus is Optional
Display	Illuminated Graphic LCD
IP Rating	NEMA 4X (IP65)
Temperature	-20°C~60°C(-4°F~140°F), 80% relative humidity
Material	Polycarbonate
Dimension	6.5(W)x9.8(H)x3.7(D) inch or 166(W)×250(H)x95(D) mm
Weight	Approx. 4.4 lbs (2 kg)
Power Supply	• 100~230 **VAC**±15%, 50/60Hz, 29VA(12W)
	Fuse: 250V T1.0A; **VDC** 9~30V, Max 8W

LXD-P 04 (Sensor)	
Range	0.3~4 m (0.98- 13.12 ft)
Bean Angle	8˚at -3dB
Process Connection	1” NPT
Weight	Approx. 2.2 lbs (1.0 kg)
Material	PVDF
Temperature	-30°C~70°C (-22°F~158°F), 80% relative humidity
Temperature Compensation	Integrated by a built-in temperature sensor in LXD-P
IP Rating	NEMA 6P (IP68)
Cable	2 Core, Shielded (AWG18)
Cable Extension	up to 450 m (1,500 ft)

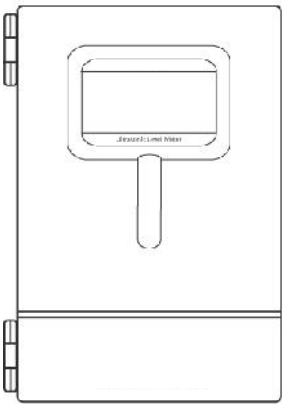
External Temperature Sensor (not required)	
Type	NTC, 10 kΩ
Temperature	-30°C~70°C (-22°F~158°F)
Process Connection	1/8” PT
IP Rating	IP68
Cable	RG174

* The Specification is subject to change without prior notice.

3. Product Package

FLOW HUNTER III is a controller operated with the sensor, LXD-P 04. The FLOW HUNTER III and sensors are packed respectively. Check all parts and the options are correct as it was ordered.

3.1 Controller Box Package



Controller

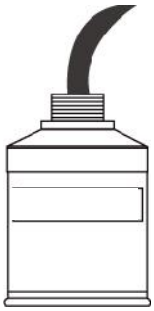
(PG13.5 1EA)
(PG11.0 2EA)

Cable Grand X3

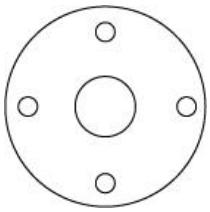
USB Connector Cable

External Temperature Sensor (Option)

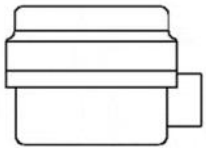
3.2 Sensor Box Package



LXD-04



Flange(option)



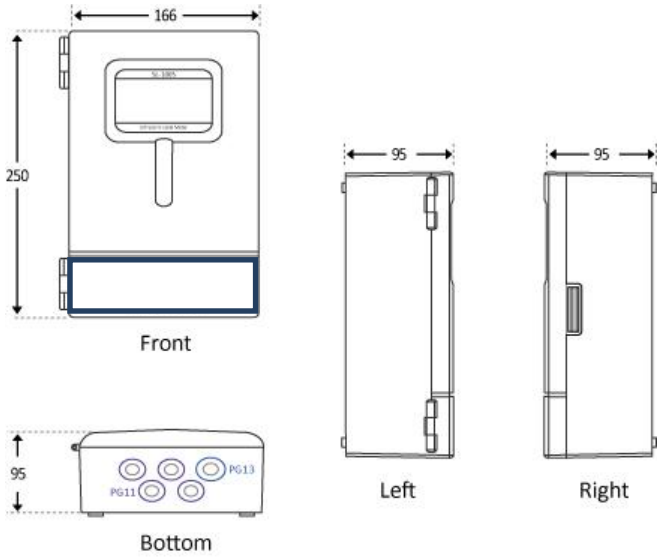
Junction Box (option)

4.Dimension

4.1 Controller

The enclosure material is polycarbonate and the protection grade is NEMA 4X (IP65).

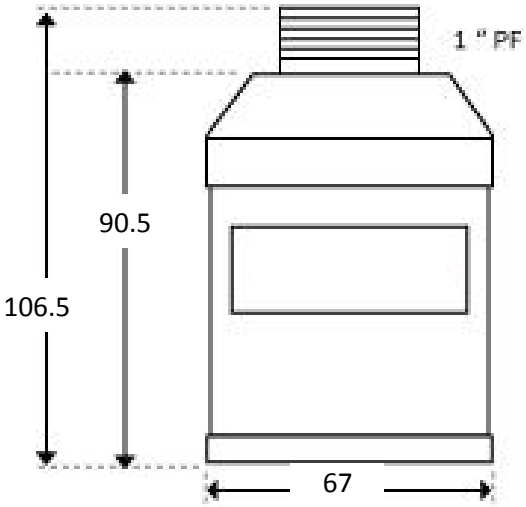
Using the hole in the back of the controller it is mounted on the wall.



4.2 Sensor

LXD-P 04 Sensor is an exclusive level sensor for the FLOW HUNTER III. Its range is 4 meters (13ft). The temperature is compensated by a built-in temperature sensor. The sensor material is PVDF. Before mounting the sensor, check the chemical compatibility chart if the sensor housing material is suitable for it.

The mounting thread is 1” NPT.



LXD-P 04

INSTALLATION

II. Installation

General Guide

Before mounting the product, read this manual and specification. Ensure it is installed in a place that is within the temperature range specified and is suitable to the enclosure rating and materials. If the products are not installed properly, it may cause malfunction.

This is general guide for installing ECHO products.

- Remove the obstacles in the space between the sensor and the measured target such as ladders, limit switches, heating spirals etc.
- When mounting the sensor, keep the distance to the vessel wall by at least 1' for every 10' vertical.
- The bottom of the sensor should be perpendicular to the surface of water.
- Do not set the maximum level into the Dead Zone range.
- Avoid the intense winds and excessive exposure to direct sunlight. The strong winds change the path of ultrasound and may cause a malfunction. If you need to install the unit in a spot exposed to direct sunlight, a sun screen should be installed.
- Keep away from strong electrical noise caused by high voltage, high current etc.
- Install the unit in a vibration free area.

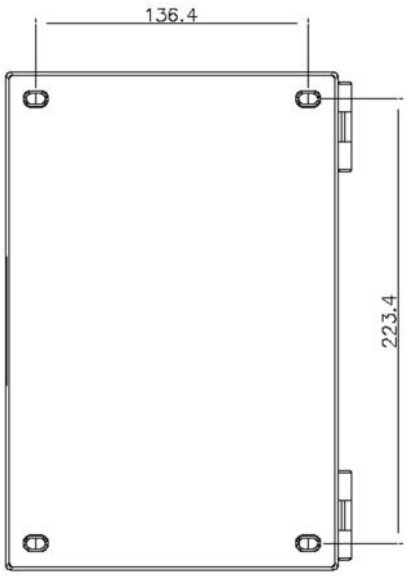
2. Controller installation

2.1 Environment condition

- In a place where ambient temperature is between -20 to +60 ° C (-4°F~140°F)
- In a place required minimum cable length.
- In a place where it can be operated conveniently
- In a place out of direct sunlight
- In a place free from vibration
- In a place that has sufficient space when its door is opened.

Do not install near high voltage, current runs or variable frequency motors.

2.2 Installation



- Open the controller door and check the four screw holes.
- Mark and drill four holes in the mounting wall.
- Fasten the screw bolt by a screwdriver and mount the controller.
- Check the controller leveled off on the wall.
- Close the controller door.

3. Sensor Installation

3.1 Environment condition

- In a place where ambient temperature is between -30 to +70 ° C (-22°F~94°F)
- Suitable to the housing rating and materials for applications.
- Perpendicular to the measuring target surface

3.2 Dead Zone (Near Blanking)

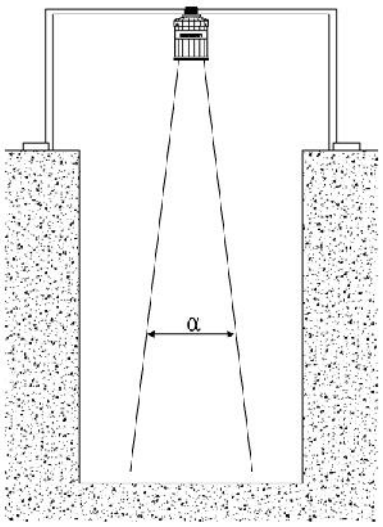
Dead zone is the area which the ultrasonic sensor can't measure. The maximum level shouldn't reach into the Dead Zone. The echo signal isn't calculated within Dead zone area, thus the measurement value may not be correct. Instead, raise the transducer 2-3 inches above the maximum liquid height.

Sensor Model	Dead zone
LXD-P 04	0.3 m (11.81in)

3.3 Beam Space

Make sure there is no interference on the emitted beam space area such as a limit switch, temperature sensors, and ladders.

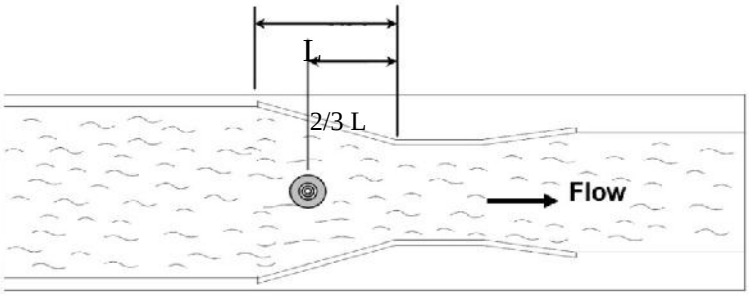
Measurement distance	Beam Space(α)
1m	0.33 ft
2m	0.66 ft
3m	1 ft
4m	1.33 ft



3.4 Installation

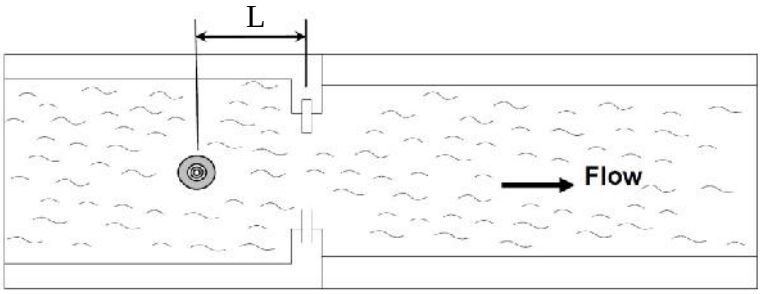
3.4.1 Parshall Flume

The sensor must be installed at 2/3 the length (L) of the converging section upstream of the beginning of the throat section.



3.4.2 Weir

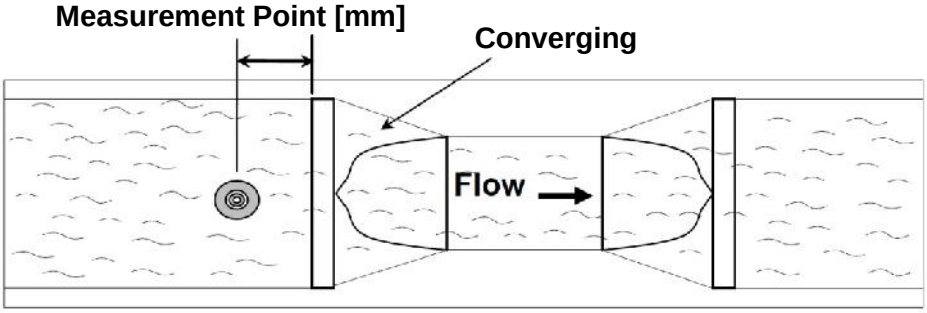
In the rectangular, triangular, and Cipolletti channels, the sensor should be installed at the top of the channel (Max. height x 4 ~ 5 times recommended).



3.4.2 Leopold Lagco Flume

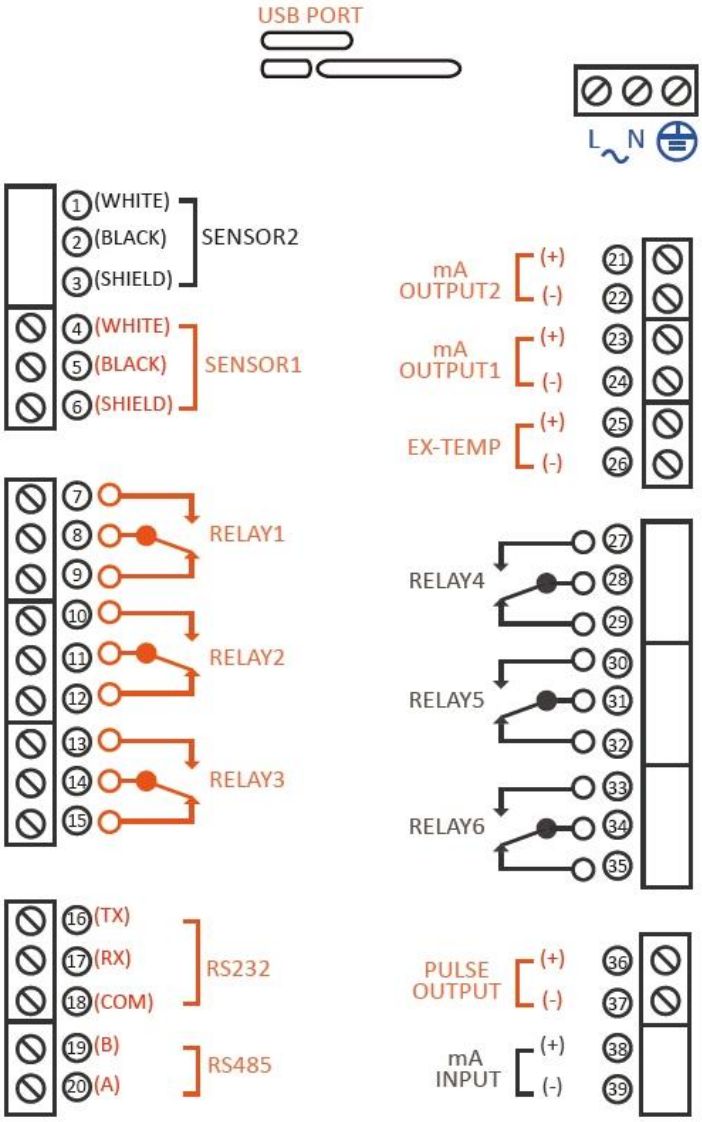
In the Leopold-Lagco Flume, the sensor should be installed at a position distant from Converging Section (corresponding to the distance of measurement point according to Flumes size)

Flume Size		Measurement Point	
mm	inches	mm	inches
100 ~	4~12	25	1.0
380	15	32	1.3
455	18	38	1.5
530	21	44	1.8
610	24	51	2.1
760	30	64	2.5



The sensor must be installed above maximum level including the dead zone.

IV. Wiring



CONTROL TERMINAL BOARD

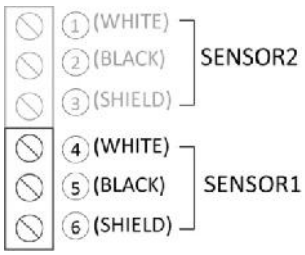
There are 39 terminal blocks inside the FLOW HUNTER III. Make sure that all related equipment is connected with each correct terminal block.

UNAVAILABLE TERMINALS

- SENSOR 2
- RELAYS 4, 5, & 6
- mA INPUT

TRANSDUCER

FLOW HUNTER III can only use the SENSOR 1 channel; SENSOR 2 Terminal block is NOT available.

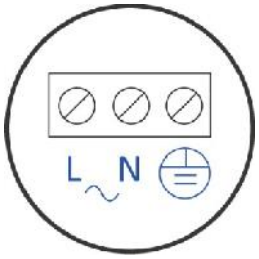


- **Do not use coaxial cable.**
- **Do not connect the shield and white transducer wires together.**

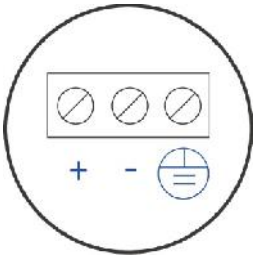
- **Do not use the old XDS-03 transducer with the new FLOW HUNTER III. Connect only the sensors stated in this manual.**

Power

The standard power type is AC power. DC power can be selected as an option if requested when ordering. The thickness of the power cable should be more than 0.755SQmm.



AC Power Terminal



DC Power Terminal

When turning on the power of FLOW HUNTER III for the first time, make sure any connected devices are disabled until all system functions are confirmed to be operating properly.

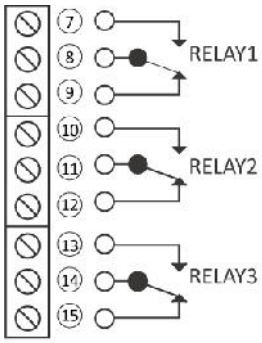
The system must be protected by a 10A fuse; otherwise it should be installed in a place where there is a circuit breaker or switch in the building. The switch must be easily accessible.

Relay

The Relay is two Form C type. The relays can be wired either normally open or normally closed. The standard model has 3 relays and the Dual Channel has 6 relays.

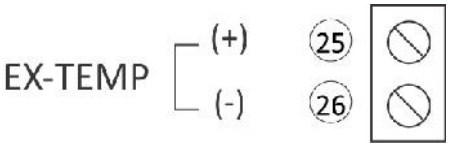
Two Form C, NO or NC relays

4A at 250Vac



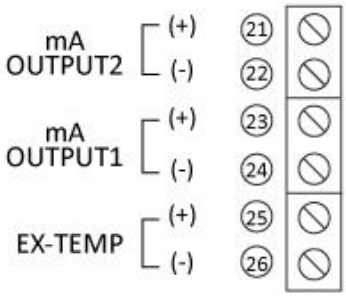
Temperature Sensor

The temperature information is a critical factor for measurement. LXD-P 04 sensor has a built-in temperature sensor internally to compensate. If the ambient temperature changes rapidly, an external temperature sensor is recommended. The external temperature sensor for FLOW HUNTER III can be purchased if requested when ordering.



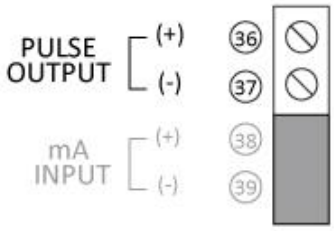
Analog output

mA OUTPUT 1 and mA OUTPUT 2 are the analog outputs for level and flow measurement. Make sure that each output is wired to the correct terminal block.



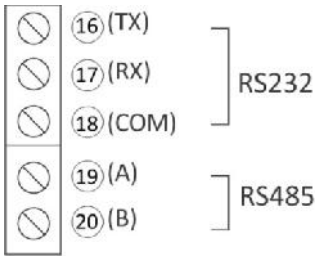
Pulse output

The measured flow value is converted into pulse.



Digital Communication

The standard communication type is RS232. RS485 Modbus can be selected as an option if requested when ordering.



2. Sensor Cable

LXD transducer cable is a shielded two-wire cable. The standard cable length is 10 meters (32.80 ft). The cable can be extended when placing the order as continuous, with a Junction Box, or Spliced. When the cable needs to extend with other cable, the cable has to be a shielded two-wire cable, same type.

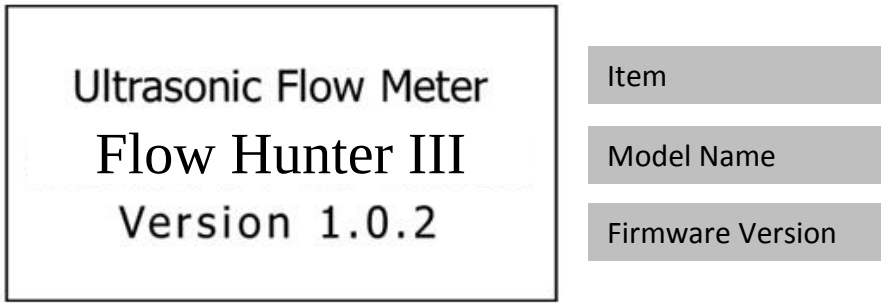
Recommend to use a grounded conduit and a junction box for cable protection. If the cable is ordered more than 10meter, there are three labels “White”, “Black” and “Shield”.

Do not use a coaxial cable for extension with FLOW HUNTER III. The extension cable must be used same specification as LXD Series sensor cable

V. Operation

1. Start-up Display

When the FLOW HUNTER III is powered on, the screen shows:

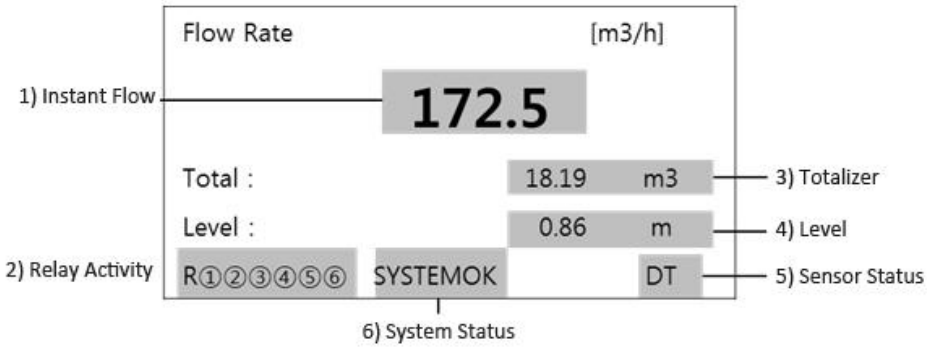


2. Display

2.1 Measuring Mode

There are 3 different display types in measuring mode. Switch by using the UP and DOWN buttons.

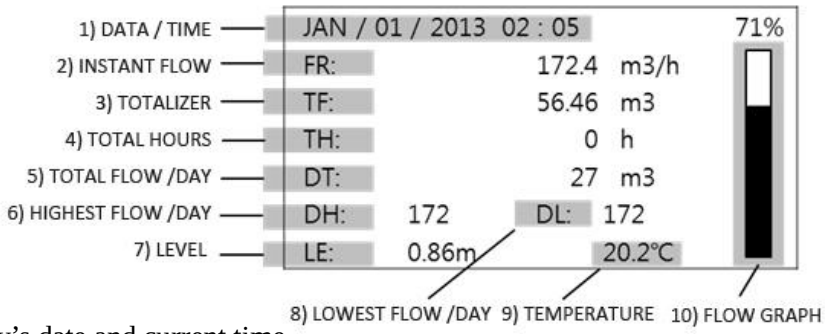
DISPLAY A



1. It shows the current flow measurement value
2. It shows the relay currently wired.
3. It shows total flow.
4. It shows current level measurement value.
5. It shows a sensor condition.
   - DT: when it operates normally
   - D: when it receive the reflected signal
   - S1: when the measurement value is over than DAMPING SPEED (The value is held)
   - S2: when it research the signal
   - LE: when it lost the signal
6. It shows a system status.
   - SYSTEM OK : normal status
   - SYSTEM OPEN: when the sensor is not wired or some cables are cut.
   - FAIL: when it can’t measure.

DISPLAY B

All the factors displayed are the same as those shown in DISPLAY A. DISPLAY B shows two sensors measurement at the same time. When only SENSOR 1 is wired, DISPLAY B isn't shown.



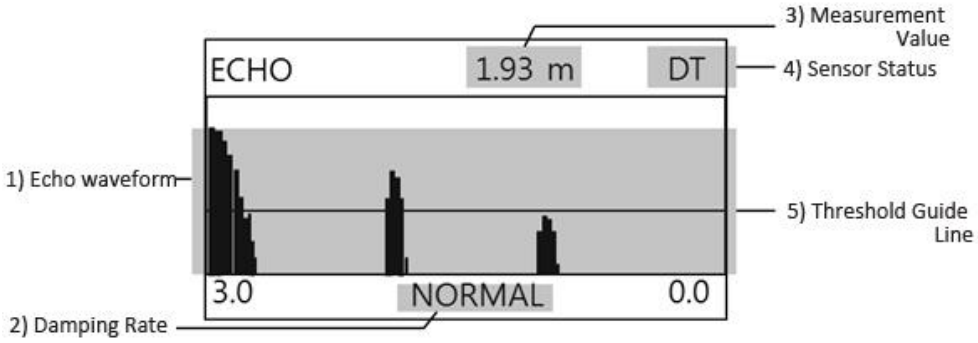
1. It shows today's date and current time
2. It shows instant flow value.
3. It shows total flow.
4. It shows the total hours measured
5. It shows total flow in a day.
6. It shows highest flow in a day
7. It shows level value currently being measured.
8. It shows lowest flow in a day
9. It shows the ambient temperature currently being measured.
10. It shows the flow graph.

DISPLAY ECHO TREND

1. It shows the echo waveform received by sensor.

2. It shows the damping rate. the setting level is as below.

- SLOW
- NORMAL
- FAST
- VERY FAST



3. It shows the measurement value currently measured.

4. It shows the sensor condition.

- DT: when it operates normally
- D: when it receive the reflected signal
- S1: when the measurement value is over than DAMPING SPEED (The value is held)
- S2: when it research the signal
- LE: when it lost the signal

5. It shows the threshold guide line.

2.2 Programming Mode

Programming Mode is to be set the menus for measurement. Programming Mode can be switched by [MENU] button in measuring mode. It shows as the picture as below.

1. LEVEL
2. FLOW
3. RELAY
4. CURRENT OUTPUT
5. PULSE OUTPUT
6. COMMUNICATION SETUP
7. LOGGING SETUP
8. SYSTEM SETUP
9. NAVIGATION

LEVEL

This menu is for detail parameter setup of level measurement.

FLOW

This menu is for detail parameter setup of flow measurement.

RELAY

This menu is for detail parameter setup of relay activity.

CURRENT OUTPUT

This menu is for detail parameter setup of current output.

PULSE OUTPUT

This menu is for detail parameter setup of pulse output.

COMMUNICATION SETUP

This menu is for detail parameter setup of communication.

LOGGING SETUP

This menu is for logging data management.

SYSTEM SETUP

This menu is for system setting

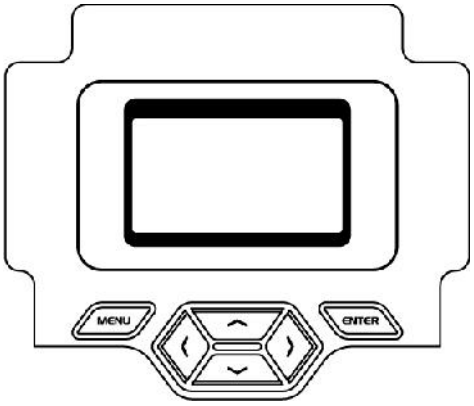
NAVIGATION

This menu allows for quick access to specific menus directly by entering the preset menu number. Refer to the menu list of FLOW HUNTER III.

* The menu list is page95.

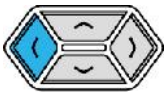
3. Buttons

FLOW HUNTER III has 6 buttons to operate the system and to setup the menus.



Move up menus or change the parameters on each menu.

Move down menus or change the parameters on each menu.



Return to the previous category
Move the cursor to the left when entering numbers.

Go to the next category
Move the cursor to the right when entering numbers.

Measuring mode and Programming Mode is switched by [MENU] button.

Select a menu in Programming Mode.
Complete menu setting

If you press [ENTER] button, after changing the value in Program Mode, every time the user is asked whether the changed value is saved or not. If you select [YES] then the value is changed and Measuring Mode is switched.
When you want to change several menus in same directory, press [ENTER] button after all parameters are changed.

VI. Programming

1. LEVEL

[1000] LEVEL		
UNIT	m	
TEMP UNIT	°C	
EMPTY	01.20m	
AUTO EMPTY	00.31m	DT
DEAD ZONE	00.25m	
TX POWER	050	
RX GAIN	093	
THRESHOLD	3 [0.5V]	
TEMP TYPE	INSIDE	
TEMP FIX	25.00°C	
TEMP	21.04°C	
DAMPING	NORMAL	
SOUND SPEED	0331.5m/s	
SPEED FACTOR	+0.60m/°C	

QUICK SETUP is the menus frequently used. Parameters can be set conveniently in short time.

UNIT

This menu is to select the unit of the value being measured.

- Unit Selection: mm, cm, m, in, yd, ft

**Round off the numbers to two decimal places

TEMP UNIT

This menu is to select the unit of ambient temperature being measured.

- Unit Selection: F or C

EMPTY

This menu is for setting the distance between the bottom of the sensor and the 0 Level Point (bottom of weir or flume). The input unit is changed depending on the measurements unit.

Sensor	setting range	Default
LXD-04	0. 30~4.50m	1.2m

AUTO EMPTY

This menu is for measuring the distance between the sensors to surface of measuring target.

DEAD ZONE (Near Blanking)

This menu is for setting DEAD ZONE of a sensor. The ultrasonic sensor is both transmission and reception sensor. The sensor is not able to measure the distance between the surface of the sensor and the certain point. That distance is called DEAD ZONE.

Sensor	Setting range	Default
LXD-04	0. 3~4.50m	0.30m

TX POWER

This menu is for adjusting the strength of the transmission signal output from the ultrasonic sensor. This adjusts the intensity of the ultrasonic wave generated form the sensor and is applicable for various environments.

[Default setting: 30, Minimum/Maximum setting range: 1~100]

- 10: When ultrasonic output is weak.
- 30: The general case (Standard mode)
- 50: When ultrasonic output is strong.
- 70: When ultrasonic output is very strong.

RX GAIN

This menu is for adjusting the sensitivity of the signal received from the sensor. Attenuation of the ultrasonic signal occurs depending on the install location, environment, and material surface condition. Below is the recommended basis for setting the following criteria.

[Default setting: 80, Maximum setting range: 1~100]

- 30 or less: The Amplification degree is weakest. When the amplification degree of the received signal is about 20dB. (Short-range measurement of enclosed space or underground water pipe.)
- 50: When the amplification degree of the received signal is about 25dB. (Short-range measurement of enclosed space or underground water pipe.)
- 80: The general case. When the amplification degree of the received signal is about 30dB. (Standard mode),
- 90: When the amplification degree of the received signal is about 40dB. (Long-range measurement in open space)
- 95: When amplification degree of the received signal is about 50dB. (When the dust, powder, and solid there is a risk of diffuse reflection of the ultrasonic wave.)

THRESHOLD

This is the menu for setting the reference value used to detect the received signal reflected. To avoid false detection, please set THRESHOLD value high in the noisy environment and please set THRESHOLD value low when environmental noise is low.

[Default setting: 4(0.8V), Maximum setting range: 1~10]

TEMP TYPE

This is the menu for selecting the type of the temperature value used in the ultrasonic distance measurement.

INSIDE: Use the temperature sensor that is built inside the sensor for ultrasonic measuring.

OUTSIDE: Use the value of the external temperature sensor for ultrasonic measuring. (optional)

FIX: Set a fixed value without using a temperature sensor when the device is used in the places where the temperature is changed rapidly.

When using the external temperature sensor for measurement, TEMP TYPE should be selected as OUTSIDE always. If it is set as OUTSIDE, but the external temperature sensor is not actually connected, it might be displayed incorrect measurement value instead of the actual measurement value.

TEMP FIX

This menu is for setting the value of the temperature manually when TEMP TYPE is selected to FIX.

Sensor	Celsius(℃)	Fahrenheit(℉)
Range	-30~70	-22~158

TEMP

This menu is for checking the temperature value measured currently.

DAMPING

This menu is for setting the speed of output change corresponding to the change in water level.

Select Item	Slow	Normal	Fast	Very Fast
Speed	**0.1m/min**	**1m/min**	**10m/min**	**100m/min**

SOUND SPEED

This menu is for setting the sound speed value of the environment used. Please enter 331.5 in general. (in the air) If this product is operated in other gases, please enter the sound speed value of the corresponding gas when the temperature is 0 ℃ (unit: m/sec).

Name of gas	Sound speed (m/sec)
Chlorine	**206**
Carbon dioxide	**259**
Argon	**308**
Oxygen	**316**
Air	**331.5**
Ammonia	**415**
Ethane	**430**
Neon	**435**
Helium	**965**

SOUND SPEED FACTOR

This menu is for setting the sound speed change value due to temperature. Sound speed is changed depending on the temperature. In the air, please enter 0.60 (m / ℃) in general. In the case of special circumstances, please enter the sound speed change value obtained by experiment to obtain an accurate measured value.

2. FLOW

Set the detail menu for flow parameters.

[2000] FLOW
FLOW UNIT
DEVICE SELECTION
LOW CUT VALUE
HIGH CUT VALUE
TOTALIZER
FLOW RATE
FLOW INDEX

FLOW UNIT

This menu is to select the unit of the flow value being measured.

Flow Rate	Total Flow
㎥/h	**㎥**
㎥/d	**㎥**
l/min	**KL(Kilo Liter)**
ft^3/s	**ft^3**
GPM(US)	**gal[US]**
GPM(UK)	**gal[UK]**
MGD[US]	**MG[US]**
MGD[US]	**MG[UK]**

DEVICE SELECTION

This menu is for channel selection and detailed parameter setting. Select the channel first and then, set parameters for the channel.

[2200] DEVICE SELECTION
1. Parshall Flume
2. Rect. Suppressed
3. Rect. Contracted
4. V-Notch Weir
5. Cipoletti Weir
6. Leopold Lagco Flume
7. Palmer Bowlus Flume
8. H Flume
9. TRAPEZOIDAL Flume
10. DIY Curve/Special

CAUTION

When the weir or flume is selected, the current value and relay are changed according to the selected weir or flume.

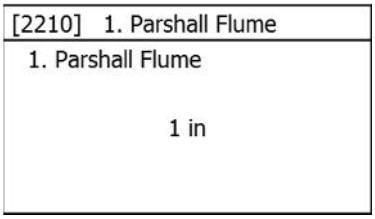
Selected device is marked by "*"

[2200] DEVICE SELECTION
1. Parshall Flume
.....
10. DIY Curve/Special

→

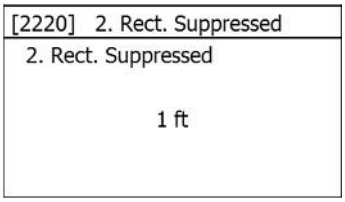
[2200] DEVICE SELECTION
* Parshall Flume
.....
10. DIY Curve/Special

Parshall Flume



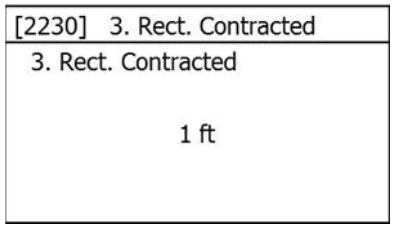
Parshall Flume	Maximum height [mm]	Parshall Flume	Maximum height [mm]
1 in	180	1 ft	760
2 in	180	1.5 ft	760
3 in	450	2ft	760
6 in	450	3 ft	760
9 in	600	4 ft	760
		5 ft	760
		6 ft	760
		8 ft	760
		10 ft	1060
		12 ft	1370

Rect. Suppressed



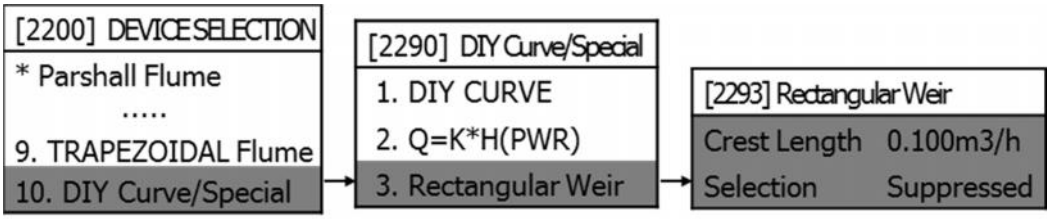
Rect. Suppressed	Maximum height [mm]	Rect. Suppressed	Maximum height [mm]
1 ft	150	4 ft	600
1.5 ft	220	5 ft	750
2 ft	300	6 ft	900
2.5 ft	370	8 ft	1200
3 ft	450	10 ft	1500

Rect. Contracted



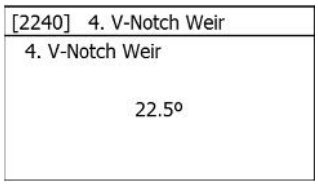
Rect. Contracted	Maximum height [mm]	Rect. Contracted	Maximum height [mm]
1 ft	**150**	**4 ft**	**600**
1.5 ft	**220**	**5 ft**	**750**
2 ft	**300**	**6 ft**	**900**
2.5 ft	**370**	**8 ft**	**1200**
3 ft	**450**	**10 ft**	**1500**

If there is no channel installed on the menu, please complete the following steps. At [2293] Rectangular Weir menu, Please select Suppressed Weir and enter the corresponding Crest Length.

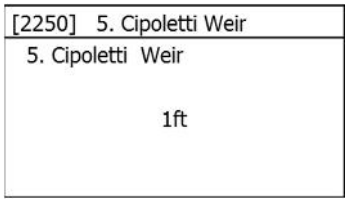


V-Notch Weir

[Type: 22.5°/ 30°/ 45°/ 60°/ 90°/ 120°]

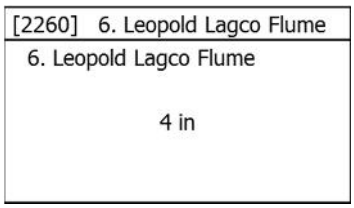


Cipolletti Weir



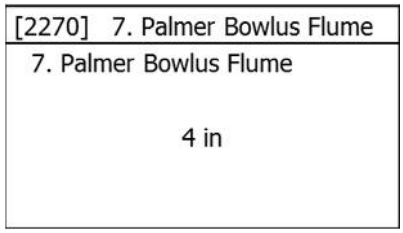
Cipolletti Weir	Maximum height [mm]	Cipolletti Weir	Maximum height [mm]
1 ft	150	4 ft	600
1.5 ft	220	5 ft	750
2 ft	300	6 ft	900
2.5 ft	370	8 ft	1200
3 ft	450	10 ft	1500

Leopold Lagco Flume



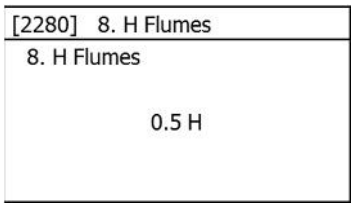
Leopold Lagco Flume	Maximum height [mm]	Leopold Lagco Flume	Maximum height [mm]
4"	**70**	**15"**	**270**
6"	**100**	**18"**	**320**
8"	**130**	**21"**	**380**
10"	**180**	**24"**	**420**
12"	**210**	**30"**	**530**

Palmer Bowlus Flume



Palmer Bowlus Flume	Maximum Height [mm]	Palmer Bowlus Flume	Maximum Height [mm]
4"	**75**	**15"**	**270**
6"	**105**	**18"**	**320**
8"	**150**	**21"**	**380**
10"	**180**	**24"**	**420**
12"	**210**	**30"**	**485**

H Flume



H Flume	Maximum Height [mm]	H Flume	Maximum Height [mm]
0.5H	**150**	**4.5 H**	**1370**
0.75H	**220**	**0.4 HS**	**120**
1.0 H	**300**	**0.6 HS**	**180**
1.5 H	**450**	**0.8 HS**	**240**
2.0 H	**610**	**1.0 HS**	**300**
2.5 H	**760**	**3.0 HS**	**910**
3.0 H	**910**	**4.0 HS**	**1220**

TRAPEZOIDAL Flume

```
[2281]  9. TRAPEZOIDAL Flume
 9. TRAPEZOIDAL Flume

        Sm. 60ºV
```

TRAPEZOIDAL Flume	Maximum height [mm]	TRAPEZOIDAL Flume	Maximum height [mm]
Sm. 60°V	90	2" 45° WSC	250
Lg. 60°V	150	12" 45° SRCRC	380
XL 60°V	285	2.0' SRCRC	860
3.0' 60°V	755		

DIY Curve/Special

This menu is used for measurement of flow rate, regardless of the type of device.

```
[2290]  DIY Curve/Special
 1. DIY CURVE
 2. Q=K*H(PWR)
 3. Rectangular Weir
```

DIY Curve: This option equally divides the known level-based flow rate into 10 parts and measures the flow rate according to change of level.

```
[2291]  DIY CURVE      [m3/h]
 MAX HEIGHT    01.20m
 0.05xMH       000000.1
 0.10xMH       000000.1
               ...
 0.95xMH       000000.1
 1.00xMH       000000.1
```

Q=K*H(PWR): This option inputs constant values, K and PWR, to a exponentially changing device and measures the flow rate.

```
[2292]  Q=K*H(PWR)
 K             0000.0001
 PWR           0.001
 H             m
 Q             m3/h
```

Rectangular Weir: This option selects Crest Length of all Rectangular Weirs in mm unit and measures the flow rate.

```
[2293]  Rectangular Weir
 Crest Length  0.100m3/h
 Selection     Suppressed
```

LOW CUT VALUE

This is the menu to set minimum measurable flow rate. Those below this value will be treated as "0". The initial value is 0.00m3/h (0.00 gal/m). (Setting range: 0.00 ~ Max. Flow Rate, Unit: 0.01m3/h (0.01 gal/m)).

```
[2300]  LOW CUT VALUE
 LOW CUT VALUE

        00000.00 m3/h
```

HIGH CUT VALUE

This is the menu to set maximum measurable flow rate. Those above this value will be treated as the maximum flow rate. The initial value is maximum flow rate of the device (gal/m). (Setting range: 0.00 ~ Max. flow rate)

```
[2400]  HIGH CUT VALUE
 HIGH CUT VALUE

        01871.97 m3/h
```

TOTALIZER

This is a menu for setting the default value of TOTAL FLOW and TOTAL TIME.

```
[2500]  TOTALIZER
 TOTAL FLOW SET
 TOTAL TIME SET
```

FLOW RATIO

This menu is to revise the output of flow rate that are measured in arbitrary ratio by user. This menu also can be used for weight conversion, error correction.

Display & Output = Measured value x FLOW RATE

(Setting range: 0.001~9.999)

```
[2600]  FR RATIO [m3/h]
 FR RATIO      1.000
 FR            288.3
 LE            1.20m
```

e.g. when FR RATIO is 1.00, FR is 2.00㎥/h, if FR RATION is changed to 1.100, the FR value will be 2.20㎥/h and the LE value isn't changed.

FLOW INDEX

Highest or lowest flow rate based on the selected height of the channel can be searched by m3/h or gal/h unit.

```
[2700]  FLOW INDEX
 FLOW INDEX    00.183m
 m3/h          0.016
 GPM           0.069
```

3. RELAY

```
[3000]  RELAY
 RELAY 1
 RELAY 2
 RELAY 3
 RELAY SIMULATION
```

RELAY1~3

```
[3100]  RELAY 1
 DETAIL
 ON POINT
 OFF POINT
```

[3110] DETAIL	
FUNCTION	NONE
GROUP	1

DETAIL FUNCTION

This menu is for selecting RELAY use state.

- NONE: No use on this RELAY
- LIMIT: Operate each RELAY depending on the value of the ON / OFF.
- ALTERNATE: Operate RELAY in sequence on the basis of the measured value and the ON / OFF POINT value of the group that has been set.

Ex) If There are RELAY1 and RELAY 2 at the GROUP1, RELAY 1 is working to the first ON / OFF point and then RELAY 2 is working at the second ON / OFF point.

- ALARM: This menu is for generating alarm signals when errors that caused by error on the Fail Safe Time value occurs consistently.

GROUP

This menu is for setting a group for ALTERNATE.

Selection range: 1~3

ON POINT

This menu is for setting a point that RELAY is ON. If OFF POINT is less than ON POINT, RELAY become ON when the measured value is bigger than ON POINT. If OFF POINT is bigger than ON POINT, RELAY become ON when the measured value is less than ON POINT.

[3120] ON POINT
ON POINT
00000.01 m3/h

OFF POINT

This menu is for setting a point that RELAY is OFF.

If OFF POINT is less than ON POINT, RELAY become OFF when the measured value is less than OFF POINT. If OFF POINT is bigger than ON POINT, RELAY become ON when the measured value is bigger than OFF POINT.

[3220] OFF POINT
OFF POINT
00000.01 m3/h

RELAY SIMULATION

The ON / OFF test of RELAY is available.

4. CURRENT OUTPUT

This menu is for setting that is needed to convert the measured value to current output.

[4100] CURRENT OUTPUT 1
INPUT TYPE
4mA POINT SET
20mA POINT SET
FAIL SAFE CURRENT

INPUT TYPE

This menu is for selecting the measurement of Level or Flow.

[4110] INPUT TYPE
INPUT TYPE
LEVEL

4mA POINT SET

This menu is to set 4mA.

[4120] 4mA POINT SET
4mA POINT SET
00.00 m

20mA POINT SET

This menu is to set 20mA.

[4130] 20mA POINT SET
20mA POINT SET
01.20 m

FAIL SAFE CURRENT

This menu is for setting the operation of the current output when an error occurs.

- 3.8Ma
- HOLD
- 22mA

[4140] FAIL SAFE CURRENT
FAIL SAFE CURRENT
22mA

CURRENT SIMULATION

This menu is that displays the output of CURRENT OUTPUT SENSOR 1 and SENSOR 2 as selected value.

- 3.8mA
- 4mA
- 12mA
- 20mA
- 22mA

[243]CURRENT SIMULATION
OUTPUT 1 MEASURE
OUTPUT 2 MEASURE

CURRENT SIMULATION

This function can simulate the cable connection status and the current output between the central control room and this device. When you move to the CURRENT SIMULATION menu, the measuring process is stopped and the current output becomes initialized to 0.

[130]CURRENT SIMULATION
OUTPUT 1 MEASURE
OUTPUT 2 MEASURE

OUTPUT 1

When you select a value of the Current Output 1 and 2, it is output by the value of the corresponding current.

- **HOLD**
- **3.8mA**
- **4mA**
- **12mA**
- **20mA**
- **22mA**

OUTPUT 2

Same as the OUTPUT 1

5. PULSE OUTPUT

```
[5000]  PULSE OUTPUT
FUNCTION      DISABLE
PULSE WIDTH   0.10 sec
PULSE VALUE   001.0 m3
```

FUNCTION

It is the menu for selection of pulse output use.

- DISABLE: PULSE OUTPUT is not used.
- ENABLE: PULSE OUTPUT is used.

PULSE WIDTH

This is a Menu to set the width of the pulse that one pulse is output depending on the flow rate value that has been set at the PULSE VALUE.

(Default setting: 0.10sec, Setting range: 0.01~1.00, Unit: 0.01sec)

PULSE VALUE

This is a menu to set the flow rate value per pulse. If you enter 1.0㎥, it means

1 pulse is discharged 1.0㎥.

6. COMMUNICATION SETUP

```
[6000] COMMUNICATION SETUP
RS-232 SETUP
RS-485 SETUP
```

RS-232 SETUP

```
[6100]RS-232 SETUP
USE          ENABLE
BAUDRATE     9600
PARITY       NONE
STOP BIT     1
DATA BIT     8
PROTOCOL     ISTEC
```

USE

This menu is for selecting the RS-232 use state.

- ENABLE / DISABLE

BAUDRATE

This menu is for selecting the transmission speed of RS-232.

- 4800 bps
- 9600 bps
- 14400 bps
- 19200 bps
- 38400 bps
- 57600 bps
- 115200 bps

PARITY

This menu is for selecting the Parity bit use state.

- None
- Odd
- Even

STOP BIT

This menu is for selecting the size of the STOP BIT of RS-232 data transmission.

- 1 bit (default)
- 2 bit

DATA BIT

This menu is for selecting the size of the transmission data of RS-232.

- 7 bit
- 8 bit (default)

PROTOCOL

This menu is for selecting the protocol of the measurement data that is output by RS-232.

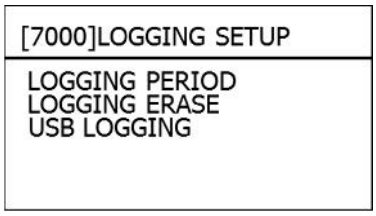
- ECHO
- BKCM
- Modbus – RTU
- Modbus–ASCII

RS-485 SETUP

[6200]RS-485 SETUP	
USE	ENABLE
BAUDRATE	9600
PARITY	NONE
STOP BIT	1
DATA BIT	8
PROTOCOL	ISTEC

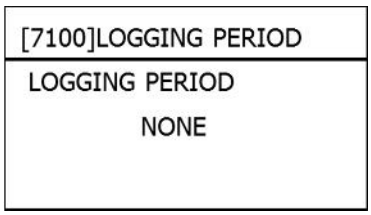
7. LOGGING SETUP

This menu is for setting LOGGING PERIOD, LOGGING ERASE, and USB LOGGING.



LOGGING PERIOD

This menu is for setting the Logging period of measurement data.



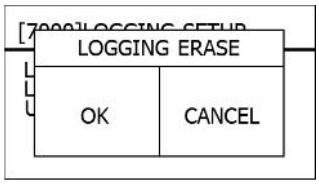
- **NONE**
- **10 SEC**
- **1 MINUTE**
- **5 MINUTE**
- **10 MINUTE**
- **15 MINUTE**
- **30 MINUTE**
- **60 MINUTE**

Maximum storage period according to the data logging period (16,128 point)

Data logging period	Maximum storage period
10 SEC	**2 days**
1 MINUTE	**11 days**
5 MINUTE	**56 days**
10 MINUTE	**112 days**
15 MINUTE	**168 days**
30 MINUTE	**336 days**
60 MINUTE	**672 days**

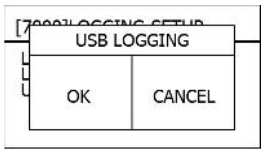
LOGGING ERASE

If you select LOGGING ERASE, Screen will be displayed as shown in [Figure 6-25]. By selecting OK, it erases the saved logging.

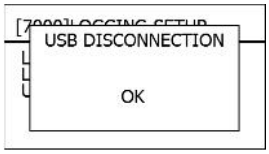


USB LOGGING

When USB is connected, screen will be displayed as shown in [Figure 6-26]. By selecting OK, it transfers logging data to USB as EXCEL file.



When USB is not connected, screen will be displayed as shown in the picture below. Please connect USB, and then click the OK button, the error pop-up will disappear.



8. SYSTEM SETUP

```
[8000]SYSTEM SETUP
SYSTEM INFO
SYSTEM ID
SYSTEM TIME
PASSWORD
LANGUAGE
FAIL SAFE TIME
SETTING BACKUP
RESET
```

SYSTEM INFO

This menu is for showing system information.

- Version: Firmware version
- SYSTEM ID: System ID for ECHO protocol
- UNIT: Measurement unit selected by a user

```
[8110]SYSTEM INFO
VERSION     0.0.1
SYSTEM ID   0
UNIT        METER
```

SYSTEM ID

```
[8200]SYSTEM ID
SYSTEM  ID     0
MODBUS ID      001
```

SYSTEM ID

This menu is for setting the SYSTEM ID to be used for ECHO Protocol.

Setting range: 0 ~ 99

Modbus ID

This menu is for setting the Slave ID required when using Modbus Protocol.

SYSTEM TIME

This menu is for setting the system time. By using the Left / Right direction button, move the cursor to the year / month / day / hour / minute, change the setting using the Up / Down direction button.

Setting range: JAN/01/2000 00:00 ~ DEC/31/2099 23:59

```
[8300]SYSTEM TIME
SYSTEM TIME
    JAN/01/2013/05:54
```

PASSWORD

This menu is for setting a password by its user. No password is set at the factory. After you set a password, you must enter the password each time there is a menu change.

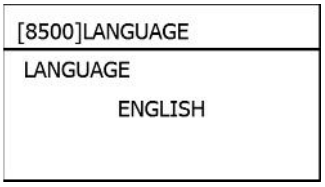
Password setting range: 0000~9999

```
[8400]PASSWORD
PASSWORD
        0000
```

User can't configure the menus when user forgets the password.
Please note password number and pay attention not to lose it.

LANGUAGE

This is the menu for setting the system language. The current support language is English only.



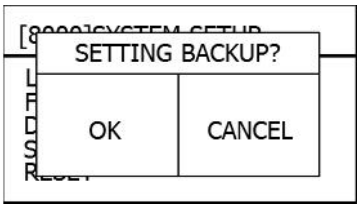
FAIL SAFE TIME

This menu is for setting the time (length) for the alarm when the device malfunctions or there is no receiving signal.

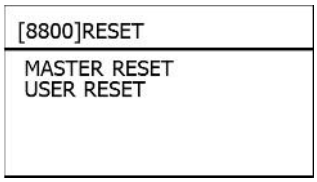
[Default setting: 300sec, Setting range: 20 ~ 999sec]

SETTING BACKUP

This menu is for saving the menu setting value by user. When user select menu, screen will be displayed as shown in picture below.

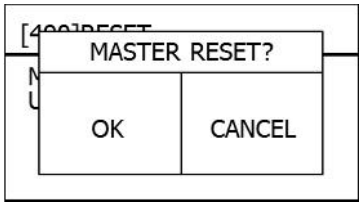


RESET



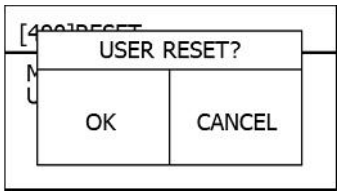
MASTER RESET

This menu is for resetting the device that is currently operating. If you select MASTER RESET function, the device will be initialized as default setting.



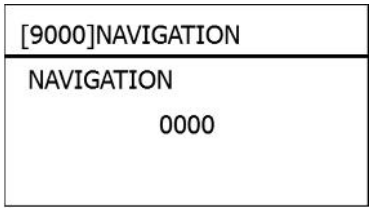
USER RESET

This menu is for resetting the device that is currently operating. If you select USER RESET, the device will be initialized as menu value that is stored at SETTING BACKUP.

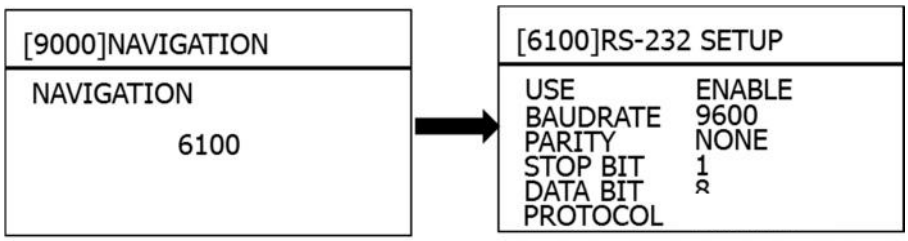


9. NAVIGATION

This menu allows for quick access to specific menus directly by entering the preset menu number. Refer to the menu list of FLOW HUNTER III.



Ex) If you want to move to the menu of LOGGING PERIOD, please enter menu number [6100]. By entering menu number [6100], you can access RS-232 SETUP menu immediately.



Maintenance

VII. Maintenance

Regular Inspection

- There are no contaminants on the surface of sensor.
- Current output is working in the normal range of 4-20mA.
- Value displayed at the screen is same as actual level value.
- Rating power supply is approved.

1. Battery

The battery which is equipped on the main board of FLOW HUNTER III is CR-2032 from Maxwell Co. The normal product life is around 10 years but it is subject to change by the environment and operating condition. The life can be shortened. Before the battery is out, check it regularly and change it.

CAUTION

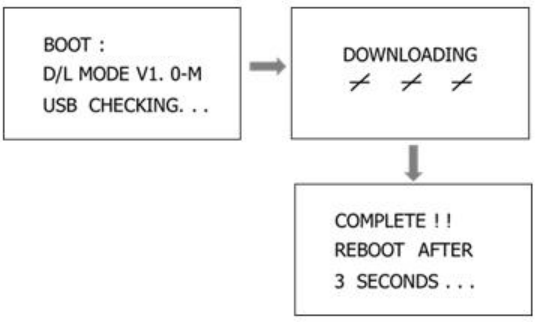
If the battery is out, the time data cannot back-up.
The battery brand and specification will be subject to change without prior notice.

2. SENSOR

- Check the sensor cable regularly.
- Check the sensor bottom if there is contaminant and clean the bottom of the sensor.

3. Firmware upgrading

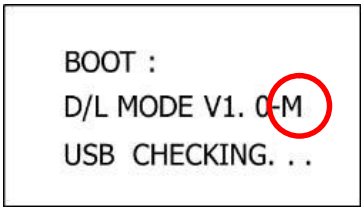
Flow Hunter III provides the firmware upgrading by a user.



Duplicate the firmware to download at the highest folder of USD memory. (File system: FAT32). Connect the USB memory to the Controller. Keep pressing the ENTER key and turn on the power.

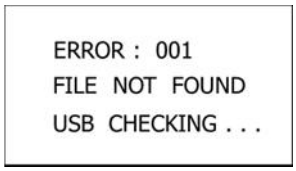
Firmware can be downloaded now.

There are two different types of Firmware version for FLOW HUNTER III. One is for Serial Version and the other is for Mod-bus version. It is distinguished by the firmware name. If the alphabet is "M" it is for Mod-bus version and if the alphabet is "S", it is for RS 232 or 485. The mismatched firmware isn't upgraded automatically.

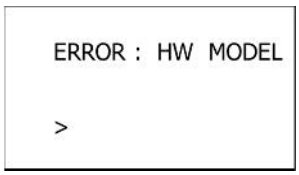


Firmware Download Error:

1. There is no Firmware file in the USB memory.



2. The downloaded firmware isn't FLOW HUNTER III s



4. Warranty Period

Warranty period is 3 years for FLOW HUNTER III but if the problem is caused by user's fault or misuse, the repair charge will be incurred.

5. Repair Service

If a problem occurs in your FLOW HUNTER III, the error code displays on the screen, it shows what the problem is. The error code information can be founded by scanning or Code inside the controller door. Even though conduct every process by the guide, still the problem exists, contract an official distributor or ECHO customer center.

When the product is sent for the repair, the repair request form has to be filled and enclosed with each product.

Despite being in warranty period, if the problem is caused by user's fault or misuse, the repair charge will be incurred.

Troubleshooting

VIII. Trouble shooting

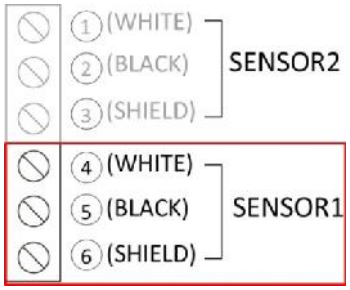
When some problem is occurred in FLOW HUNTER III, the error code displays on the screen, it shows what the problem is. The error code information can be founded by scanning QR Code inside the controller door.

ERROR CODE LIST

ERROR CODE	CAUSE
E1101	**Not connected SENSOR1**
E2101	**Not connected SENSOR2**
E0101	**Not connected SENSOR1 and SENSOR2**
E1102	**Temperature error of SENSOR1**
E2102	**Temperature error of SENSOR2**
E0102	**Temperature error of SENSOR1 and SENSOR2**
E0401	**External Temperature sensor Error**
E0210	**Flash memory error**
E0202	**EEPROM error**
E0203	**Real time clock error**
E1204	**The received signal of SENSOR1 is abnormal**
E2204	**The received signal of SENSOR2 is abnormal**
E0204	**The received signal of SENSOR1 and SENSOR2 is abnormal**

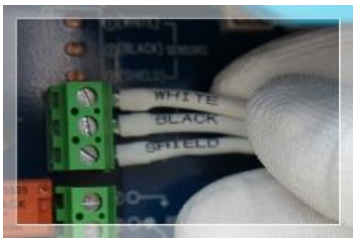
E1101

This error appears when sensor1 is not connected to the terminal or if it is connected to the terminal incorrectly. Please proceed as follows to solve this problem.



When the transducer doesn’t make sound/pulse

1. Please check that you can hear the sound emitted from the ultrasonic sensor. If you cannot hear the sound, please refer to (2). If you can hear the sound, please refer to (5).



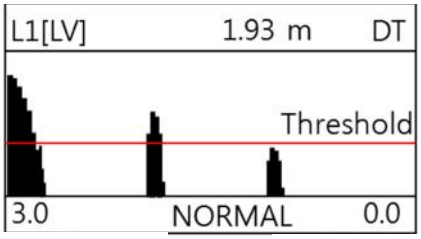
2. Please check the sensor cable (white, black) visually or by using Multi-meter if it is cut or shorted. If you find a problem, please repair or replace the cable. If the problem has not been solved yet, please refer to (3)

3. Please check that the sensor cable (white, black) is properly connected on the terminal at the exact position. If it is not, please connect the sensor cable properly.

4. If the problem has not been solved yet even though you have confirmed the process above (2) and (3), please contact our service center or your local dealer.

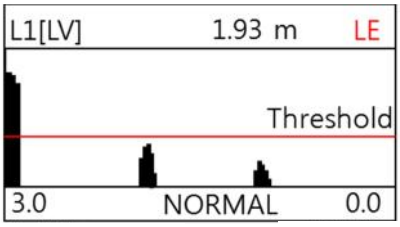
When the transducer makes sound/pulse

5. If you can hear the sound emitted from the ultrasonic sensor, please check the strength of the transmitted signal at the Echo Trend graph on the screen. You can suspect a faulty sensor if the transmitted signal is weak or received signal shows lower waveform than the Threshold value.



Transmitting Signal Receiving Signal

Normal condition



Transmitting Signal Receiving Signal

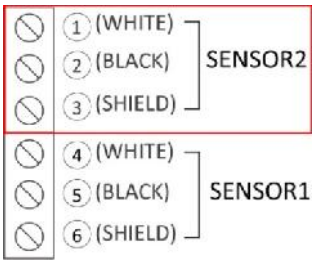
Abnormal condition

*** To see Echo Trend graph, press the [down] button on the Measuring Mode till the graph shows up on the screen.*

6. If there is a spare sensor, please replace it with other sensors and test again. If the changed sensor operates properly, the sensor is defective. If it doesn’t operate normally even if the other sensor has been replaced, you should check the controller.

7. If you don’t have a spare sensor, the faulty sensor needs repair or replacement. Please contact our service center or your local dealer.

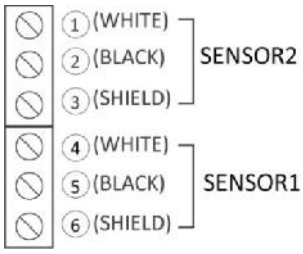
E2101



This error appears when sensor2 is not connected to the terminal or if it is connected to the terminal incorrectly. Please proceed as follows to solve this problem.

Processing method is the same as the E1101. （Please refer to Page 82）

E0101



This error appears when sensor1 and sensor2 are not connected to the terminal or connected to the terminal incorrectly. Please proceed as follows to solve this problem.

Processing method is the same as the E1101. （Please refer to Page81）

E1102

This error appears when the built-in temperature sensor in sensor1 is not operating properly. The value of the temperature on the screen could be displayed abnormally. Please proceed as follows to solve this problem.

When the sensor doesn’t make sound/pulse

1. Please check that you can hear the sound emitted from the ultrasonic sensor. If you cannot hear the sound, please refer to (2). If you can hear the sound, please refer to (5).

2. Please check the sensor cable (white, black) visually or by using Multimeter if it is cut or shorted. If you find a problem, please repair or replace it. If the problem has not been solved yet, please refer to (3)

3. Please check that the sensor cable (white, black) is properly connected on the terminal at the exact position. If it is not, please connect the sensor cable properly.

4. If the problem has not been solved yet even though you have confirmed through the process (2) and (3), please contact our service center or your dealer.

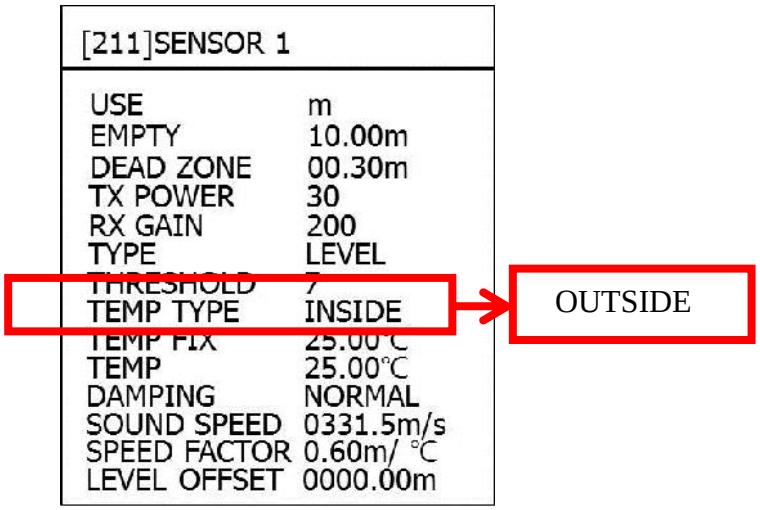
When the sensor makes sound/pulse

5. If you can hear the sound emitted from the ultrasonic sensor, please check the color of the sensor cable (black & shield) that connected to the terminal block. If it is not connected correctly, please re-assemble according to the color.

6. Please check that the ultrasonic sensor is not connected to the sensor terminal block or the bolt is not tightened. If reconnection is needed, please reconnect it.

7. If the problem has not been solved yet even though you have confirmed the process above (5) and (6) please check the resistance of cable (black & shield). At room temperature, it is normal if the resistance value is within about 9kΩ ~ 15kΩ. If the resistance value is over this range, the built-in temperature sensor is defective. A faulty sensor needs repair or replacement. Please contact our service center or your local dealer.

8. If there is an external thermometer, you can use it instead of the built-in temperature sensor. When you change the temperature sensor, you have to change the menu option as well. The menu is as follows.



E2102

This error appears when the built-in temperature sensor in sensor2 is not operating properly. The value of the temperature on the screen could be displayed abnormally. Please proceed as follows to solve this problem.

Processing method is the same as the E1102. （Please refer to Page 83）

E0102

This error appears when the built-in temperature sensor in sensor1 and sensor2 are not operating properly. The value of the temperature on the screen could be displayed abnormally. Please proceed as follows to solve the problem.

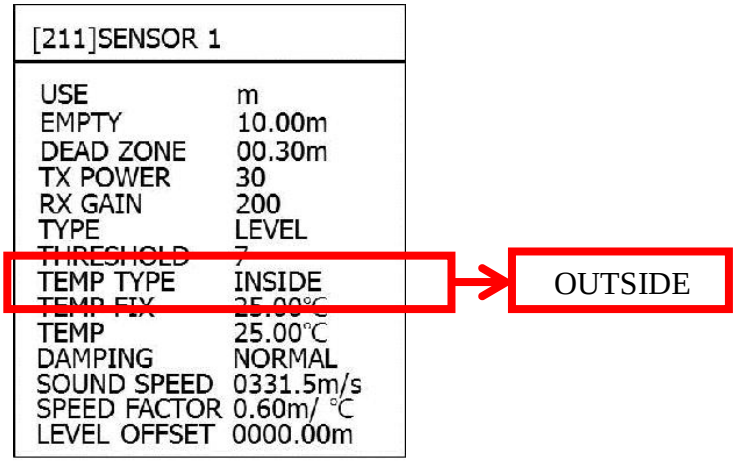
Processing method is the same as the E1102. （Please refer to Page 83）

E0401

This error appears when an external thermometer that connected to the controller is not operating properly. Please proceed as follows to solve this problem.

When the temperature type is selected incorrectly in the menu

1. If you select “OUTSIDE” on the TEMP TYPE when setting the menu of the sensor, the value is measured based on the temperature value that measured by the external temperature sensor. Please check if you chose “OUTSIDE” instead of “INSIDE” on the TEMP TYPE menu even though an external temperature sensor is not connected.

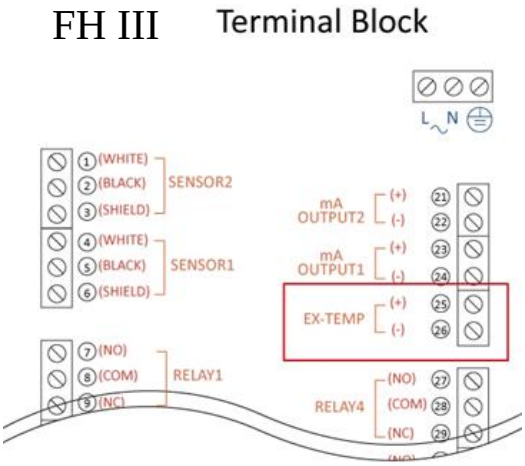


When the temperature sensor is connected incorrectly

2. Please check the sensor cable visually or by using Multimeter if it is cut or shorted. If you find a problem, please repair or replace it. If the problem has not been solved yet, please refer to (3)

3. Please check that the sensor cable is properly connected on the terminal at the exact position. If you find a problem, please connect the sensor cable properly.

4. If the problem has not been solved yet even though you have confirmed the process above (2) and (3), please contact our service center or your local dealer.



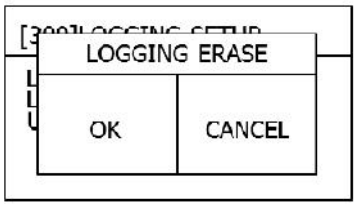
E0201

This error appears when the flash memory inside controller is not operating properly. Please proceed as follows to solve the problem.

Logging data Recovery

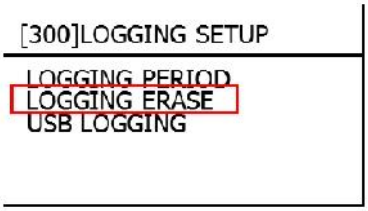
If the flash memory is defective, it is difficult to recover the stored data. For the recovery of the lost data, you will need to send the product to our service center for repair.

Memory Reset



1. Please try to reset the flash memory at the menu.

2. Please refer to the menu directory as follows. All data will be deleted and the memory will be rest.



3. If the problem continues, please contact our service center or your local dealer.

E0202

1. This error appears when the EEPROM memory inside controller is not operating properly. Please proceed as follows to solve the problem.

2. Please contact our service center immediately. Do not attempt to fix it yourself

(EEPROM memory stores the important information about the product and cannot be handled by non-experts. If you need specific inspection and repair, please contact our service center or your local dealer.)

E0203

This error appears when the REAL TIME CLOCK inside of the controller is not operating properly. Please proceed as follows to solve the problem.

1. Please contact our service center immediately. Do not attempt to fix it yourself

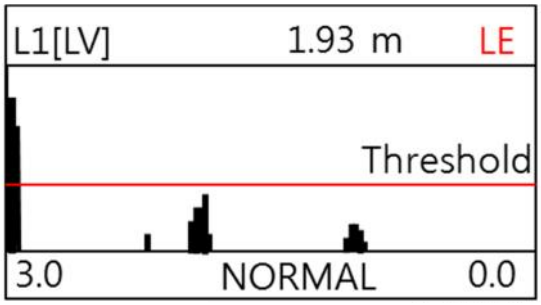
2. REAL TIME CLOCK is sensitive and cannot be handled by non-experts. If you need specific inspection and repair, please contact our service center or your local dealer.

E1204

This error appears when the received signal from sensor1 is abnormal. “LE” will be flashing on the screen. Please proceed as follows to solve the problem.

1. Check the installation position of the sensor

2. Please check the strength of the received signal at the Echo Trend graph on the screen. If the received signal shows lower waveform than the default Threshold value, please check the installation location of the sensor.



Transmitting Signal Receiving Signal

*** To see Echo Trend graph, press the [down] button on the Measuring Mode till the graph shows up on the screen.*

3. Please make sure that the sensor is installed perpendicularly to the object you’re measuring. If it is not, please reinstall it correctly.

4. Check the contamination on the bottom of the sensor

5. Please check if there is a contaminant adhering to the radiating surface. If the radiating surface is contaminated, please wipe it with a soft cloth.

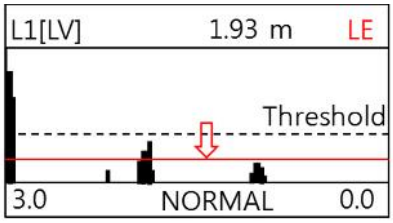
Adjust settings menu corresponding to the measurement object

6. Please check if the measurement object is the ultrasonic absorber (foam, sludge). If it is, the received signal is attenuated than normal condition. Please adjust TX POWER, RX GAIN, and Threshold value at menu [211] to set an appropriate status for your environment.

TX POWER: Please change the default value from 30 to 50 ~ 70

RX GAIN: Please change the default value from 85 to 90 ~ 95

7. If “LE” appears on the screen repeatedly and received value is lower than Threshold value, please change the default Threshold value from 4(0.8V) to 3(0.5V). if it is operating normally, “DT” will be displayed on the screen during normal operation.



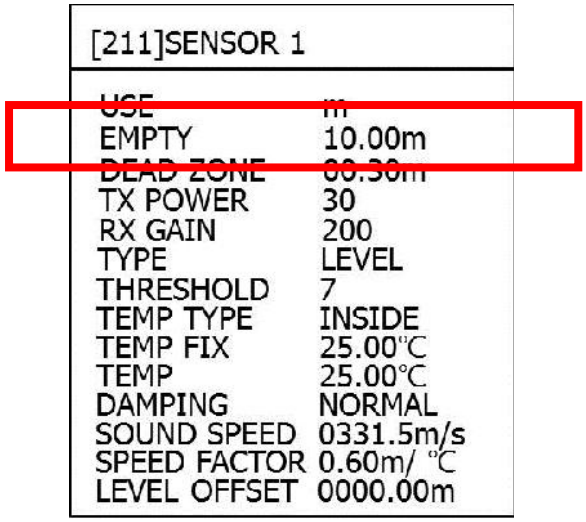
Transmitting Signal Receiving Signal

*** To see Echo Trend graph, press the [down] button on the Measuring Mode till the graph shows up on the screen.*

8. Check the bottom distance setting

9. Please check that the value of the EMPTY has been set within the range.

10. If the problem keeps occurring, please contact our service center or your local dealer.



E2204

This error appears when the signal from sensor2 is not received normally. “LE” will be flashing on the screen. Please proceed as follows to solve the problem.

Processing method is the same as the E1204. （Please refer to Page88.）

E0204

This error appears when the signals from sensor1 and sensor2 are abnormal. “LE” will be flashing on the screen. Please proceed as follows to solve the problem.

Processing method is the same as the E1204. （Please refer to Page 88）

APPENDIX A
FLOW HUNTER III Menu List

APPENDIX A. FLOW HUNTER III Menu List

LEVEL (1000)		
2rd MENU	Range	Default
UNIT	mm/ cm/ m/ in/ yd/ ft	meter
TEMP UNIT	℃ or ℉	℃
EMPTY	0.3m~4.5m	1.2m
DEAD ZONE	0.25m~4.5m	0.30m
TX POWER	1~100	30
RX GAIN	0~100	80
THRESHOLD	1[0.1V], 2[0.3V], 3[0.5V], 4[0.8V], 5[0.9V], 6[1.1V], 7[1.3V], 8[1.6V], 9[1.7V], 10[2.0V]	4[0.8V]
TEMP TYPE	INSIDE/ OUTSIDE/ FIX	INSIDE
TEMP FIX	-30~70℃	25℃
TEMP	Current ambient Temperature	
DAMPING	SLOW/ NORMAL/ FAST/ VERY FAST	NORMAL
SOUND SPEED	1~9999 m/s	331.5m/s
SOUND SPEED FACTOR	-2.0~2.0 m/℃	0.60m/℃

FLOW (2000) > FLOW UNIT(2100)	
l/m, ft3/s, gal/min(US), gal/min(UK), MGD(US), MGD(UK), m3/h, m3/d	m3/h

FLOW (2000) > DEVICE SELECTION(2200)		
3rd MENU	Range	Default
1.Parshall Flume(2210)	1in/ 2in/ 3in/ 6in/ 9in/1ft/ 1.5ft/ 2ft/ 3ft/ 4ft/ 5ft/ 6ft/ 8ft/ 10ft/ 12ft	1in
2.Rect. Suppressed(2220)	1ft/ 1.5ft/ 2ft/ 2.5ft/ 3ft/ 4ft/ 5ft/ 6ft/ 8ft/ 10ft	1ft

3.Rect. Contracted(2230)	1ft/ 1.5ft/ 2ft/ 2.5ft/ 3ft/ 4ft/ 5ft/ 6ft/ 8ft/ 10ft	1ft
4. V-Notch Weir (2240)	22.5°/ 30°/ 45°/ 60°/ 90°/ 120°	22.5°
5. Cipolletti Weir (2250)	1ft/ 1.5ft/ 2ft/ 2.5ft/ 3ft/ 4ft/ 5ft/ 6ft/ 8ft/ 10ft	1ft
6.Leopold Lagco Flume(2260)	4in/ 6in/ 8in/ 10in/ 12in/ 15in/ 18in/ 21in/ 24in/ 30in	4in
7.Palmer Bowlus Flume(2270)	4in/ 6in/ 8in/ 10in/ 12in/ 15in/ 18in/ 21in/ 24in/ 30in	4in
8.H Flume(2280)	0.5H/ 0.75H/ 1.0H/ 1.5H/ 2.0H/ 2.5H/ 3.0H/ 4.5H/ 0.4HS/ 0.6HS/ 0.8HS/ 1.0HS/ 3.0HS/ 4.0HS	0.5H
9.TRAPEZOIDAL Flume(2281)	Sm.60°V / Lg.60°V / XL 60°V / 3.0' 60°V/ 2"45° WSC / 12" 45° SRCRC/ 2.0' SRCRC	Sm.60°V

FLOW (2000) > DEVICE SELECTION(2200) > 10.DIY Curve/Special (2290)			
4th MENU	5th MENU	Range	Default
DIY CURVE (2291)	MAX HEIGHT	DEAD ZONE ~ EMPTY	1.2m
	DIY CURVE 1~20	0.1~200000.0 m3/h	0.1
Q=K*H (PWR) (2292)	K	Constant (0.0001~9999.9999)	0.0001
	PWR	Constant (0.001~9.999)	0.001
	H	mm/ cm/ m/ in/ yd/ ft	m
	Q	m3/h or gal/h	m3/h
Rectangular Weir(2293)	Crest Length	0~10m	0.10m
	Selection	1.Suppressed Weir/ 2.Contraced Weir	1

FLOW (2000) > LOW CUT VALUE(2300)	
0.00 ~ Max. peak flow	0

FLOW (2000) > HIGH CUT VALUE(2400)	
0.00 ~ Max. peak flow	20929.28 m3/h

FLOW (2000) > TOTALIZER(2500)		
3rd MENU	Range	Default
TOTAL FLOW SET (2510)	0.00~999999999.99 unit: 0.01m3	0
TOTAL TIME SET (2520)	0~999999999 unit: 1h	0

RELAY (3000) > FLOW RATE (2600)	
0.001~9.999	1
RELAY (3000) > FLOW INDEX (2700)	
0.001m~ EMPTY	

RELAY (3000) > RELAY1~RELAY3(3100~3300)			
3rd MENU	4th MENU	Range	Defaul t
DETAIL (3210)	FUNCTION	NONE/ LIMIT/ ALTERNATE/ ALARM	NONE
	GROUP	1,2	1
ON POINT (3220)		0.01~ Max. peak flow unit: 0.01m3/h	0.01
OFF POINT (3130)		0.01~ Max. peak flow unit: 0.01m3/h	0.01

RELAY (3000) > SIMULATION (3400)		
3rd MENU	Range	Default
RELAY 1	ON/ OFF	OFF
RELAY 2	ON/ OFF	OFF
RELAY 3	ON/ OFF	OFF

CURRENT OUTPUT(4000)			
2nd MENU	3rd MENU	Range	Default
CURRENT OUTPUT 1 (4100)	INPUT TYPE(4110)	LEVEL/FLOW	FLOW
	4mA POINT SET(4120)	0.00 ~ Max. peak Flow or (0.00~ EMPTY)	0
	20mA POINT SET(4130)	0.00 ~ Max. peak Flow or (0.00~ EMPTY)	0 m3/h
	FAIL SAFE CURRENT (4140)	3.8mA/HOLD/22mA	22mA
CURRENT OUTPUT 2 (4200)	INPUT TYPE(4110)	LEVEL/FLOW	LEVEL
	4mA POINT SET(4120)	0.00 ~ Max. peak Flow or (0.00~ EMPTY)	0

	20mA POINT SET(4130)	0.00 ~ Max. peak Flow or (0.00~ EMPTY)	0
	FAIL SAFE CURRENT (4140)	3.8mA/HOLD/22mA	22mA
SIMULATION(4300)	OUTPUT 1	MEASURE/3.8mA/4mA/12mA/20mA/21mA	MEASURE
	OUTPUT 2	MEASURE/3.8mA/4mA/12mA/20mA/21mA	MEASURE

PULSE OUTPUT (5000)		
2nd MENU	Range	Default
FUNCTION	NONE/USE	NONE
PULSE WIDTH	0.01~1.00 unit: 0.01sec	0.10 sec
PULSE VALUE	0.1~999.9 m3/h 0~9.99999MG	1 m3

COMMUNICATION SETUP (6000)			
2nd MENU	3rd MENU	Range	Default
RS-232 SETUP (6100)	USE	ENABLE/ DISABLE	ENABLE
	BAUDRATE	4800, 9600, 14400, 19200, 38400, 57600, 115200	9600
	PARITY	NONE/ ODD/ EVEN	NONE
	STOP BIT	1 or 2	1
	DATA BIT	8 or 9	8
	PROTOCOL	ECHO/KICT/Modbus-RTU/ Modbus-ASCII	ECHO
RS-485 SETUP (6200)	USE	ENABLE/ DISABLE	DISABLE
	BAUDRATE	4800, 9600, 14400, 19200, 38400, 57600, 115200	9600
	PARITY	NONE/ ODD/ EVEN	NONE
	STOP BIT	1 or 2	1
	DATA BIT	8 or 9	8
	PROTOCOL	ECHO/KICT/Modbus-RTU/ Modbus-ASCII	ECHO

LOGGING SETUP (7000)			
2nd MENU	3nd MENU	Range	Default
LOGGING PERIOD (7100)	LOGGING PERIOD	NONE/ 10 SEC/ 1 MINUTE/ 5 MINUTE/ 10 MINUTE/ 15 MINUTE/ 30 MINUTE/ 60 MINUTE	NONE
LOGGING ERASE (7200)			
USB LOGGING (7300)			

SYSTEM SETUP (8000)			
2nd MENU	3nd MENU	Range	Default
SYSTEM INFO (8100)	-		
SYSTEM ID (8200)	SYSTEM ID	0~99	1
	MODBUS ID	1~247	1
SYSTEM TIME (8300)	SYSTEM TIME	2000/00/00/ 00:00 ~ 2099/12/31 23:59	2013/1/1/00:00
PASSWORD (8400)	PASSWORD	0~9999	0
LANGUAGE (8500)	LANGUAGE	ENGLISH	ENGLISH
FAIL SAFE TIME (8600)	-	20~999 sec	300 sec
BACKUP PARAMETER(8700)	-		
RESET (8800)	FACTORY RESET (8810)		
	USER PAR RESET (8820)		

NAVIGATION (9000)

APPENDIX B
RS-232/RS-485 Protocol

APPENDIX B. RS-232/RS-485 Protocol

1. ECHO Protocol

1.1 Data Output Format

Data format is ASCII and the Data information is as follows.

Data field	DATA START					SYSTEM ID				YEAR
Byte number	1	2	3	4	5	6	7	8	9	10
Data		D	A	T	A		0	0		2
Data field	YEAR				MONTH			DAY		
Byte number	11	12	13	14	15	16	17	18	19	20
Data	0	1	3		1	2		0	3	
Data field	HOUR			MINUTE			SECOND			UNIT
Byte number	21	22	23	24	25	26	27	28	29	30
Data	1	0		5	0		1	5		M
Data field	UNIT	LEVEL							FLOW RATE	
Byte number	31	32	33	34	35	36	37	38	39	40
Data		0	0	0	0	0	0		0	0
Data field	FLOW RATE					TOTAL FLOW				
Byte number	41	42	43	44	45	46	47	48	49	50
Data	0	0	0	0		0	0	0	0	0
Data field	TOTAL FLOW				TEMPERATURE UNIT			TEMPERATURE		
Byte number	51	52	53	54	55	56	57	58	59	60
Data	0	0	0	0		C		+/-	0	0
Data field	TEMPERATURE		DATA END							
Byte number	61	62	63	64	65					
Data	0	0		\n	\r					

The gray column in the table above means space (0*20).

Data output e.g.:

DATA 01 2013 01 01 01 06 15 M 009.60 000.00 009.60 -09.60 000188.46 000000.00 C +0024.0 +0000.0

1.2 Data

1. SYSTEM
2. YEAR/MONTH/DAY/MINUTE/SECOND
3. MEASUREMENT UNIT

UNIT	LEVEL	FLOW RATE	TOTAL FLOW
M	Meter	㎥/h	㎥
c	Centimeter	㎥/h	㎥
m	Millimeter	㎥/h	㎥
f	Feet	GPM[US]	gal[US]
i	Inch	GPM[US]	gal[US]
y	yard	GPM[US]	gal[US]

4. LEVEL
5. FLOW RATE
6. TOTAL FLOW
7. TEMPERATURE UNIT

UNIT	
C	℃
F	℉

8. TEMPERATURE
9. DATA END

2. Modbus

2.1 Modbus DATA Register Table

FLOW HUNTER III provides Modbus RTU frame format and Modbus ASCII frame format. All data register codes are read holding registers. Modbus ID can be set from 1 to 247. (Relevant menu SYSTEM SETUP (8000) > SYSTEM ID > MODBUS ID)

TYPE	Description	START REGISTER		REGISTER OFFSET		REGISTER	DATA DESCRIPTION		R/W
		Hex	Decimal	Hex	Decimal				
ID	Product Code	8001	32769	8000	32768	1	0 = Level(SL-100S) 10 = Flow(FLOW HUNTER III) 20 = Sludge(SL-300S)		R
Unit	Measurement Unit (Level)	8002	32770	8001	32769	1	1 = Meter 2 = Millimeter 3 = Centimeter 4 = feet 5 = inch 6 = yard		R
	Measurement Unit(Flow)	8003	32771	8002	32770	1	1 = cubic meters per hour [m3/h] 2 = cubic meters per day [m3/d] 3 = liters per second [l/s] 4 = cubic feet per second [ft3/s] 5 = imperial gallons per minute [gal/m] 6 = US gallons per minute [gal/m] 7 = imperial million gallons per day [MGD] 8 = US million gallons per day [MGD]		R
	Temperature Unit	8004	32772	8003	32771	1	0 = ℃ 1 = ℉		R
Data	Distance	8011	32785	8010	32784	2	Distance	float	R
	Level	8013	32787	8012	32786	2	level	float	R
	Flowrate	8021	32801	8020	32800	2	Instant Flow	float	R
	Maximum flow rate of the day	8023	32803	8022	32802	2	Highest Flow in a day	float	R
	Minimum flow rate of the day	8025	32805	8024	32804	2	Lowest Flow in a day	float	R
	Total flow	8027	32807	8026	32806	2	Total Flow	float	R
	Total Hour	8029	32809	8028	32808	2	Total Hour	unit32	R
	Temp (inside)	802B	32811	802A	32810	2	Inside Temperature	float	R
	Temp (outside)	802F	32815	802E	32814	2	Outside Temperature	float	R

2.2 Request PDU Example

Product code Request

Function Code	Data Request	
	Register Offset	Quantity
0 X 03	**0 X 8000**	**0 X 0001**

Distance, Level, Flow Rate, Total Flow Request

Function Code	Data Request	
	Register Offset	Quantity
0 X 03	**0 X 8000**	**0 X 0002**
0 X 03	**0 X 8012**	**0 X 0002**
0 X 03	**0 X 8014**	**0 X 0002**
0 X 03	**0 X 8016**	**0 X 0002**

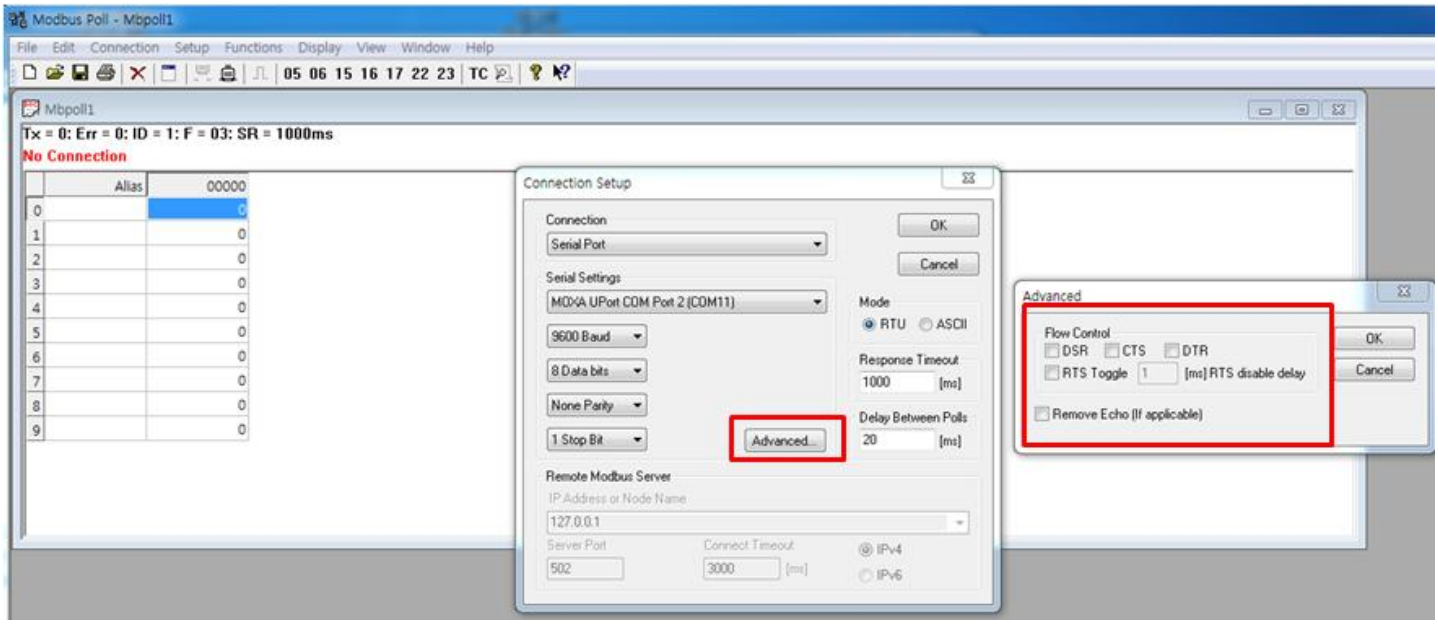
2.3 Modbus Register Data type

Data field: 4byte floating type

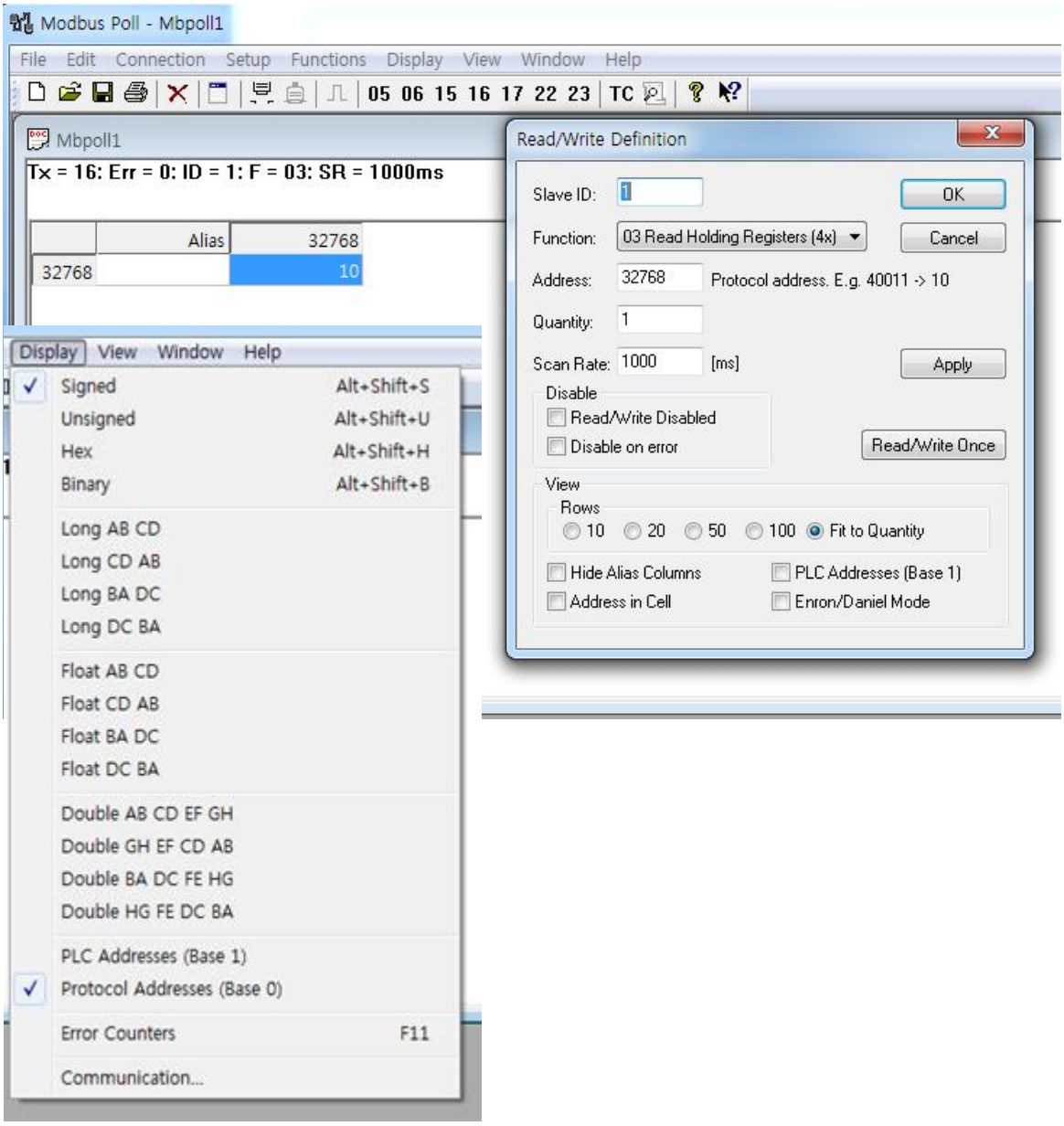
ID, UNIT, Relay field: Unsigned short (2byte) type

Examples using ModBus Poll Software

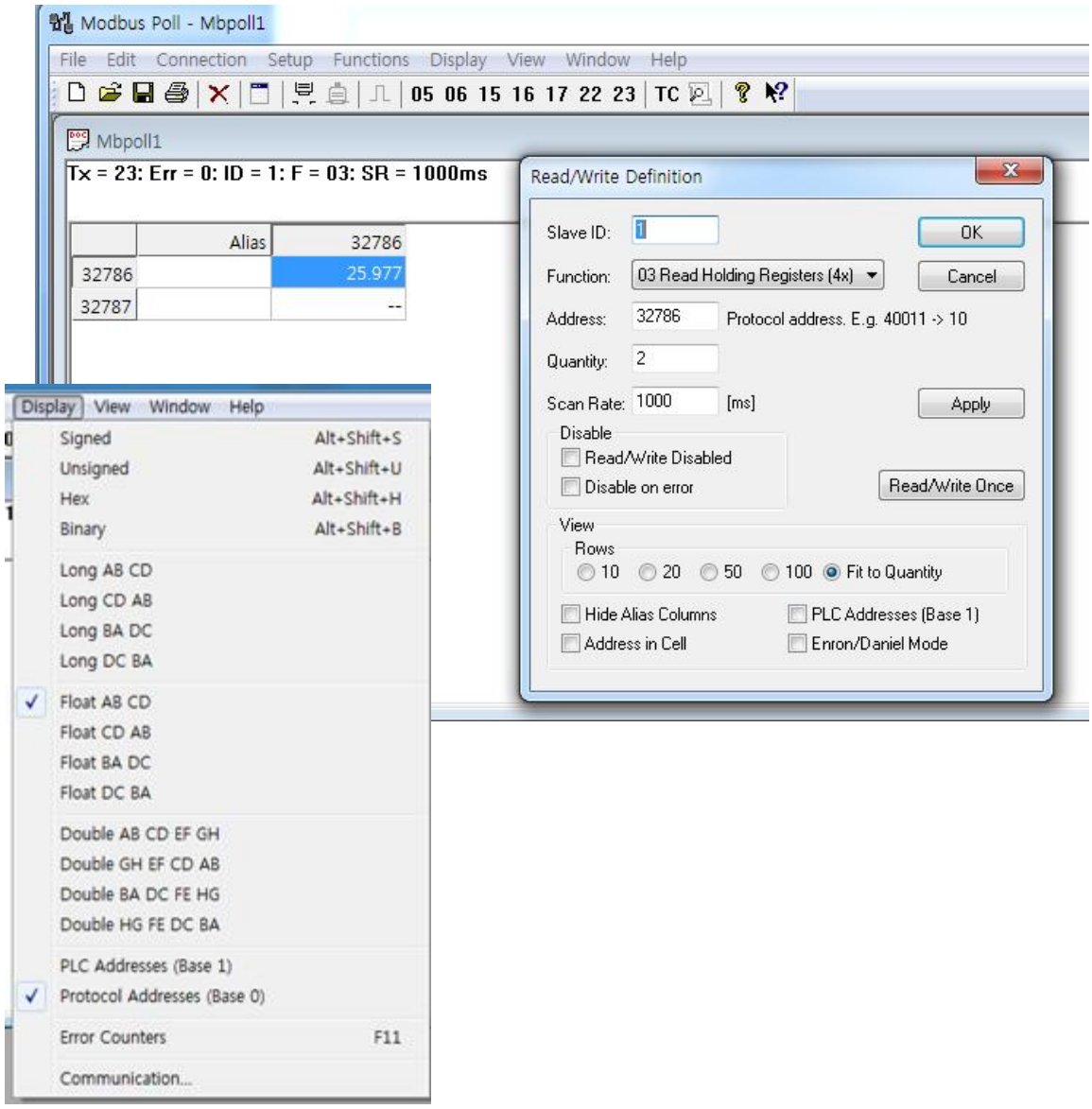
1. Communication Settings



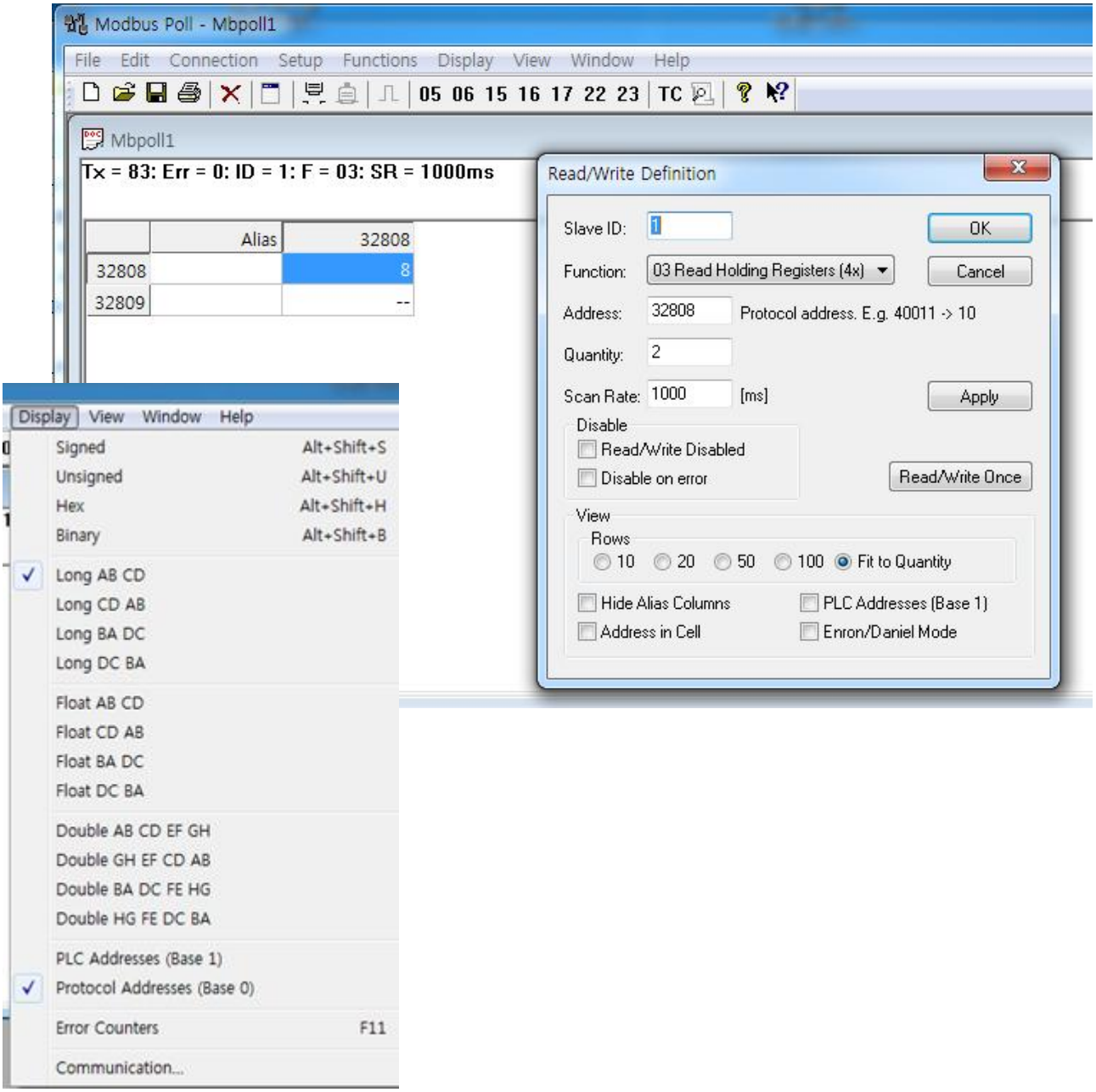
2. Setting for reading the Product Code Register.



3. Setting for reading the Level Register.



4. Setting for reading the Total Hour Register.



APPENDIX C
Hunter III Software

APPENDIX C. Hunter III Software

1. Minimum Requirement

OS & Library

OS: Microsoft Windows XP or Windows 7 32bit/64bit

Library: Microsoft .net Framework v.3.5, MS Chart for .net Framework 3.5 library

Hardware

CPU: 32bit or 64bit Intel Pentium 31 Ghz

Memory: 256MB

Port: RS232 port (when receiving the data from the control board through RS232)

2. Installation

Installing program file

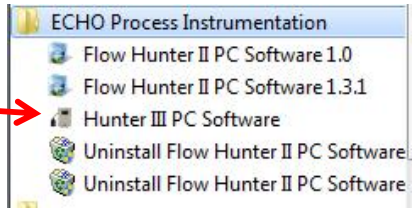
The software is provided by ECHO. Click the Hunter III PC Software.

Installing Process

Select the options in each process and click the [Next] button.

Running Program

The directory "ECHO Process Instrumentation" is created in the computer. Click the Hunter III PC Software.



3. Initial Display

4. File menu

4.1 Open

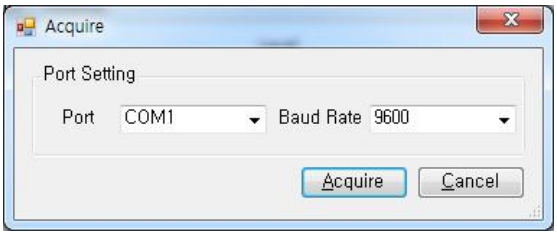
The flow data format is CSV. This menu is to open the CSV files.

4.2 Save

This menu is to save the flow data from FLOW HUNTER III when it is connected with RS232 port. The data is saved as CSV format. File name is made by the user.

4.3 Acquire

This menu is to acquire the data from FLOW HUNTER III when it is connected with RS232 port.



Port

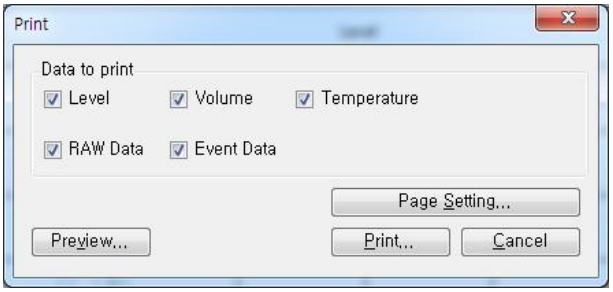
Select COM Port to access the device.

Baud Rate

Select the Baud Rate which set in menu 6100. If the Baud Rate is not identical with the selected rate in menu 6100, errors may occur.

4.4. Print

This menu is to print the selected file or the data from the device.



Data to Print

It is selection of data range such as Level, Volume, Temperature, Raw data, and Event Data. Level, Volume and Temperature are printed always horizontally.

Page Setting

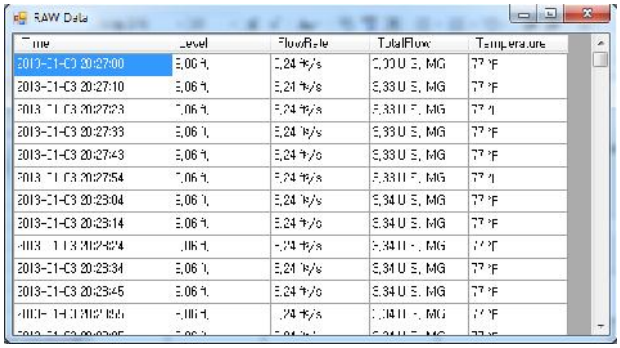
It is selection of paper size, layout, margin width etc.

Preview

The selected data is previewed.

Print

The selected data is printed.



5. View

5.1 RAW Data

This menu is to view the raw data from the device.

Time

It shows the time when the data was logged.

The format is Year-Month-Day Hour: Minute: Second.

Level

It shows the level data by selected unit in the program.

Flowrate

It shows the instant flow rate by selected unit in the program.

Total Flow

It shows the Total Flow rate by selected unit in Flowrate menu. Please refer to the table as follows.

(e.g.) if the Flowrate unit is selected ㎥/h, the total Flow is displayed in ㎥ unit.

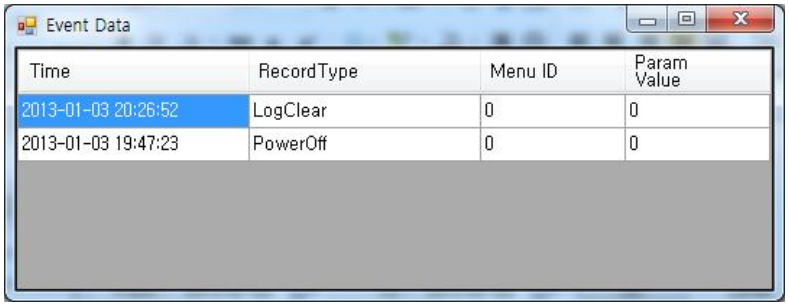
Flow Unit	Total Flow Unit
m3/h	**m3**
m3/d	**m3**
l/min	**KL(Kilo Liter)**
ft3/s	**ft3**
GPM[US]	**gal[US]**
GPM[UK]	**gal[UK]**
MGD[US]	**MG[US]**
MGD[US]	**MG[UK]**

Temperature

It shows the temperature when the data were logged. If there was some problem to log the temperature, it shows “- - -“

Event Data

It shows the event data.



Time

It shows the time when the event data was logged.

Record Type

It shows the event classification.

Menu ID

It shows menu ID when the log type is parameter change Previous or Parameter Change Current.

Parameter Value

It shows changed menu ID and original menu ID when the log type is parameter change Previous or Parameter Change Current.

6. About

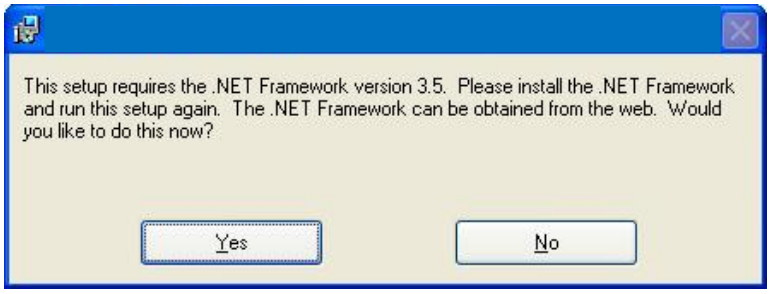
This menu is the information of SW copyright and the contact number of the manufacturer.

7. Troubleshooting

7.1 Installation

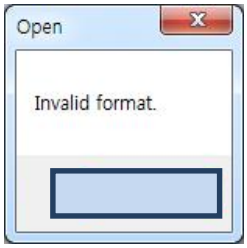
When the library; .net Framework 3.5 isn’t installed in the computer, the message will be occurred as below.

Click the YES button, download .net Framework 3.5 from Microsoft homepage. Reinstall Hunter III program.



OPEN

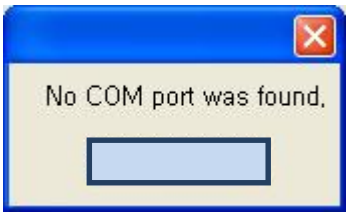
IF the file is not suitable for the SW, the error message shows as below. Check the log file is it from HUNTER III.



Acquire

No COM port was found.

When COM port is not found, the error message shows as right side. When USB to RS232 port is used, check the computer control panel.



Device is not responding

When connected improperly, the error message shows as the picture in right side.

Check the menu; Communication Setup (6100) of FLOW HUNTER III.

It must be as follows.

USE= ENABLE

PROTOCOL= ECHO

Check the BAUDRATE of FH III and the BAUDRATE of the Hunter III SW. They must be identical.

Device is not responding. Check Communication settings.

When connected improperly, the error message shows as the picture in right side.

Check the menu; Communication Setup (6100) of FLOW HUNTER III.

It must be as follows.

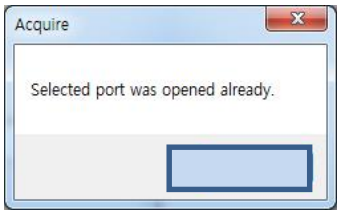
USE= ENABLE

PROTOCOL= ECHO

Check the BAUDRATE of FH III and the BAUDRATE of the Hunter III SW. They must be identical.

Selected port was opened already

When the serial port of the computer is used by another program, this error message shows. Finish the other program and restart the computer.



APPENDIX D
Flow Charts

APPENDIX D. Flow Charts

1. Parshall Flume

LEVEL	FLOW RATE [m3/h]														
[cm]	1"	2"	3"	6"	9"	1ft	1.5ft	2ft	3ft	4ft	5ft	6ft	8ft	10ft	12ft
2	0.5	1.0													
3	0.9	1.9	2.8	5.4	9.0	12.0	17.3								
4	1.5	3.0	4.4	8.5	14.0	18.5	26.9	35.0	50.9						
5	2.1	4.2	6.2	12.1	19.7	26.0	37.9	49.5	72.1						
6	2.8	5.5	8.2	16.1	26.0	34.4	50.2	65.7	96.0	125.5	154.6				
7	3.5	7.0	10.4	20.5	33.0	43.4	63.7	83.4	122.2	160.1	197.4	234.1	306.7		
8	4.3	8.7	12.8	25.4	40.4	53.2	78.2	102.6	150.6	197.6	244.0	289.7	380.1		
9	5.2	10.4	15.3	30.6	48.4	63.7	93.7	123.1	181.1	238.0	294.2	349.6	459.4	570.1	
10	6.1	12.2	18.0	36.1	56.9	74.8	110.2	144.9	213.6	281.0	347.7	413.6	544.1	674.8	801.1
11	7.1	14.2	20.9	42.0	65.8	86.4	127.6	168.0	248.0	326.6	404.5	481.5	634.2	786.0	933.1
12	8.1	16.2	23.9	48.1	75.2	98.7	145.8	192.3	284.2	374.7	464.4	553.2	729.3	903.4	1072.5
13	9.2	18.4	27.1	54.6	85.0	111.5	164.9	217.7	322.1	425.1	527.3	628.5	829.5	1026.9	1219.0
14	10.3	20.6	30.3	61.4	95.2	124.8	184.9	244.2	361.7	477.8	593.1	707.3	934.4	1156.1	1372.5
15	11.5	23.0	33.8	68.5	105.8	138.6	205.5	271.7	403.0	532.8	661.8	789.6	1043.9	1291.1	1532.7
16	12.7	25.4	37.3	75.9	116.7	152.9	227.0	300.3	445.9	589.9	733.1	875.2	1158.0	1431.5	1699.4
17	13.9	27.9	41.0	83.5	128.1	167.7	249.2	329.9	490.3	649.1	807.2	964.1	1276.5	1577.3	1872.5
18	15.2	30.5	44.8	91.4	139.8	182.9	272.1	360.5	536.2	710.4	883.8	1056.1	1399.3	1728.4	2051.8
19	16.6	33.1	48.7	99.5	151.9	198.6	295.7	392.0	583.6	773.7	963.0	1151.2	1526.3	1884.5	2237.2
20	17.9	35.9	52.7	107.9	164.3	214.7	319.9	424.4	632.4	838.9	1044.7	1249.4	1657.5	2045.7	2428.6
21	19.3	38.7	56.8	116.6	177.0	231.3	344.9	457.8	682.6	906.1	1128.8	1350.5	1792.6	2211.8	2625.8
22	20.8	41.6	61.1	125.5	190.0	248.3	370.5	492.0	734.2	975.1	1215.3	1454.5	1931.8	2382.7	2828.7
23	22.3	44.5	65.4	134.6	203.4	265.6	396.7	527.1	787.1	1045.9	1304.1	1561.4	2074.8	2558.4	3037.2
24	23.8	47.6	69.9	143.9	217.1	283.4	423.5	563.0	841.3	1118.6	1395.2	1671.1	2221.7	2738.7	3251.2
25	25.3	50.7	74.4	153.5	231.1	301.6	450.9	599.8	896.9	1193.0	1488.6	1783.5	2372.3	2923.5	3470.6

LEVEL	FLOW RATE [m3/h]														
[cm]	1"	2"	3"	6"	9"	1ft	1.5ft	2ft	3ft	4ft	5ft	6ft	8ft	10ft	12ft
26	26.9	53.9	79.1	163.4	245.4	320.1	479.0	637.4	953.7	1269.2	1584.2	1898.6	2526.7	3112.8	3695.4
27	28.6	57.1	83.8	173.4	260.0	339.1	507.6	675.8	1011.8	1347.1	1682.0	2016.4	2684.6	3306.6	3925.4
28	30.2	60.4	88.7	183.6	274.8	358.4	536.8	715.0	1071.1	1426.6	1781.9	2136.8	2846.2	3504.7	4160.6
29	31.9	63.8	93.6	194.1	290.0	378.0	566.6	755.0	1131.6	1507.8	1884.0	2259.8	3011.3	3707.1	4400.9
30	33.6	67.2	98.7	204.8	305.4	398.0	596.9	795.7	1193.3	1590.7	1988.1	2385.4	3179.9	3913.8	4646.2
31			103.8	215.7	321.2	418.4	627.8	837.2	1256.1	1675.2	2094.3	2513.5	3352.0	4124.6	4896.5
32			109.0	226.8	337.1	439.1	659.2	879.4	1320.2	1761.2	2202.5	2644.0	3527.5	4339.5	5151.6
33			114.3	238.1	353.4	460.2	691.1	922.4	1385.3	1848.9	2312.7	2777.1	3706.3	4558.5	5411.6
34			119.8	249.6	369.9	481.6	723.6	966.1	1451.6	1938.1	2424.9	2912.5	3888.4	4781.5	5676.4
35			125.2	261.3	386.7	503.3	756.6	1010.5	1519.0	2028.8	2539.1	3050.3	4073.8	5008.5	5945.8
36			130.8	273.2	403.7	525.3	790.1	1055.6	1587.6	2121.0	2655.2	3190.5	4262.5	5239.4	6220.0
37			136.5	285.3	421.0	547.7	824.1	1101.4	1657.2	2214.7	2773.2	3333.0	4454.4	5474.2	6498.7
38			142.2	297.5	438.5	570.4	858.6	1147.8	1727.8	2309.9	2893.1	3477.8	4649.4	5712.9	6782.0
39			148.1	310.0	456.3	593.4	893.6	1195.0	1799.6	2406.5	3014.8	3625.0	4847.6	5955.3	7069.8
40			154.0	322.6	474.3	616.7	929.1	1242.8	1872.4	2504.6	3138.4	3774.3	5048.9	6201.5	7362.1
41			160.0	335.5	492.6	640.3	965.0	1291.3	1946.2	2604.1	3263.9	3926.0	5253.3	6451.4	7658.8
42			166.1	348.5	511.1	664.2	1001.5	1340.4	2021.0	2705.1	3391.1	4079.8	5460.7	6705.0	7959.8
43			172.2	361.7	529.8	688.5	1038.4	1390.2	2096.9	2807.4	3520.1	4235.8	5671.1	6962.2	8265.2
44			178.4	375.1	548.8	713.0	1075.8	1440.7	2173.7	2911.1	3650.9	4394.0	5884.6	7223.1	8574.9
45			184.8	388.6	568.0	737.8	1113.6	1491.7	2251.6	3016.2	3783.5	4554.4	6101.0	7487.5	8888.8
46					587.4	762.9	1151.9	1543.4	2330.5	3122.7	3917.8	4716.9	6320.3	7755.5	9207.0
47					607.1	788.3	1190.6	1595.8	2410.3	3230.4	4053.8	4881.5	6542.5	8027.0	9529.3
48					627.0	813.9	1229.8	1648.7	2491.1	3339.6	4191.6	5048.2	6767.7	8302.0	9855.8
49					647.1	839.9	1269.4	1702.2	2572.8	3450.0	4331.0	5217.0	6995.7	8580.5	10186.4
50					667.4	866.1	1309.5	1756.4	2655.5	3561.8	4472.1	5387.8	7226.5	8862.4	10521.0
55					772.1	1001.3	1516.2	2036.0	3083.0	4139.8	5202.4	6272.4	8422.6	10322.4	12254.2
60					882.1	1143.1	1733.3	2330.0	3533.0	4749.1	5972.7	7206.2	9686.7	11864.3	14084.7

LEVEL	FLOW RATE [m3/h]														
[cm]	1"	2"	3"	6"	9"	1ft	1.5ft	2ft	3ft	4ft	5ft	6ft	8ft	10ft	12ft
65					997.0	1291.2	1960.4	2637.7	4004.8	5388.5	6781.7	8187.5	11016.3	13485.3	16009.1
70					1116.7	1445.4	2197.1	2958.8	4497.6	6057.0	7628.1	9214.8	12409.6	15182.9	18024.4
75					1241.0	1605.4	2443.0	3292.8	5010.8	6753.6	8510.8	10286.7	13864.6	16955.0	20128.1
80														18799.4	22317.7
85														20714.3	24591.0
90														22698.0	26945.9
95														24749.0	29380.7
100														26865.8	31893.7
105														29047.1	34483.2
110															37147.8
115															39886.1
120															42696.8
125															45578.6
130															48530.5
135															51551.2

2. Rect. Suppressed

LEVEL [cm]	FLOW RATE [m3/h]									
	1ft	1.5ft	2ft	2.5ft	3ft	4ft	5ft	6ft	8ft	10ft
5	22.55	33.83	45.11	56.39	67.66	90.22	112.77	135.32	180.43	225.54
6	29.65	44.47	59.30	74.12	88.94	118.59	148.24	177.89	237.18	296.48
7	37.36	56.04	74.72	93.40	112.08	149.44	186.80	224.16	298.89	373.61
8	45.65	68.47	91.29	114.12	136.94	182.58	228.23	273.88	365.17	456.46
9	54.47	81.70	108.93	136.17	163.40	217.87	272.33	326.80	435.74	544.67
10	63.79	95.69	127.58	159.48	191.38	255.17	318.96	382.75	510.34	637.92
11	73.60	110.40	147.19	183.99	220.79	294.39	367.98	441.58	588.77	735.97
12	83.86	125.79	167.71	209.64	251.57	335.43	419.29	503.14	670.86	838.57
13	94.55	141.83	189.11	236.39	283.66	378.22	472.77	567.33	756.44	945.55
14	105.67	158.51	211.34	264.18	317.02	422.69	528.36	634.03	845.38	1056.72
15	117.19	175.79	234.39	292.99	351.58	468.78	585.97	703.17	937.55	1171.94
16		193.66	258.21	322.77	387.32	516.43	645.53	774.64	1032.85	1291.07
17		212.10	282.80	353.49	424.19	565.59	706.99	848.39	1131.18	1413.98
18		231.08	308.11	385.14	462.17	616.22	770.28	924.33	1232.45	1540.56
19		250.61	334.14	417.68	501.21	668.28	835.35	1002.42	1336.56	1670.70
20		270.65	360.86	451.08	541.30	721.73	902.16	1082.59	1443.46	1804.32
21		291.20	388.26	485.33	582.40	776.53	970.66	1164.79	1553.06	1941.32
22		312.24	416.33	520.41	624.49	832.65	1040.81	1248.98	1665.30	2081.63
23			445.03	556.29	667.55	890.06	1112.58	1335.10	1780.13	2225.16
24			474.37	592.96	711.55	948.74	1185.92	1423.11	1897.47	2371.84
25			504.32	630.40	756.49	1008.65	1260.81	1512.97	2017.29	2521.62
26			534.88	668.60	802.33	1069.77	1337.21	1604.65	2139.53	2674.42
27			566.04	707.55	849.06	1132.07	1415.09	1698.11	2264.15	2830.18
28			597.77	747.22	896.66	1195.55	1494.43	1793.32	2391.09	2988.86
29			630.08	787.60	945.12	1260.16	1575.20	1890.24	2520.32	3150.40
30			662.95	828.69	994.43	1325.90	1657.38	1988.85	2651.80	3314.75
31				870.47	1044.56	1392.75	1740.93	2089.12	2785.49	3481.86

32				912.92	1095.51	1460.68	1825.85	2191.02	2921.35	3651.69
33				956.05	1147.26	1529.68	1912.10	2294.52	3059.36	3824.20
34				999.83	1199.80	1599.73	1999.67	2399.60	3199.47	3999.33
35				1044.27	1253.12	1670.83	2088.53	2506.24	3341.65	4177.07
36				1089.34	1307.21	1742.94	2178.68	2614.41	3485.88	4357.35
37				1135.04	1362.05	1816.07	2270.08	2724.10	3632.13	4540.17
38					1417.64	1890.19	2362.73	2835.28	3780.37	4725.47
39					1473.97	1965.29	2456.61	2947.93	3930.57	4913.22
40					1531.02	2041.36	2551.70	3062.04	4082.72	5103.39

LEVEL [cm]	FLOW RATE [m3/h]									
	1ft	1.5ft	2ft	2.5ft	3ft	4ft	5ft	6ft	8ft	10ft
41					1588.79	2118.39	2647.98	3177.58	4236.77	5295.96
42					1647.27	2196.36	2745.45	3294.54	4392.72	5490.89
43					1706.45	2275.26	2844.08	3412.90	4550.53	5688.16
44					1766.32	2355.09	2943.87	3532.64	4710.19	5887.73
45					1826.88	2435.84	3044.79	3653.75	4871.67	6089.59
46						2517.48	3146.85	3776.22	5034.96	6293.70
47						2600.02	3250.02	3900.02	5200.03	6500.04
48						2683.43	3354.29	4025.15	5366.87	6708.59
49						2767.73	3459.66	4151.59	5535.45	6919.32
50						2852.88	3566.11	4279.33	5705.77	7132.21
55						3291.34	4114.18	4937.02	6582.69	8228.36
60						3750.21	4687.77	5625.32	7500.43	9375.53
65							5285.78	6342.94	8457.25	10571.56
70							5907.26	7088.71	9451.62	11814.52
75							6551.35	7861.62	10482.17	13102.71
80							7217.29	8660.75	11547.66	14434.58
85								9485.25	12647.00	15808.75

90								10334.37	13779.17	17223.96
95									14943.23	18679.04
100									16138.35	20172.94
105									17363.73	21704.67
110									18618.65	23273.31
115									19902.42	24878.03
120									21214.41	26518.02
125										28192.54
130										29900.90
135										31642.43
140										33416.52
145										35222.58
150										37060.06

3. Rect. Contracted

LEVEL [cm]	FLOW RATE [m3/h]									
	1ft	1.5ft	2ft	2.5ft	3ft	4ft	5ft	6ft	8ft	10ft
5	21.81	33.09	44.37	55.65	66.92	89.48	112.03	134.58	179.69	224.80
6	28.48	43.30	58.13	72.95	87.78	117.42	147.07	176.72	236.02	295.31
7	35.64	54.33	73.01	91.69	110.37	147.73	185.09	222.45	297.17	371.89
8	43.25	66.07	88.90	111.72	134.54	180.19	225.83	271.48	362.77	454.07
9	51.25	78.48	105.72	132.95	160.18	214.65	269.12	323.59	432.52	541.45
10	59.61	91.50	123.40	155.30	187.19	250.98	314.78	378.57	506.15	633.74
11	68.28	105.08	141.88	178.68	215.48	289.07	362.67	436.27	583.46	730.65
12	77.25	119.18	161.11	203.04	244.97	328.83	412.68	496.54	664.26	831.97
13	86.49	133.77	181.04	228.32	275.60	370.15	464.71	559.26	748.37	937.48
14	95.96	148.80	201.64	254.47	307.31	412.98	518.65	624.33	835.67	1047.02
15	105.66	164.26	222.85	281.45	340.05	457.24	574.44	691.63	926.02	1160.41
16		180.11	244.66	309.21	373.77	502.87	631.98	761.09	1019.30	1277.51

17		196.32	267.02	337.72	408.42	549.82	691.22	832.61	1115.41	1398.20
18		212.89	289.92	366.94	443.97	598.03	752.08	906.14	1214.25	1522.36
19		229.78	313.31	396.85	480.38	647.45	814.52	981.59	1315.73	1649.88
20		246.97	337.19	427.40	517.62	698.05	878.48	1058.91	1419.78	1780.64
21		264.45	361.51	458.58	555.65	749.78	943.91	1138.04	1526.31	1914.57
22		282.19	386.28	490.36	594.44	802.60	1010.76	1218.93	1635.25	2051.58
23			411.45	522.71	633.97	856.48	1079.00	1301.51	1746.54	2191.58
24			437.02	555.61	674.20	911.39	1148.57	1385.75	1860.12	2334.49
25			462.96	589.04	715.12	967.28	1219.44	1471.61	1975.93	2480.25
26			489.26	622.98	756.70	1024.14	1291.58	1559.02	2093.91	2628.79
27			515.90	657.41	798.91	1081.93	1364.95	1647.97	2214.01	2780.04
28			542.86	692.30	841.75	1140.63	1439.52	1738.41	2336.18	2933.95
29			570.13	727.65	885.17	1200.21	1515.25	1830.29	2460.37	3090.45
30			597.70	763.44	929.17	1260.65	1592.13	1923.60	2586.55	3249.50
31				799.64	973.73	1321.92	1670.11	2018.29	2714.67	3411.04
32				836.25	1018.83	1384.00	1749.17	2114.34	2844.68	3575.02
33				873.24	1064.45	1446.87	1829.29	2211.71	2976.55	3741.39
34				910.61	1110.58	1510.51	1910.44	2310.38	3110.24	3910.11
35				948.34	1157.19	1574.90	1992.60	2410.31	3245.72	4081.14
36				986.41	1204.28	1640.01	2075.75	2511.48	3382.95	4254.43
37				1024.81	1251.82	1705.84	2159.86	2613.87	3521.91	4429.94

LEVEL	FLOW RATE [m3/h]									
[cm]	1ft	1.5ft	2ft	2.5ft	3ft	4ft	5ft	6ft	8ft	10ft
38				1063.54	1299.81	1772.36	2244.91	2717.45	3662.55	4607.64
39					1348.23	1839.56	2330.88	2822.20	3804.84	4787.49
40					1397.07	1907.41	2417.75	2928.09	3948.77	4969.45
41					1446.31	1975.91	2505.50	3035.10	4094.29	5153.49

42					1495.94	2045.03	2594.12	3143.21	4241.39	5339.57
43					1545.96	2114.77	2683.59	3252.40	4390.04	5527.67
44					1596.33	2185.11	2773.88	3362.65	4540.20	5717.75
45					1647.07	2256.02	2864.98	3473.94	4691.86	5909.78
46						2327.51	2956.88	3586.25	4844.99	6103.73
47						2399.56	3049.56	3699.56	4999.57	6299.58
48						2472.14	3143.00	3813.86	5155.58	6497.29
49						2545.26	3237.19	3929.12	5312.98	6696.85
50						2618.89	3332.11	4045.33	5471.77	6898.21
55						2994.39	3817.22	4640.06	6285.73	7931.40
60						3381.10	4318.65	5256.21	7131.31	9006.42
65							4834.89	5892.05	8006.36	10120.68
70							5364.60	6546.05	8908.96	11271.86
75							5906.54	7216.81	9837.35	12457.89
80							6459.57	7903.03	10789.94	13676.86
85								8603.53	11765.28	14927.03
90								9317.21	12762.00	16206.79
95									13778.86	17514.67
100									14814.67	18849.26
105									15868.33	20209.27
110									16938.82	21593.48
115									18025.14	23000.75
120									19126.38	24429.98
125										25880.16
130										27350.29
135										28839.46
140										30346.76
145										31871.35
150										33412.41

4. V-Notch Weir

LEVEL	FLOW RATE [m3/h]						LEVEL	FLOW RATE [m3/h]					
[cm]	22.5°	30°	45°	60°	90°	120°	[cm]	22.5°	30°	45°	60°	90°	120°
1.0	0.01	0.01	0.02	0.03	0.05	0.09	31.0	52.85	71.25	110.07	153.45	265.86	460.47
2.0	0.06	0.08	0.12	0.16	0.28	0.49	32.0	57.22	77.14	119.16	166.13	287.82	498.51
3.0	0.15	0.21	0.32	0.45	0.77	1.34	33.0	61.79	83.30	128.69	179.42	310.84	538.37
4.0	0.32	0.43	0.66	0.92	1.59	2.75	34.0	66.58	89.76	138.66	193.32	334.92	580.09
5.0	0.55	0.74	1.15	1.60	2.78	4.81	35.0	71.59	96.51	149.08	207.85	360.10	623.69
6.0	0.87	1.17	1.81	2.53	4.38	7.59	36.0	76.81	103.55	159.96	223.01	386.37	669.20
7.0	1.28	1.73	2.67	3.72	6.44	11.16	37.0	82.26	110.89	171.30	238.83	413.77	716.64
8.0	1.79	2.41	3.72	5.19	8.99	15.58	38.0	87.93	118.53	183.11	255.29	442.29	766.05
9.0	2.40	3.24	5.00	6.97	12.07	20.91	39.0	93.83	126.49	195.39	272.42	471.97	817.45
10.0	3.12	4.21	6.51	9.07	15.71	27.21	40.0	99.96	134.75	208.16	290.22	502.81	870.86
11.0	3.96	5.34	8.26	11.51	19.94	34.54	41.0	106.32	143.33	221.42	308.70	534.82	926.31
12.0	4.93	6.64	10.26	14.31	24.79	42.93	42.0	112.92	152.23	235.17	327.87	568.03	983.83
13.0	6.02	8.11	12.53	17.48	30.28	52.44	43.0	119.77	161.46	249.41	347.73	602.45	1043.44
14.0	7.24	9.77	15.09	21.03	36.44	63.11	44.0	126.85	171.01	264.17	368.31	638.09	1105.17
15.0	8.61	11.60	17.93	24.99	43.30	74.99	45.0	134.18	180.89	279.44	389.59	674.97	1169.04
16.0	10.12	13.64	21.06	29.37	50.88	88.12	46.0	141.76	191.11	295.22	411.60	713.09	1235.07
17.0	11.77	15.87	24.51	34.17	59.21	102.55	47.0	149.59	201.66	311.53	434.33	752.48	1303.29
18.0	13.58	18.30	28.28	39.42	68.30	118.30	48.0	157.68	212.56	328.36	457.80	793.15	1373.73
19.0	15.54	20.95	32.37	45.13	78.19	135.42	49.0	166.02	223.81	345.73	482.02	835.10	1446.40
20.0	17.67	23.82	36.80	51.30	88.88	153.95	50.0	174.62	235.40	363.64	506.99	878.36	1521.33
21.0	19.96	26.91	41.57	57.96	100.41	173.92	51.0	183.48	247.35	382.10	532.72	922.94	1598.54
22.0	22.42	30.23	46.70	65.11	112.80	195.37	52.0	192.61	259.65	401.11	559.22	968.85	1678.06
23.0	25.06	33.78	52.19	72.76	126.06	218.33	53.0	202.00	272.32	420.67	586.50	1016.11	1759.90
24.0	27.87	37.58	58.05	80.93	140.21	242.84	54.0	211.67	285.34	440.79	614.55	1064.72	1844.09
25.0	30.87	41.61	64.28	89.62	155.27	268.94	55.0	221.60	298.74	461.48	643.40	1114.70	1930.65
26.0	34.05	45.90	70.91	98.86	171.27	296.64	56.0	231.81	312.50	482.75	673.05	1166.06	2019.61

27.0	37.42	50.44	77.92	108.64	188.22	325.99	57.0	242.30	326.64	504.59	703.50	1218.81	2110.98
28.0	40.98	55.24	85.34	118.98	206.13	357.02	58.0	253.07	341.16	527.01	734.76	1272.98	2204.79
29.0	44.74	60.31	93.16	129.89	225.03	389.76	59.0	264.12	356.05	550.02	766.84	1328.56	2301.06
30.0	48.69	65.64	101.40	141.38	244.94	424.23	60.0	275.45	371.33	573.63	799.75	1385.57	2399.81

5. Cipoletti Weir

LEVEL [cm]	FLOW RATE [m3/h]									
	1ft	1.5ft	2ft	2.5ft	3ft	4ft	5ft	6ft	8ft	10ft
5	22.80	34.21	45.61	57.01	68.41	91.23	114.06	136.81	182.46	228.05
6	29.98	44.97	59.95	74.95	89.92	119.93	149.93	179.85	239.86	299.77
7	37.78	56.67	75.55	94.45	113.32	151.13	188.94	226.63	302.25	377.76
8	46.15	69.24	92.31	115.39	138.45	184.64	230.84	276.89	369.28	461.53
9	55.07	82.62	110.14	137.69	165.20	220.32	275.44	330.40	440.64	550.72
10	64.50	96.76	129.00	161.26	193.48	258.04	322.60	386.97	516.09	645.01
11	74.41	111.63	148.83	186.05	223.22	297.70	372.18	446.44	595.40	744.14
12	84.79	127.20	169.58	211.99	254.34	339.21	424.07	508.68	678.41	847.89
13	95.61	143.42	191.21	239.03	286.79	382.48	478.17	573.58	764.96	956.06
14	106.85	160.29	213.69	267.13	320.51	427.45	534.39	641.02	854.90	1068.46
15	118.50	177.76	236.99	296.26	355.45	474.06	592.66	710.91	948.11	1184.96
16		195.83	261.08	326.37	391.59	522.24	652.90	783.17	1044.49	1305.41
17		214.47	285.94	357.44	428.86	571.96	715.06	857.73	1143.92	1429.69
18		233.67	311.53	389.44	467.26	623.16	779.07	934.51	1246.32	1557.67
19		253.42	337.85	422.34	506.73	675.81	844.88	1013.46	1351.61	1689.27
20		273.68	364.87	456.12	547.26	729.86	912.46	1094.51	1459.71	1824.37
21		294.46	392.58	490.75	588.81	785.27	981.74	1177.62	1570.55	1962.89
22		315.74	420.95	526.22	631.36	842.03	1052.69	1262.73	1684.06	2104.76
23			449.98	562.50	674.90	900.09	1125.28	1349.80	1800.17	2249.88
24			479.64	599.58	719.39	959.42	1199.45	1438.78	1918.84	2398.20
25			509.93	637.45	764.81	1020.01	1275.20	1529.63	2040.01	2549.64

26			540.83	676.07	811.16	1081.81	1352.47	1622.32	2163.63	2704.13
27			572.33	715.45	858.40	1144.82	1431.24	1716.81	2289.65	2861.63
28			604.41	755.56	906.53	1209.01	1511.49	1813.06	2418.02	3022.07
29			637.08	796.40	955.53	1274.35	1593.18	1911.06	2548.70	3185.41
30			670.32	837.95	1005.38	1340.83	1676.29	2010.75	2681.66	3351.58
31				880.19	1056.06	1408.43	1760.80	2112.12	2816.86	3520.55
32				923.12	1107.57	1477.13	1846.68	2215.14	2954.25	3692.27
33				966.73	1159.89	1546.90	1933.92	2319.78	3093.81	3866.69
34				1011.00	1213.01	1617.75	2022.49	2426.02	3235.50	4043.77
35				1055.93	1266.92	1689.64	2112.37	2533.84	3379.28	4223.48
36				1101.51	1321.60	1762.57	2203.54	2643.20	3525.14	4405.77
37				1147.72	1377.05	1836.52	2295.99	2754.09	3673.04	4590.61
38				1194.56	1433.25	1911.47	2389.69	2866.50	3822.94	4777.97

LEVEL [㎝]	FLOW RATE [m3/h]									
	1ft	1.5ft	2ft	2.5ft	3ft	4ft	5ft	6ft	8ft	10ft
39					1490.20	1987.42	2484.64	2980.39	3974.84	4967.81
40					1547.88	2064.35	2580.82	3095.75	4128.69	5160.10
41					1606.28	2142.24	2678.20	3212.57	4284.48	5354.81
42					1665.41	2221.09	2776.78	3330.81	4442.18	5551.90
43					1725.24	2300.89	2876.54	3450.48	4601.77	5751.36
44					1785.77	2381.61	2977.46	3571.54	4763.23	5953.15
45					1846.99	2463.27	3079.54	3693.98	4926.53	6157.25
46						2545.83	3182.76	3817.80	5091.66	6363.63
47						2629.30	3287.11	3942.97	5258.59	6572.26
48						2713.65	3392.57	4069.47	5427.31	6783.13
49						2798.90	3499.14	4197.30	5597.79	6996.20
50						2885.01	3606.80	4326.45	5770.02	7211.46
55						3328.41	4161.13	4991.38	6656.82	8319.78

60						3792.45	4741.26	5687.26	7584.89	9479.71
65							5346.10	6412.78	8552.49	10689.03
70							5974.67	7166.77	9558.06	11945.80
75							6626.11	7948.19	10600.21	13248.29
80							7299.65	8756.11	11677.71	14594.96
85							7994.58	9589.69	12789.42	15984.40
90							8710.25	10448.17	13934.34	17415.33
95									15111.51	18886.59
100									16320.09	20397.08
105									17559.27	21945.83
110									18828.32	23531.91
115									20126.55	25154.45
120									21453.31	26812.66
125										28505.79
130										30233.13
135										31994.01
140										33787.82
145										35613.94
150										37471.83

6. Leopold Lagco Flume

LEVEL [cm]	FLOW RATE [m3/h]									
	4"	6"	8"	10"	12"	15"	18"	21"	24"	30"
1.0	0.44	0.64	0.84	1.04	1.24	1.54	1.83	2.12	2.40	2.97
1.5	0.82	1.20	1.58	1.95	2.33	2.88	3.42	3.96	4.50	5.57
2.0	1.27	1.87	2.47	3.05	3.63	4.49	5.34	6.19	7.03	8.69
2.5	1.80	2.65	3.48	4.31	5.12	6.34	7.54	8.74	9.92	12.27
3.0	2.38	3.51	4.62	5.71	6.79	8.40	10.00	11.58	13.15	16.27
3.5	3.03	4.45	5.86	7.25	8.62	10.67	12.69	14.70	16.70	20.65

4.0	3.72	5.48	7.21	8.91	10.60	13.11	15.60	18.07	20.53	25.39
4.5	4.47	6.57	8.65	10.69	12.72	15.74	18.72	21.69	24.63	30.47
5.0	5.26	7.73	10.18	12.59	14.97	18.52	22.04	25.53	28.99	35.86
5.5	6.09	8.96	11.80	14.59	17.35	21.46	25.54	29.58	33.60	41.56
6.0	6.97	10.25	13.49	16.69	19.85	24.56	29.22	33.84	38.44	47.54
6.5	7.89	11.60	15.27	18.89	22.47	27.79	33.07	38.30	43.50	53.81
7.0	8.84	13.01	17.13	21.18	25.20	31.17	37.08	42.96	48.79	60.35
7.5		14.48	19.06	23.57	28.04	34.68	41.26	47.80	54.29	67.15
8.0		16.00	21.06	26.04	30.98	38.32	45.59	52.82	59.98	74.20
8.5		17.57	23.13	28.60	34.03	42.09	50.08	58.01	65.88	81.49
9.0		19.20	25.27	31.25	37.18	45.98	54.71	63.37	71.97	89.03
9.5		20.87	27.47	33.97	40.42	49.99	59.48	68.90	78.25	96.79
10.0		22.60	29.74	36.78	43.76	54.12	64.39	74.59	84.72	104.79
11.0			34.47	42.62	50.71	62.72	74.62	86.44	98.17	121.43
12.0			39.43	48.76	58.02	71.75	85.37	98.89	112.32	138.93
13.0			44.63	55.19	65.66	81.21	96.63	111.93	127.13	157.24
14.0				61.89	73.64	91.08	108.36	125.53	142.57	176.34
15.0				68.86	81.93	101.34	120.57	139.67	158.63	196.21
16.0				76.09	90.54	111.98	133.23	154.33	175.28	216.81
17.0				83.58	99.44	122.99	146.33	169.50	192.52	238.12
18.0				91.30	108.63	134.36	159.86	185.18	210.31	260.14
19.0					118.11	146.08	173.80	201.33	228.66	282.83
20.0					127.86	158.14	188.16	217.96	247.55	306.19
21.0					137.89	170.54	202.91	235.04	266.95	330.20
22.0						183.27	218.05	252.58	286.87	354.84

LEVEL [cm]	FLOW RATE [m3/h]									
	4"	6"	8"	10"	12"	15"	18"	21"	24"	30"
23.0						196.31	233.57	270.56	307.29	380.10
24.0						209.67	249.47	288.98	328.21	405.96
25.0						223.34	265.73	307.82	349.60	432.43
26.0						237.31	282.35	327.07	371.47	459.48
27.0						251.58	299.33	346.73	393.81	487.10
28.0							316.65	366.80	416.60	515.29
29.0							334.31	387.26	439.84	544.04
30.0							352.32	408.12	463.52	573.33
31.0							370.65	429.35	487.64	603.17
32.0							389.31	450.97	512.19	633.53
33.0								472.95	537.16	664.42
34.0								495.31	562.55	695.82
35.0								518.03	588.35	727.74
36.0								541.10	614.56	760.15
37.0								564.53	641.17	793.06
38.0								588.31	668.17	826.47
39.0									695.57	860.35
40.0									723.35	894.72
41.0									751.52	929.56
42.0									780.06	964.87
43.0										1000.64
44.0										1036.86
45.0										1073.54
46.0										1110.67
47.0										1148.25
48.0										1186.26
49.0										1224.71

50.0										1263.59

7. Palmer Bowlus Flume

LEVEL [cm]	FLOW RATE [m3/h]									
	4"	6"	8"	10"	12"	15"	18"	21"	24"	30"
1.0	0.30	0.40	0.48	0.55	0.63	0.71	0.82	0.91	0.98	1.06
1.5	0.63	0.83	1.01	1.16	1.32	1.50	1.71	1.91	2.06	2.23
2.0	1.07	1.41	1.71	1.96	2.23	2.54	2.90	3.23	3.48	3.77
2.5	1.61	2.11	2.57	2.95	3.36	3.82	4.36	4.85	5.24	5.67
3.0	2.24	2.95	3.58	4.12	4.69	5.34	6.09	6.77	7.32	7.92
3.5	2.98	3.91	4.75	5.47	6.21	7.07	8.07	8.98	9.70	10.50
4.0	3.80	5.00	6.06	6.98	7.93	9.03	10.31	11.47	12.39	13.40
4.5	4.71	6.20	7.52	8.66	9.84	11.21	12.79	14.23	15.36	16.63
5.0	5.71	7.52	9.12	10.50	11.94	13.59	15.51	17.25	18.63	20.16
5.5	6.80	8.95	10.86	12.50	14.21	16.18	18.46	20.54	22.18	24.00
6.0	7.98	10.49	12.73	14.66	16.66	18.97	21.65	24.08	26.01	28.15
6.5	9.24	12.15	14.74	16.97	19.29	21.96	25.06	27.88	30.11	32.59
7.0	10.58	13.91	16.88	19.44	22.09	25.15	28.70	31.93	34.49	37.32
7.5		15.78	19.15	22.05	25.07	28.54	32.56	36.23	39.13	42.34
8.0		17.76	21.55	24.82	28.21	32.12	36.65	40.77	44.03	47.65
8.5		19.85	24.08	27.73	31.52	35.88	40.95	45.56	49.20	53.24
9.0		22.04	26.74	30.79	35.00	39.84	45.46	50.58	54.63	59.11
9.5		24.33	29.52	33.99	38.64	43.98	50.19	55.84	60.31	65.26
10.0		26.72	32.42	37.33	42.44	48.31	55.13	61.34	66.24	71.68
11.0			38.60	44.45	50.52	57.52	65.63	73.02	78.86	85.34
12.0			45.27	52.12	59.24	67.45	76.96	85.63	92.48	100.07
13.0			52.41	60.34	68.59	78.09	89.10	99.14	107.07	115.85
14.0			60.02	69.10	78.55	89.43	102.05	113.53	122.62	132.68
15.0			68.10	78.40	89.12	101.46	115.78	128.81	139.12	150.54

16.0				88.23	100.30	114.18	130.29	144.96	156.56	169.41
17.0				98.58	112.07	127.58	145.58	161.97	174.93	189.29
18.0				109.45	124.42	141.65	161.63	179.83	194.22	210.16
19.0					137.36	156.38	178.44	198.53	214.41	232.01
20.0					150.88	171.77	196.00	218.07	235.52	254.85

LEVEL [cm]	FLOW RATE [m3/h]									
	4"	6"	8"	10"	12"	15"	18"	21"	24"	30"
21.0					164.97	187.81	214.31	238.44	257.51	278.65
22.0						204.50	233.35	259.62	280.39	303.41
23.0						221.83	253.13	281.63	304.16	329.12
24.0						239.80	273.63	304.44	328.79	355.78
25.0						258.40	294.86	328.05	354.30	383.38
26.0						277.63	316.80	352.46	380.66	411.90
27.0						297.48	339.45	377.67	407.88	441.36
28.0							362.81	403.66	435.95	471.73
29.0							386.87	430.43	464.86	503.02
30.0							411.63	457.98	494.62	535.21
31.0							437.09	486.30	525.20	568.31
32.0							463.24	515.39	556.62	602.31
33.0								545.25	588.87	637.20
34.0								575.86	621.93	672.98
35.0								607.23	655.81	709.64
36.0								639.36	690.51	747.19
37.0								672.23	726.01	785.61
38.0								705.86	762.32	824.90
39.0									799.44	865.06
40.0									837.35	906.08

41.0									876.05	947.96
42.0									915.55	990.70
43.0										1034.29
44.0										1078.73
45.0										1124.02
46.0										1170.15
47.0										1217.12
48.0										1264.93
49.0										1313.57
50.0										1363.05

8. H Flume

LEVEL [cm]	FLOW RATE [m3/h]													
	0.5H	0.75H	1.0H	1.5H	2.0H	2.5H	3.0H	4.5H	0.4HS	0.6HS	0.8HS	1.0HS	3.0HS	4.0HS
5.0	2.86	3.39	3.90	4.97	6.08	5.97	8.16	11.24	1.19	1.41	1.59	1.88	16.08	19.95
6.0	4.24	4.93	5.61	7.02	8.47	8.53	11.21	15.29	1.77	2.04	2.29	2.67	22.01	27.11
7.0	5.96	6.80	7.68	9.46	11.26	11.54	14.74	19.90	2.48	2.82	3.13	3.61	28.85	35.29
8.0	8.02	9.04	10.11	12.29	14.47	15.01	18.74	25.07	3.33	3.74	4.12	4.70	36.60	44.50
9.0	10.44	11.65	12.95	15.55	18.11	18.97	23.24	30.81	4.34	4.81	5.27	5.96	45.30	54.75
10.0	13.26	14.67	16.19	19.24	22.19	23.41	28.25	37.12	5.50	6.05	6.59	7.39	54.96	66.05
11.0	16.48	18.11	19.87	23.38	26.74	28.37	33.77	44.02	6.84	7.46	8.09	9.00	65.60	78.44
12.0	20.12	21.99	23.99	27.99	31.76	33.84	39.82	51.51	8.35	9.04	9.76	10.79	77.25	91.91
13.0	24.20	26.33	28.58	33.09	37.27	39.85	46.41	59.60		10.80	11.63	12.76	89.93	106.50
14.0	28.74	31.15	33.66	38.68	43.30	46.41	53.56	68.31		12.75	13.69	14.94	103.66	122.21
15.0	33.75	36.48	39.23	44.78	49.84	53.53	61.27	77.63		14.89	15.94	17.31	118.46	139.08
16.0		42.32	45.32	51.41	56.93	61.22	69.55	87.59		17.24	18.41	19.89	134.36	157.11
17.0		48.69	51.93	58.57	64.56	69.51	78.43	98.19		19.79	21.08	22.68	151.37	176.33
18.0		55.62	59.08	66.29	72.77	78.40	87.91	109.44		22.55	23.98	25.69	169.53	196.77
19.0		63.12	66.80	74.58	81.56	87.90	97.99	121.36			27.09	28.92	188.84	218.42

20.0		71.21	75.08	83.44	90.94	98.03	108.70	133.94			30.44	32.38	209.33	241.33
21.0		79.90	83.95	92.90	100.93	108.80	120.05	147.21			34.02	36.07	231.03	265.50
22.0		89.20	93.42	102.95	111.55	120.22	132.04	161.17			37.84	40.00	253.94	290.95
23.0			103.50	113.62	122.81	132.31	144.68	175.83			41.90	44.17	278.10	317.71
24.0			114.20	124.92	134.72	145.07	157.99	191.20			46.21	48.58	303.52	345.79
25.0			125.53	136.86	147.30	158.52	171.98	207.29				53.25	330.22	375.21
26.0			137.52	149.45	160.55	172.66	186.66	224.11				58.17	358.22	405.99
27.0			150.16	162.69	174.50	187.52	202.03	241.67				63.35	387.54	438.15
28.0			163.48	176.61	189.16	203.10	218.11	259.98				68.80	418.20	471.70
29.0			177.48	191.21	204.53	219.40	234.91	279.04				74.51	450.22	506.66
30.0			192.18	206.51	220.63	236.45	252.43	298.87				80.50	483.61	543.05
31.0				222.51	237.48	254.26	270.69	319.48					518.39	580.89
32.0				239.22	255.08	272.82	289.70	340.88					554.59	620.19
33.0				256.66	273.46	292.16	309.46	363.06					592.21	660.97
34.0				274.83	292.61	312.28	329.99	386.05					631.28	703.26
35.0				293.75	312.56	333.20	351.30	409.85					671.82	747.05

LEVEL [cm]	FLOW RATE [m3/h]													
	0.5H	0.75H	1.0H	1.5H	2.0H	2.5H	3.0H	4.5H	0.4HS	0.6HS	0.8HS	1.0HS	3.0HS	4.0HS
36.0				313.42	333.31	354.92	373.38	434.47					713.84	792.38
37.0				333.85	354.88	377.45	396.26	459.92					757.35	839.25
38.0				355.06	377.28	400.81	419.95	486.21					802.38	887.69
39.0				377.05	400.52	425.00	444.44	513.34					848.94	937.71
40.0				399.83	424.62	450.03	469.75	541.33					897.05	989.32
41.0				423.41	449.57	475.91	495.89	570.17					946.72	1042.55
42.0				447.80	475.41	502.65	522.87	599.89					997.98	1097.40
43.0				473.02	502.13	530.26	550.69	630.49					1050.83	1153.89
44.0				499.06	529.74	558.75	579.36	661.97					1105.29	1212.05
45.0				525.94	558.27	588.13	608.90	694.34					1161.38	1271.87

46.0					587.72	618.41	639.31	727.62					1219.11	1333.38
47.0					618.10	649.59	670.59	761.81					1278.50	1396.60
48.0					649.42	681.69	702.77	796.92					1339.57	1461.53
49.0					681.69	714.71	735.83	832.95					1402.32	1528.20
50.0					714.93	748.66	769.80	869.92					1466.78	1596.61
55.0					895.95	932.68	953.47	1069.01					1815.14	1965.39
60.0					1102.63	1141.24	1160.85	1292.55					2208.27	2379.98
65.0						1375.33	1392.89	1541.45					2647.92	2842.08
70.0						1635.91	1650.48	1816.56					3135.77	3353.35
75.0						1923.89	1934.48	2118.74					3673.43	3915.38
80.0						2240.18	2245.73	2448.80					4262.48	4529.71
85.0						2585.64	2585.05	2807.53					4904.46	5197.87
90.0						2961.11	2953.22	3195.71					5600.83	5921.31
95.0						3367.41	3351.02	3614.09					6353.06	6701.47
100.0						3805.34	3779.20	4063.41					7162.55	7539.73
105.0						4275.67	4238.48	4544.38					8030.67	8437.46
110.0						4779.17	4729.59	5057.71					8958.77	9395.99
115.0						5316.59	5253.22	5604.10					9948.17	10416.62
120.0						5888.63	5810.05	6184.20					11000.15	11500.64
125.0													12115.97	12649.28
130.0													13296.88	13863.79

9. TRAPEZOIDAL Flume

LEVEL [cm]	FLOW RATE [m3/h]							LEVEL [cm]	FLOW RATE [m3/h]						
	Sm. 60°V	Lg. 60°V	XL. 60°V	3.0' 60°V	2" 45° WSC	12" 45° SRCRC	2.0' SRCRC		Sm. 60°V	Lg. 60°V	XL. 60°V	3.0' 60°V	2" 45° WSC	12" 45° SRCRC	2.0' SRCRC
2.5	0.249	0.249	0.216					18.0			0.386	0.340	0.980	1.202	1.202
3.0	0.399	0.399	0.350					19.0			0.445	0.391	1.111	1.351	1.351
3.5	0.594	0.594	0.525					20.0			0.510	0.447	1.253	1.511	1.511
4.0	0.008	0.008	0.007	0.007				21.0			0.580	0.507	1.405	1.683	1.683
4.5	0.011	0.011	0.010	0.010				22.0			0.655	0.571	1.569	1.866	1.866
5.0	0.015	0.015	0.013	0.012				23.0			0.737	0.641	1.743	2.061	2.061
5.5	0.019	0.019	0.017	0.016				24.0			0.824	0.715	1.929	2.267	2.267
6.0	0.023	0.023	0.021	0.020				25.0			0.918	0.795		2.486	2.486
6.5	0.029	0.029	0.026	0.025	0.110			26.0			1.018	0.879		2.717	2.717
7.0	0.035	0.035	0.032	0.030	0.127			27.0			1.125	0.969		2.961	2.961
7.5	0.042	0.042	0.038	0.036	0.146			28.0			1.238	1.064		3.217	3.217
8.0	0.049	0.049	0.046	0.042	0.166	0.249		29.0				1.165		3.487	3.487
8.5		0.057	0.053	0.049	0.188	0.275		30.0				1.272		3.770	3.770
9.0		0.067	0.062	0.057	0.212	0.304		35.0				1.893		5.389	5.389
9.5		0.077	0.072	0.065	0.237	0.335		40.0				2.672		7.370	7.370
10.0		0.087	0.082	0.075	0.264	0.368		45.0				3.621		9.735	9.735
11.0		0.112	0.105	0.096	0.324	0.439		50.0				4.752		12.506	12.506
12.0		0.140	0.133	0.120	0.392	0.520		55.0				6.077		15.705	15.705
13.0		0.172	0.164	0.147	0.468	0.609		60.0				7.607		19.351	19.351
14.0		0.208	0.199	0.178	0.552	0.708		65.0				9.352		23.463	23.463
15.0		0.249	0.239	0.213	0.645	0.816	0.816	70.0				11.323		28.060	28.060
16.0			0.283	0.251	0.747	0.934	0.934	75.0				13.529			33.159
17.0			0.332	0.294	0.859	1.063	1.063	80.0				15.981			38.778

ECHO Process Instrumentation, Inc.
Mail to: PO Box 800, Shalimar, FL 32579
Ship to: 70 6th Ave, Shalimar, FL 32579
Phone: 850.609.1300 Fax: 850.651.4777
Email: info@echopi.com
Website: www.echopi.com