Installation & Maintenance Instructions

MAGNETROL AMETEK ECLIPSE 706GWR

High Performance Guided Wave Radar Level Transmitter

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ECLIPSE® 706GWR

SIL Certified Safety Manual for Eclipse® Model 706-512X-XXX

High Performance Guided Wave Radar Level Transmitter

This manual complements and is intended to be used with the Magnetrol® Eclipse® Model 706 High Performance Guided Wave Radar Installation and Operating manual (Bulletin 57-606).

Safety Function

The HART® version of the Eclipse® Enhanced Model 706 Guided Wave Radar (GWR) transmitter will measure level and transmit a signal proportional to that level within the stated safety accuracy of ±2% of span (or the measured error published in I/O Manual 57-606, whichever is greater). In addition, when continuous, automatic diagnostics detect that the transmitter cannot perform this function, the output will be driven to the customer-specified out-of-range signal (i.e., 3.6 mA or 21 mA).

The Enhanced Model 706 is certified for use in low demand level measurement applications.

Application

The HART® version of the Eclipse Model 706 Guided Wave Radar level transmitter can be applied in most process or storage vessels, bridles, and bypass chambers up to the probe's rated temperature and pressure. It can be used in liquids, slurries, or solids with a dielectric constant in the range 1.4–100 to meet the safety system requirements of IEC 61508.

Benefits

- Level protection to SIL 3 as certified by exida Certification per IEC 61508.
- Probe designs to +850 °F (+454 °C), 6250 psig (430 bar) and full vacuum.
- Cryogenic applications to -320 °F (-190 °C).
- Intrinsically safe, Explosion-proof and Non-Incendive approvals.
- Quick connect/disconnect probe coupling.

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Eclipse® Model 706 High Performance Guided Wave Radar Level Transmitter

SIL Safety Manual for Eclipse® Model 706-512x-xxx

Table of Contents

1.0 Introduction

1.1 Product Description

The Eclipse Model 706 High Performance Guided Wave Radar Level Transmitter is a two-wire, loop-powered 24 VDC level transmitter based on Guided Wave Radar (GWR) technology.

NOTE: For Safety Instrumented Systems usage, it is assumed that the 4–20 mA output is used as the safety variable.

The analog output from the Model 706 meets the NAMUR NE 43 standard (3.8 mA to 20.5 mA usable). The transmitter contains self-diagnostics and is programmed to drive the output to a user-selected failure state, either low or high, upon internal detection of a diagnostic indicator. The device can be equipped with or without an optional non-interfering graphic liquid crystal display (LCD).

Table 1 indicates the version of the Eclipse Model 706 transmitter that has been certified for SIL 2/3 applications.

Table 1

Enhanced Eclipse Model Numbers

1	Transmitters: Model 706, 706-512*-*** (HART) Hardware Version (or later) Analog Board 030-9160-001 Rev K Digital Board 030-9159-001 Rev AC Wiring Board 030-9165-001 Rev F Software Version (or later) Model 706 HT 1.0hA.hex
2	Probes: All Eclipse probes can be utilized. Refer to I/O Manual 57-606 for complete probe offering.

1.2 Theory of Operation

Guided Wave Radar is based upon the principle of TDR (Time Domain Reflectometry). TDR utilizes pulses of electromagnetic energy transmitted down a wave guide (probe). When a pulse reaches a liquid surface that has a higher dielectric constant than the air ($\varepsilon r = 1$) in which it is traveling, a portion of the pulse is reflected. The transit time of the pulse is then measured via ultra high-speed timing circuitry that provides an accurate measure of the liquid level. The amplitude of the reflection depends on the dielectric constant of the product. The higher the dielectric constant, the larger the reflection.

1.3 Determining Safety Integrity Level (SIL)

Safety Instrumented System designers using the Enhanced Eclipse Model 706 must verify their design per applicable standards, including IEC 61508.

Three limits must be met to achieve a given SIL level:

1. The PFDavg numbers for the entire Safety Instrumented Function (SIF) must be calculated. Table 2 shows the relationship between the Safety Integrity Level (SIL) and the Probability of Failure on Demand Average (PFDavg).
2. Architecture constraints must be met for each subsystem per the requirement in IEC 61508.

Table 2

SIL vs. PFDavg

Safety Ingretity Level (SIL)	Target Average probability of failure on demand (PFDavg)
4	$\geq 10^{-5}$ to $<10^{-4}$
3	$\geq 10^{-4}$ to $<10^{-3}$
2	$\geq 10^{-3}$ to $<10^{-2}$
1	$\geq 10^{-2}$ to $<10^{-1}$

Table 3

SIL (Low Demand)	SIL 2 @ HFT = 0
	SIL 3 @ HFT = 1
SIL (High Demand)	SIL 2 @ HFT = 1
	SIL 3 @ HFT = 1

- The use of the Eclipse Enhanced Model 706 3X Guided Wave Radar Level Transmitter must be constrained by Table 3 in order to meet the minimum hardware fault tolerance architectural constraints for a SIL 2 or SIL 3 safety function.

3. All products chosen for use in the SIF must meet the requirements of IEC 61508 for the given SIL Capability level or be justified based on proven in use data collected for each job.

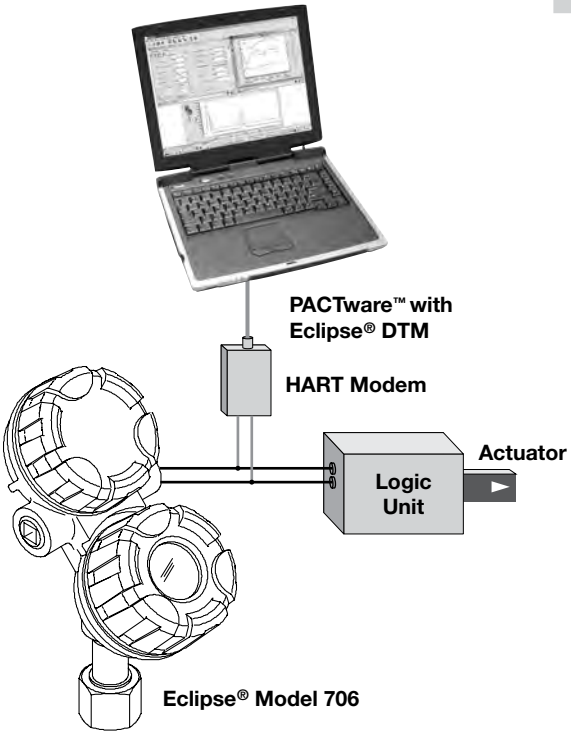
   The exSILentia tool from exida is recommended for design verification. This automatically checks all three limits and displays the results for any given design. The Eclipse Model 706 is in the exSILentia database. This tool contains all needed failure rate, failure mode, SIL Capability and common cause data as well as suggested proof test methods.

2.0 Applicable Models

This manual is only applicable to the HART versions of the Eclipse Model 706 transmitter shown in Table 1.

NOTE: Ensure that the Model 706 transmitter and probe are installed as a set matched by the serial number shown on the name plates.

3.0 Level Measuring System



The diagram at left shows the structure of a typical measuring system incorporating the Eclipse Model 706 transmitter. This SIL 2/3 Certified device is only available with an analog signal (4–20 mA) with HART communications; and, the measurement signal used by the logic solver can be the analog 4–20 mA signal proportional to the Level, Interface Level or Upper Layer Thickness.

- For fault monitoring, the logic unit must recognize both high alarms (≥ 21.5 mA) and low alarms (≤ 3.6 mA).
- If the logic solver loop uses intrinsic safety barriers, caution must be taken to ensure the loop continues to operate properly under the low alarm condition.
- The only unsafe mode is when the unit is reading an incorrect level within the 4–20 mA range (> ±2% deviation).
- Magnetrol defines the faulted mode as one in which the 4–20 mA current is driven out of range (i.e., less than 3.8 mA or greater than 21.5 mA).
- Volume and flow are not included in the safety function for the Eclipse Model 706.
- The 4–20 mA output signal can be configured for overrange per NAMUR NE43.

  HART communication cannot be used while the Model 706 is in safe mode operation.

3.1 Miscellaneous Electrical Considerations

Following are miscellaneous electrical issues to be considered in a safety system.

3.1.1 Pollution Degree 2

The Eclipse Model 706 transmitter is designed for use in a Category II, Pollution Degree 2 installation, which is defined by a nonconductive pollution of the sort where occasionally a temporary conductivity caused by condensation must be expected.

This is the usual pollution degree used for equipment being evaluated to IEC/EN 61010.

3.1.2 Electromagnetic Compatibility

The Eclipse Model 706 is designed to meet the requirements of EN 61326 and NAMUR NE21.

4.0 Mean Time To Repair (MTTR)

SIL determinations are based on a number of factors including the Mean Time To Repair (MTTR). The analysis for the Eclipse Model 706 is based on a MTTR of 24 hours.

5.0 Supplementary Documentation

- The Eclipse Model 706 Installation and Operating Manual 57-606 must be available to ensure proper installation of the transmitter.
- The following Electronic Device Description File is required if HART is used:
- Manufacturer Code 0x56
- Model 706 Device ID 0x56E0, device revision 1, DD revision 2.
- For device installations in a classified area, the relevant safety instructions and electrical codes must be followed.

6.0 General Instructions

6.1 Systematic Limitations

The following instructions must be observed to avoid systematic failures:

6.1.1 Application

Choosing the proper Guided Wave Radar (GWR) probe is the most important decision in the application process.

Coaxial, twin flexible cable, and single element (rod or cable) are the three basic configurations. As the probe configuration establishes fundamental performance characteristics, the probe for use with the Eclipse Model 706 transmitter should be selected as appropriate for the application.

The Model 706 is designed for use in many applications in process industries. Consult factory for assistance with probe options.

Careful selection of probe design and materials for a specific application will minimize media buildup on the probe.

Refer to Installation and Operating Manual 57-606 for more information.

6.1.2 Environmental

Refer to Installation and Operating Manual 57-606 for Environmental limitations.

6.1.2.1 Operating

The operating temperature range is -67 to +175 °F (-55 to +80 °C).

6.1.2.2 Storage

The device should be stored in its original shipping box and not be subjected to temperatures outside the storage temperature range of -67 to +185 °F (-55 to +85 °C).

6.2 Installation

Refer to the Model 706 Installation and Operating Manual 57-606 manual for complete installation instructions.

- Contains information on the use, changing and resetting of the password-protection function.
- Provides menu selection items for configuration of the transmitter as a level sensing device.
- Offers configuration recommendations.
- Input voltage and loop resistance must be within the safe operating area of the device.

6.3 Skill Level of Personnel

Personnel following the procedures of this safety manual should have technical expertise equal to or greater than that of a qualified Instrument Technician.

6.4 Necessary Tools

Following are the necessary tools needed to carry out the prescribed procedures:

- Open-wrenches or adjustable wrench to fit the process connection size and type.
  - Coaxial probe: 1½" (38mm)
  - Twin Rod and Single rod probes: 7⅞" (47mm)
  - Transmitter: 1½" (38mm)
  - Torque wrench is highly desirable
- Flat-blade screwdriver
- Cable cutter and 3⁄32" (2.5mm) hex wrench (7y1, 7y2, 7y5 and 7y7 Flexible probes only)
- Digital multimeter or digital volt/ammeter
- 24 VDC power supply, 23 mA minimum

6.5 Configuration Information

6.5.1 General

The Eclipse Model 706 transmitter can be configured via the local display, a HART compatible handheld terminal, or a PC using PACT*ware*™ and the associated DTM.

6.5.2 Configuration

Ensure the Model 706 transmitter has been properly configured for the application and probe. Special consideration should be given to the following configuration parameters:

Dielectric Range: Ensure this is set to “1.7–3.0” for the majority of typical hydrocarbon applications or “Below 1.7” for propane and butane applications.

Failure Alarm: DO NOT choose HOLD for this parameter as a Fault will not be annunciated on the current loop.

Failure Alarm Delay: Should remain at default value of 0.

Blocking Distance: This value MUST be Zero for overfill applications. Consult factory prior to making any changes.

Analog Output Mode: Ensure this is set to ENABLED.

Level Threshold Mode: Set to FIXED VALUE if used in a hydrocarbon application with any possibility of water bottoms.

User Password: Must be changed to a specific value other than Zero.

6.5.3 Write Protecting / Locking

The Model 706 transmitter can be protected with a numerical password between 0 and 59,999.

NOTE: Default Password = 0 = Password disabled.

Refer to the Model 706 Installation and Operating Manual Bulletin 57-606 for additional information on password protection.

For an SIS system, it is required that, after configuration of the system is complete, a password is utilized to prevent inadvertent changes to the device.

6.6 Site Acceptance Testing

To ensure proper operation after installation and configuration, a site acceptance test should be completed. This procedure is identical to the Proof Test Procedure described in Section 7.1.4.

6.7 Recording Results

Results of Site Acceptance Testing must be recorded for future reference.

6.8 Maintenance

With no moving parts to wear out or lose tolerance, routine maintenance is not required.

6.8.1 Diagnostics and Response Times

Continuous internal diagnostics are present within the Enhanced Eclipse Model 706 transmitter. In the event a Fault is detected, a message will appear on the LCD and the output current will be driven to 3.6 mA or 22mA depending on how the FAULT parameter is configured.

A) Start-up Time:

   a. From application of power to normal operating mode: 8 seconds

   b. From application of power to Fault mode: 29 seconds or less (Assuming a Fault is present upon start-up)

B) Diagnostic Test Interval: 15 seconds

   a. This is defined as the time from the normal operating mode to the Fault mode upon the occurrence of a fault.

C) Safety Function Response Time: 3 seconds (with Damping=0)

6.8.2 Troubleshooting

Report all failures to the Magnetrol Technical Support Department.

Refer to the Model 706 Installation and Operating Manual Bulletin 57-606 for troubleshooting device errors.

- As there are no moving parts in this device, the only maintenance required is the SIL Proof Test.
- Firmware can only be upgraded by factory personnel.

7.0 Recurrent Function Tests

7.1 Proof Testing

7.1.1 Introduction

Following is the procedure utilized to detect Dangerous Undetected (DU) failures.

7.1.2 Interval

To maintain the appropriate Safety Integrity Level of a Safety Instrumented System, it is imperative that the entire system be tested at regular time intervals (shown as TI in the appropriate standards). The suitable SIL for the Model 706 transmitter is based on the assumption that the end user will carry out this test and inspection at least once per year.

NOTE: It is the responsibility of the owner/operator to select the type of inspection and the time period for these tests.

7.1.3 Recording Results

Results of the Proof Test should be recorded for future reference.

7.1.4 Suggested Proof Test

The suggested proof test below, in combination with the built-in automatic diagnostics, will detect 98% of possible DU failures in Model 706-512x-xxx.

Step	Action
1	Bypass the PLC or take other action to avoid a false trip.
2	Inspect the unit in detail outside and inside for physical damage or evidence of environmental or process leaks a.) Inspect the exterior of the Unit housing. If there is any evidence of physical damage that may impact the integrity of the housing and the environmental protection, the unit should be repaired or replaced. b.) Inspect the interior of the unit. Any evidence of moisture, from process or environment, is an indication of housing damage, and the unit should be repaired or replaced.
3	Use the unit's DIAGNOSTICS menu to observe Present Status, and review EVENT HISTORY in the Event Log. Up to 10 events are stored. The events will be date and time stamped if the internal clock is set and running. It is suggested that the internal clock be set at the time of commissioning of the unit. If the clock is set at the time of the proof test, event times are calculated. a.) Choose the menu DIAGNOSTICS / Present Status. i.) Present Status should indicate OK. b.) Choose the menu DIAGNOSTICS / EVENT HISTORY/ Event Log i.) Any FAULT or WARNING messages must be investigated and understood. ii.) Corrective actions should be taken for FAULT messages. *continued on next page*

Step	Action
4	Use the DIAGNOSTICS menu to perform a “CURRENT LOOP TEST”. Select DIAGNOSTICS / ADVANCED DIAGNOSTICS / TRANSMITTER TESTS / Analog Output Test to change the output loop current and confirm the actual current matches the value chosen. a.) Send a HART command to the transmitter (or use the local interface) to go to the high alarm current output, 22 mA, and verify that the analog current reaches the valve. i.) This step tests for compliance voltage problems such as low supply voltage or increased wiring resistance. ii.) This also tests for current loop control circuitry and adjustment problems. b.) Send a HART command to the transmitter (or use the local interface) to go to the low alarm current output, 3.6 mA, and verify that the analog current reaches the valve. i.) This step tests for high quiescent current and supply voltage problems. ii.) This also tests for current loop control circuitry and adjustment problems. c.) Exit the “Analog Output Test” and confirm that the output returns to its original state—with the proper loop current as indicated and controlled by the unit.
5	Use the DIAGNOSTICS menu to observe the present Echo Curve. Confirm that the ECHO Waveform is normal. The echo curve is dependent on the type of probe, the installation conditions and the level of process on the probe. Comparison of the present Echo Curve to the one stored at the time of commissioning the unit gives additional confidence of the normal operation of the unit. Use of the DTM and digital communications is necessary for comparison of echo curves. a.) Select DIAGNOSTICS/ ECHO CURVE/ View Echo Curve i.) Observe the present Echo Curve, identify the characteristic portions of the waveform related to the FIDUCIAL, Process level, End of Probe and other features. ii.) Confirm that the FIDUCIAL appears acceptable. Confirm the FIDUCIAL is located where expected. iii.) Confirm that the signal from the process level appears normal and is located as expected. iv.) Verify that the baseline of the waveform is smooth and flat. v.) Compare to Echo Curve from commissioning in the FIDUCIAL area. b.) Access the Fiducial Ticks and Fiducial Strength values in the menu: DIAGNOSTICS / ADVANCES DIAGNOSTICS / INTERNAL VALUES i.) Observe and record: 1.) Fiducial Ticks _____ 2.) Fiducial Strength _____ ii.) Confirm that these values match the previous values. 1.) Fiducial Ticks differs within ±100 2.) Fiducial Strength differs within ±15
6	Perform two-point calibration check of the transmitter by applying level to two points on the probe and compare the transmitter display reading and the current level value to a known reference measurement.
7	If the calibration is correct the proof test is complete. Proceed to step 9.
8	If the calibration is incorrect, remove the transmitter and probe from the process. Inspect the probe for buildup or clogging. Clean the probe, if necessary. Perform a bench calibration check by shorting the probe at two points. Measure the level from the bottom of the probe to the two points and compare to the transmitter display and current level readings. a.) If the calibration is off by more than 2%, contact the factory for assistance. b.) If the calibration is correct, the proof test in complete. c.) Re-install the probe and transmitter.
9	Restore loop to full operation.
10	Remove the bypass from the safety PLC to restore normal operation.

8.0 Safety Requirements

This section specifies those safety characteristics allocated to the Eclipse Model 706 that are conditions for its acceptance as a SIL certified device.

NOTE: This SIL evaluation has assumed that the customer will be able to acknowledge an over- or under-current condition via the Logic Solver.

8.1 System Safety Assumptions

The System Safety Assumptions provide a list of safety relevant assumptions made on the usage of the product over the safety life cycle of a user Safety Integrity Function, SIF. Magnetrol cannot directly control the user life cycle of a SIF using this product but needs to have assumptions on how the product will be used. It is important that users have full knowledge of these assumptions to ensure they are met when using the product as part of a SIF. This is to ensure the product is used in a manner consistent with the safety design.

This section only lists product specific assumptions and is not intended to specify measures required of the end user that are standard requirements for safety applications.

Assumptions for Safety
The user SIF will detect and properly handle annunciation of detected fault conditions signaled by the alarm level output according to the specific requirements of the SIF.
Proper operation of the Eclipse Model 706 is dependent on having the voltage across the transmitter terminals meet the Safe Operating Area requirements during normal operation.
A user SIF integrating the Eclipse Model 706 current loop output will detect faulted field wiring and other faults resulting in a current loop value signal outside of the specified range and take proper actions to maintain safety integrity according to the specific requirements of the SIF.
Optional Local User Interface will not be relied upon by the end user SIF during normal operation and will be considered non-interfering to the safety function.
HART communications will not be relied upon by the end user for the SIF normal operation and will be considered non-interfering to the safety function.
The impact of end user configured damping values is not included in the published safety (function) response time. (The end user must consider this as part of overall time response of the SIF.)
The end user will independently verify all changes to end user configured parameters and validate the safety functionality prior to reliance on the product for safety protection.
The end user will enable the User Password to lock out any end user modifiable configuration parameters available via the Local User Interface during normal operation.
The end user will enable the User Password to lock out any end user modifiable configuration parameters available via the HART interface during normal operation.
The end user will have proper procedures in place to ensure safe operation over the product life cycle.
The end user will ensure the device is properly installed per the product literature. The proper probe will be used for the application with the transmitter properly connected to the probe.
The end user must not select HOLD for the alarm output.
Loop Current mode must be enabled.

8.2 Safety Function Requirements

This section lists the Safety Function Requirements that specify what safety relevant functionality is to be performed for implementation of the safety integrity function and also to maintain the desired level of safety integrity. These requirements may also rule out particular functionality for SIF usage that could lead to designs that are difficult to validate for deterministic performance or safety integrity.

Safety Function Requirement
Upon application of power and successful initialization, the Eclipse Model 706 **shall** enter the Normal Mode or Faulted Mode of operation.
Upon application of power and successful initialization, the Eclipse Model 706 **shall** enter the Normal Mode operation within 6 seconds.
Upon application of power and successful initialization, the Eclipse Model 706 **shall** enter the Faulted Mode of operation in less than 29 seconds.
The Eclipse Model 706 **shall** transition to the Faulted Mode from the Normal Mode within the Diagnostic Test Interval after a diagnostic event occurs. The safety function will respond to a change from the user's process within the safety (function) response time.
The Eclipse Model 706 **shall** transition to the Faulted Mode from the Normal Mode within the Diagnostic Test Interval of 15 seconds after a diagnostic event occurs.
The safety function output of the Eclipse Model 706 **shall** respond to a change from the user's process within the safety (function) response time of 3 seconds assuming Damping is set to 0.
The Eclipse Model 706 **may** leave the Faulted Mode when all diagnostics are clear.

8.3 Safety User Programming and Configuration Requirements

The Safety User Programming and Configuration Requirements provide the requirements for field configuration of the device required to create and maintain SIF configurations. These requirements should provide the necessary guidance to ensure that the engineering environment will meet both the intended market and safety certification requirements, along with guidance and user restrictions documented in the safety manual.

Safety User Programming Requirement
Setup, configuration, and maintenance functionality for the Eclipse Model 706 **shall** be supported by the
non-interfering HART communications interface.
Setup, configuration and maintenance functionality for the Eclipse Model 706 **shall** be supported by the optional Local User Interface.

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The manufacturer may use the mark:

exida • CERTIFIED • IEC 61508 • SIL 3 CAPABLE •

Revision 4.1 June 27, 2022
Surveillance Audit Due July 1, 2025

ANAB

Certificate / Certificat
Zertifikat / 合格証

MAG 1512025 C001

exida hereby confirms that the:

Eclipse 706GWR Level Transmitter

Magnetrol International, Inc.
Aurora, IL - USA

Has been assessed per the relevant requirements of:

IEC 61508 : 2010 Parts 1-7

and meets requirements providing a level of integrity to:

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type B Element

SIL 2 @ HFT=0; SIL 3 @ HFT = 1; Route 2_H

PFD_{AVG} and Architecture Constraints must be verified for each application

Safety Function:
The Eclipse 706GWR Level Transmitter will measure level and transmit a corresponding signal within the stated safety accuracy.

Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.

Evaluating Assessor

Certifying Assessor

Eclipse 706GWR Level Transmitter

exida

Certificate / Certificat / Zertifikat / 合格証

MAG 1512025 C001

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type B Element

SIL 1 @ HFT=0; SIL 2 @ HFT = 1; Route 1_H

SIL 2 @ HFT=0; SIL 3 @ HFT = 1; Route 2_H

PFH/PFD_{avg} and Architecture Constraints must be verified for each application

Systematic Capability:
The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.
A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than stated.

Random Capability:
The SIL limit imposed by the Architectural Constraints must be met for each element. This element meets *exida* criteria for Route 2_H

IEC 61508 Failure Rates in FIT[1]

Device	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}
Model 706-512*-****	0	78	748	61

[1] FIT = 1 failure / 10^9 hours

SIL Verification:
The Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) must be verified via a calculation of PFD_{avg} considering redundant architectures, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each element must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

The following documents are a mandatory part of certification:

Assessment Report: MAG 15-12-025 R002 V4 R1 IEC 61508 Assessment

Safety Manual: 57-657.4: May 2022 or later

NOTE: This product has been tested and approved for use in temperatures down to -55C. See FMEDA report (MAG 15-12-025 R001 V2R1 or later) when using product with temperatures below -40C.

Failure Modes, Effects and Diagnostic Analysis

Project:
Eclipse Model 706 GWR Level Transmitter

Company:
Magnetrol International

Aurora, Illinois
USA

Contract Number: Q19-02-022
Report No.: MAG 15-12-025 R001
Version V2, Revision R1, June 27, 2019
Ted Stewart

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Management Summary

This report summarizes the results of the hardware assessment in the form of a Failure Modes, Effects, and Diagnostic Analysis (FMEDA) of the Eclipse Model 706 GWR Level Transmitter. The hardware version is defined by the assembly drawings in section 2.5. The software version is 1.0gA. A Failure Modes, Effects, and Diagnostic Analysis is one of the steps to be taken to achieve functional safety certification per IEC 61508 of a device. From the FMEDA, failure rates are determined. The FMEDA that is described in this report concerns only the hardware of the Model 706-512*-***. For full functional safety certification purposes all requirements of IEC 61508 must be considered.

Model 706-512*-*** is a loop-powered, 24 VDC level transmitter, based on Guided Wave Radar (GWR) technology. For safety instrumented systems usage it is assumed that the 4 – 20mA output is used as the primary safety variable. The analog output meets NAMUR NE 43 (3.8mA to 20.5mA usable). The transmitter contains self-diagnostics and is programmed to send its output to a specified failure state, either low or high upon internal detection of a failure (output state is programmable). The device can be equipped with or without display.

Table 1 gives an overview of the different versions that were considered in the FMEDA of the Model 706-512*-***.

Table 1 Version Overview

Option 1	Model 706-512*-***

The Model 706-512*-*** is classified as a Type B[1] element according to IEC 61508, having a hardware fault tolerance of 0.

The failure rate data used for this analysis meets the *exida* criteria for Route 2_H (see Section 5.2). Therefore the Model 706-512*-*** meets the hardware architectural constraints for up to SIL 2 at HFT=0 (or SIL 3 @ HFT=1) when the listed failure rates are used.

The analysis shows that the Model 706-512*-*** has a Safe Failure Fraction between 90% and 99% (assuming that the logic solver is programmed to detect over-scale and under-scale currents) and therefore meets hardware architectural constraints for up to SIL 2 as a single device.

Based on the assumptions listed in 4.3, the failure rates for the Model 706-512*-*** are listed in section 4.4.

These failure rates are valid for the useful lifetime of the product, see Appendix A.

The failure rates listed in this report are based on over 250 billion-unit operating hours of process industry field failure data. The failure rate predictions reflect realistic failures and include site specific failures due to human events for the specified Site Safety Index (SSI), see section 4.2.2.

A user of the Model 706-512*-*** can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL).

[1] Type B element: "Complex" element (using micro controllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2, ed2, 2010.

9.3 Specific Model 706 Values

Product	Eclipse Model 706-512x-xxx
SIL	SIL 2
HFT	0
SFF	93.1%
PFD_{avg}	Refer to FMEDA report

9.4 Report: Lifetime of Critical Components

According to section 7.4.9.5 of IEC 61508-2, a useful lifetime, based on experience, should be assumed.

Although a constant failure rate is assumed by probabilistic estimation method, this only applies provided that the useful lifetime of components is not exceeded. Beyond their useful lifetime the result of the probabilistic calculation method is therefore meaningless, as the probability of failure significantly increases with time. The useful lifetime is highly dependent on the subsystem itself and its operating conditions.

The assumption of a constant failure rate is based on the bathtub curve. Therefore it is obvious that the PFDavg calculation is only valid for components that have this constant domain and that the validity of the calculation is limited to the useful lifetime of each component.

The expected useful life of Eclipse Model 706-512x-xxx is at least 50 years.

It is the responsibility of the end user to maintain and operate the Model 706-512x-xxx per manufacturer's instructions. Furthermore, regular inspection should indicate that all components are clean and free from damage.

When plant experience indicates a shorter lifetime than indicated here, the number based on plant experience should be used.

References

- IEC 61508-1: 2010-04
- IEC 61508-2: 2010-04
- IEC 61508-3: 2010-04

Disclaimer

AMETEK LMS accepts no liability whatsoever for the use of these numbers or for the correctness of the standards on which the general calculation methods are based.

ASSURED QUALITY & SERVICE COST LESS

Service Policy

Owners of AMETEK LMS controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. AMETEK will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a “Return Material Authorization” (RMA) number be obtained from the factory, prior to the material’s return. This is available through an AMETEK LMS local representative or by contacting the factory. Please provide the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

MAGNETROL® / AMETEK®

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Installation & Maintenance Instructions

MAGNETROL AMETEK ECLIPSE 706GWR

High Performance, 4th Generation Guided Wave Radar Level Transmitter

Supplied by

247able.com

Call us on +44 (0)118 916 9420 | Email info@247able.com

ECLIPSE®
706GWR

Hart Installation and Operating Manual for Eclipse® Model 706

Software Version 1.x

High Performance, 4th Generation Guided Wave Radar Level Transmitter

MAGNETROL®

AMETEK®

Read this Manual Before Installing

This manual provides information on the Eclipse® transmitter. It is important that all instructions are read carefully and followed in sequence. The *QuickStart Installation* instructions are a brief guide to the sequence of steps for experienced technicians to follow when installing the equipment. Detailed instructions are included in the *Complete Installation* section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

NOTES

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

WARNINGS

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

The ECLIPSE system is designed for use in Category II, Pollution Degree 2 installations. Follow all standard industry procedures for servicing electrical and computer equipment when working with or around high voltage. Always shut off the power supply before touching any components. Although high voltage is not present in this system, it may be present in other systems.

Electrical components are sensitive to electrostatic discharge. To prevent equipment damage, observe safety procedures when working with electrostatic sensitive components.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

WARNING! Explosion hazard. Do not connect or disconnect designs rated Explosion proof or Non-incendive unless power has been switched off and/or the area is known to be non-hazardous.

Low Voltage Directive

For use in Installations Category II, Pollution Degree 2. If equipment is used in a manner not specified by the manufacturer, protection provided by equipment may be impaired.

Notice of Copyright and Limitations

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MAGNETROL reserves the right to make changes to the product described in this manual at any time without notice. MAGNETROL makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All MAGNETROL electronic level and flow controls are warranted free of defects in materials or workmanship for 18 months from the date of original factory shipment. If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, MAGNETROL will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

MAGNETROL shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some MAGNETROL products.

Quality Assurance

The quality assurance system in place at MAGNETROL guarantees the highest level of quality throughout the company. MAGNETROL is committed to providing full customer satisfaction both in quality products and quality service.

The MAGNETROL quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.

Eclipse® Model 706 Guided Wave Radar Transmitter

Table of Contents

1.0 QuickStart Installation

The QuickStart Installation procedures provide an overview of the key steps required for mounting, wiring, and configuring the ECLIPSE Model 706 Guided Wave Radar level transmitter. These procedures are intended for more experienced installers of ECLIPSE transmitters (or other electronic level measurement instruments).

Section 2.0, Complete Installation, offers more detailed installation instructions for the first time user.

WARNING: Overfill-capable probes such as the Model 7yD, 7yG, 7yJ, 7yL, 7yP, or 7yT should be used for all Safety Shutdown/Overfill applications.

The Model 706 transmitter, when used with an overfill coaxial or caged probe, is capable of measuring true liquid level all the way up to the face of the flange or NPT connection. This is a very unique advantage as compared to other Guided Wave Radar (GWR) devices that may infer level at the top of the probe when signals are lost or uncertain. Refer to Section 3.2.6 for additional information on overfill capability.

Depending on the probe type, all other ECLIPSE probes should be installed so the maximum overfill level is a minimum of 150–300 mm (6"-12") below the flange or NPT connection. This may include utilizing a nozzle or spool piece to raise the probe. Consult factory to ensure proper installation and operation.

1.1 Getting Started

Have the proper equipment, tools, and information available before beginning the QuickStart Installation procedures.

1.1.1 Equipment and Tools

- Open-end wrenches (or adjustable wrench) to fit the process connection size and type.
  - Coaxial probe: 1 1/2" (38 mm)
  - Single rod probe: 1 7/8" (47 mm)
  - Transmitter 1 1/2" (38 mm).
  - A torque wrench is highly desirable.
- Flat-blade screwdriver
- Cable cutter and 3/32" hex wrench (for flexible cable probes only)
- Digital multimeter or digital volt/ammeter
- 24 VDC power supply, 23 mA minimum

1.1.2 Configuration Information

To utilize the QuickStart menu available on the ECLIPSE Model 706, some key information is required for configuration.

Gather the information and complete the following operating parameters table before beginning configuration.

NOTES: The QuickStart menu is available for Level Only applications.

1. Refer to Section 2.6.5 for configuration menus for Interface, Volume or Flow applications.
2. These configuration steps are not necessary if the transmitter was pre-configured prior to shipment.

Display	Question	Answer
Level Units	What units of measurement will be used? (inches, millimeters, centimeters, feet or meters)	_____
Probe Model	What probe model is listed on the model information? (first three digits of probe model number)	_____
Probe Mount	Is the probe mounted NPT, BSP, or flange? (Refer to probe model.)	_____
Probe Length	What probe length is listed on the probe model information? (last three digits of the probe model number)	_____
Level Offset	The desired level reading when the liquid is at the tip of the probe. (Refer to Section 3.4 for more information.)	_____
Dielectric Range	What is the dielectric constant range of the process medium?	_____
4.0 mA Set Point *(Does not apply for FOUNDATION Fieldbus™ or PROFIBUS PA)*	What is the 0% reference point for the 4.0 mA value?	_____
20.0 mA Set Point *(Does not apply for FOUNDATION Fieldbus™ or PROFIBUS PA)*	What is the 100% reference point for the 20.0 mA value? (Ensure that this value is outside of the Blocking Distance when utilizing non-overfill-capable probes.)	_____
Failure Alarm *(Does not apply for FOUNDATION Fieldbus™ or PROFIBUS PA)*	What output current is desired when a Failure Indicator is present?	_____

1.2 QuickStart Mounting

Ensure that the configuration style and process connection size/type of the ECLIPSE transmitter and probe matches the requirements of the installation before continuing with the QuickStart installation.

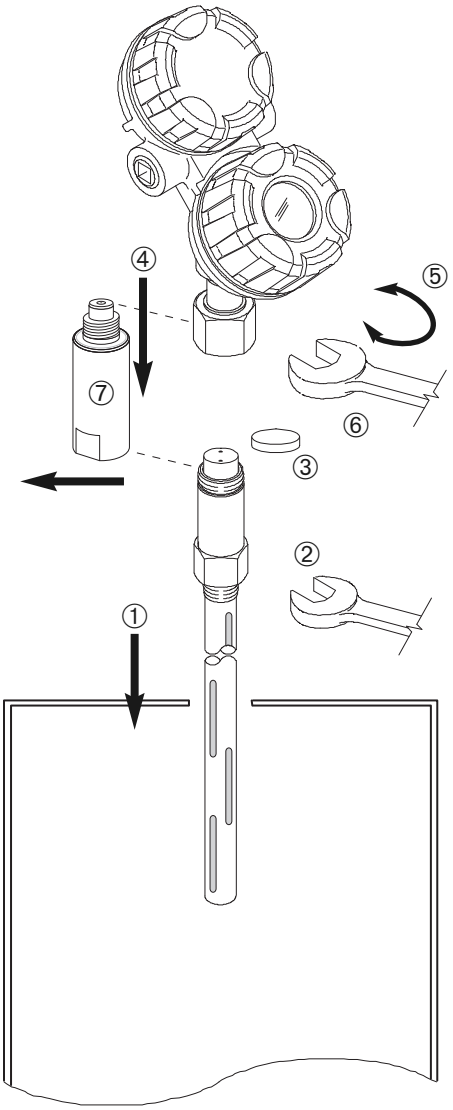
For optimal performance (and correlation to the Calibration Certificate included with all units), confirm the model and serial numbers shown on the nameplates of the ECLIPSE probe and transmitter are identical.

NOTE: For applications using the Model 7yS Steam Probe, it is mandatory to keep the transmitter and probe matched as a set. (Refer to Section 3.2.5 for additional information regarding saturated steam applications.)

To avoid moisture ingress in the housing, covers should be fully tightened at all times. For same reason, conduit entries should be properly sealed.

1.2.1 Probe

1. Carefully place the probe into the vessel. Align the probe process connection with the threaded or flanged mounting on the vessel.
2. Tighten the hex nut of the probe process connection or flange bolts.



NOTE: Leave the plastic protective cap in place on the probe until you are ready to install the transmitter. Do not use sealing compound or TFE tape on probe connection to transmitter as this connection is sealed with a Viton® o-ring.

If using a segmented probe or removable rod, ensure that all pieces are assembled and connected before installation.

1.2.2 Transmitter

3. Remove the protective plastic cap from the top of the probe and store for future use. Make sure the top probe connector (male connection) is clean and dry. Clean with isopropyl alcohol and cotton swabs if necessary.
4. Carefully place the transmitter onto the probe. Align the universal connection at the base of the transmitter housing with the top of the probe. Only hand-tighten the connection at this point in time.
5. Rotate the transmitter so that it is in the most convenient position for wiring, configuring and viewing.
6. Using a 1 1/2" (38 mm) wrench, tighten the universal connection on the transmitter 1/4 to 1/2 turn beyond hand-tight. As this is a critical connection, a torque wrench is highly recommended to obtain 60 Nm (45 ft-lbs).

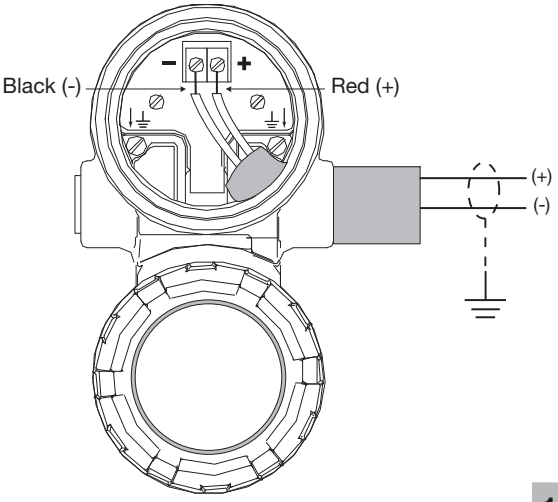
   DO NOT LEAVE HAND-TIGHT.

NOTE: The ECLIPSE Model 706 transmitter can be supplied with a universal connector containing lock screws for applications with significant vibration. Contact the factory for additional information.

7. If available, install optional adapter for use with Model 705 probes. As this is a critical connection, a torque wrench is highly recommended to obtain 60 Nm (45 ft-lbs).

1.3 QuickStart Wiring

WARNING! Possible explosion hazard. Do not connect or disconnect equipment unless power has been switched off and the area is known to be non-hazardous.



NOTE: Ensure that the electrical wiring to the ECLIPSE Model 706 transmitter is complete and in compliance with all local regulations and codes.

1. Remove the cover of the upper wiring compartment of the Model 706 transmitter.
2. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal. For Explosion Proof Installations, see Wiring, Section 2.5.
3. Replace and tighten the cover.

1.4 QuickStart Configuration

If requested, the ECLIPSE Model 706 transmitter is shipped fully pre-configured for the application and can be installed immediately. Otherwise it is shipped configured with default values from the factory and can be easily reconfigured in the shop.

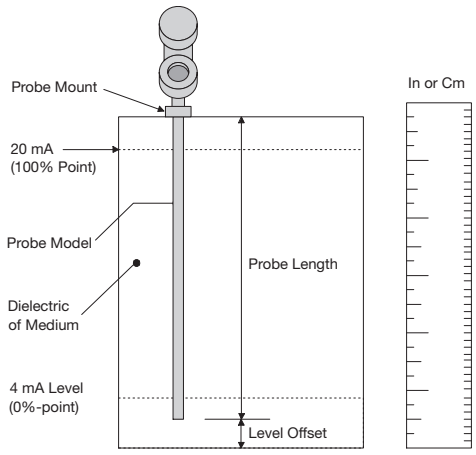
The minimum configuration instructions required for using the QuickStart menu follow. Use the information from the operating parameters table in Section 1.1.2 before proceeding with the configuration.

The QuickStart menu offers a very simple two screen overview showing the basic parameters required for typical "Level Only" operation.

1. Apply power to the transmitter.

   The graphic LCD display can be programmed to change every 2 seconds to show pertinent Measured Values on the Home Screen. For example: Level, %Output, and Loop current can all be displayed on a rotating screen.

   The LCD can also be programmed to always show just one of the Measured Variables at all times. For example: Level can be the only value displayed on the screen.
2. Remove the lower electronic compartment cover.



NOTE: A small transition zone (0–12") (0-300 mm) may exist at the top and bottom of certain probes.

STEP 4

STEP 5

STEP 6

3. The push buttons offer multiple forms of functionality for menu navigation and data entry. (See Section 2.6 for complete explanation).

   ⇧ **UP** moves up through the menu or increases a displayed value.

   ⇩ **DOWN** moves down through the menu or decreases a displayed value.

   ⇦ **BACK** exits a branch of the menu or exits without accepting entered value.

   ⇨ **ENTER** enters a branch of the menu or accepts a displayed entry.

NOTE: Holding down ENTER when any menu or parameter is highlighted will show help text in reference to that item.

The default User Password = 0. (If a password is requested, enter it at that time.)

The following configuration entries are the minimum required for a QuickStart configuration. Refer to figures at left.

4. Press any key at the Home Screen to access the Main Menu.
5. Press ⇨ ENTER with the DEVICE SETUP menu item highlighted.
6. Press ⇨ ENTER with the QUICKSTART menu item highlighted.

   The QuickStart shows the basic parameters, with the present value of the highlighted parameter shown at the bottom of the screen.

   One can now quickly and easily scroll through the QuickStart configuration items, changing those parameters as required:

   - Scroll to the parameter to be changed.
   - Press ⇨ ENTER at the highlighted parameter.
   - Scroll to the desired option, then press ⇨ ENTER.
   - Scroll to next parameter or press ⇦ BACK when finished to exit the QuickStart menu.

   Section 1.4.1 lists and describes the nine parameters in the QuickStart menu.

7. After making all of the necessary changes in the QuickStart menu, press the BACK button three times to return to the Home Screen.
8. The QuickStart configuration is complete. If properly configured, the Model 706 transmitter is measuring level and is ready for service.

1.4.1 QuickStart Menu Options

Level Units		Select the Units of measurement for the level readout: • Inches • Feet • Millimeters • Centimeters • Meters
Adapter		YES — Model 705 probe models appear below NO — Model 706 probe models appear below
Probe Model		Select the Probe Model to be used with Model 706: (NOTE: All Probe Models may not be available depending on the firmware version.) • 7YD Coaxial High Temperature High Pressure • 7YF Single Rod for installation onto tanks • 7YG Single Rod for installation into cages • 7YH Single Hygienic (Future) • 7YJ Single High Temperature High Pressure for cages • 7YL Single Rod High Pressure for cages • 7YM Single Rod High Pressure for tanks • 7YN Single Rod High Temperature High Pressure for tanks • 7YP Coaxial High Pressure • 7YS Coaxial Steam • 7YT Coaxial Standard • 7YV Coax High Vibration (Future) • 7Y1 Single Flexible Standard • 7Y2 Single Flexible Bulk Solids • 7Y3 Single Flexible Standard High Temperature High Pressure • 7Y6 Single Flexible High Temperature High Pressure for Cages
Probe Mount		Select the type of Probe Mounting to the vessel: (NOTE: All Probe Mount options may not be available depending on the firmware version). • NPT (National Pipe Thread) • BSP (British Standard Pipe) • Flange (ASME or EN) • NPT with Flushing Connection • BSP with Flushing Connection • Flange with Flushing Connection • Hygienic
Probe Length		Enter the exact Probe Length as printed on the probe nameplate. Probe Length is shown as the last three digits of the Probe Model number. Range is 30 cm to 30 meters (12 inches to 100 feet) probe dependent. Refer to Section 1.4.1.1.
Level Offset		Enter the desired level reading when the liquid is at the end of the probe. Range is -762 cm to 22 meters (-25 feet to 75 feet). Refer to Section 3.4 for further information. (With default Level Offset = 0, all measurements are referenced from the bottom of the probe.)
Dielectric Range		Enter the Dielectric Range for the material to be measured. Below 1.7 (Light Hydrocarbons like Propane and Butane) 1.7 to 3.0 (Most typical hydrocarbons) 3.0 to 10 (Varying dielectric, for example: mixing tanks) Above 10 (Water-based media)
Hart Only	**4 mA Set Point (LRV)**	Enter the level value (0 %-point) for the 4 mA point. Lower Range Value (LRV). Refer to Section 1.4.1.1.
	20 mA Set Point (URV)	Enter the level value (100 %-point) for the 20 mA point. Upper Range Value (URV). Refer to Section 1.4.1.1.
	Failure Alarm	Enter the desired output state when a Failure Indicator is active. • 22 mA • 3.6 mA • Hold (Hold last value is not recommended)

1.4.1.1 QuickStart Numerical Data Entry

To make numerical entry changes to Probe Length and Level Offset:

- **UP** moves up to the next highest digit (0,1,2,3,....,9 or the decimal point).
  If held down the digits scroll until the push button is released.
- **DOWN** moves up to the next lowest digit (0,1,2,3,....,9 or the decimal point). If held down the digits scroll until the push button is released.
- **BACK** moves the cursor to the left and deletes a digit. If the cursor is already at the leftmost position, then the screen is exited without changing the previously saved value.
- **ENTER** Moves the cursor to the right. If the cursor is located at a blank character position, the new value is saved.

Scrolling further DOWN in the QuickStart menu results in the remaining parameters appearing one by one, with the present highlighted value shown at the bottom of the screen.

- **BACK** returns to the previous menu without changing the original value, which is immediately redisplayed.
- **ENTER** accepts the displayed value and returns to the previous menu.

Negative values can be entered by highlighting the "+" sign shown prior to the number, then pressing **UP** to change it to show "-".

2.0 Complete Installation

This section provides detailed procedures for properly installing, wiring, and configuring the ECLIPSE Model 706 Guided Wave Radar Level Transmitter.

2.1 Unpacking

Unpack the instrument carefully. Make sure all components have been removed from the packing material. Check all the contents against the packing slip and report any discrepancies to the factory.

Before proceeding with the installation, do the following:

- Inspect all components for damage. Report any damage to the carrier within 24 hours.
- Make sure the nameplate model number on the probe and transmitter agree with the packing slip and purchase order.
- Record the model and serial numbers for future reference when ordering parts.

Model Number

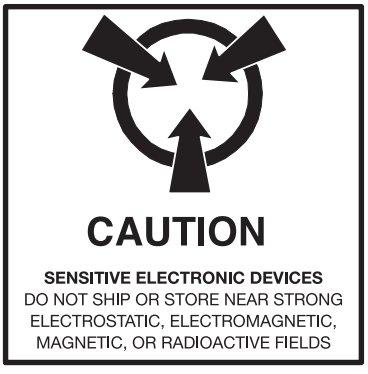
Serial Number

For optimal performance (and correlation to the Calibration Certificate included with all units), confirm the model and serial numbers shown on the nameplates of the ECLIPSE probe and transmitter are identical.

NOTE: For applications using the Model 7yS Steam Probe, it is mandatory to keep the transmitter and probe matched as a set. (Refer to section 3.2.5 for additional information regarding saturated steam applications.)

To avoid moisture ingress in the housing, covers should be fully tightened at all times. For same reason, conduit entries should be properly sealed.

2.2 Electrostatic Discharge (ESD) Handling Procedure



MAGNETROL electronic instruments are manufactured to the highest quality standards. These instruments use electronic components that may be damaged by static electricity present in most work environments.

The following steps are recommended to reduce the risk of component failure due to electrostatic discharge.

- Ship and store circuit boards in anti-static bags. If an anti-static bag is not available, wrap the board in aluminum foil. Do not place boards on foam packing materials.

- Use a grounding wrist strap when installing and removing circuit boards. A grounded workstation is recommended.
- Handle circuit boards only by the edges. Do not touch components or connector pins.
- Make sure that all electrical connections are completely made and none are partial or floating. Ground all equipment to a good, earth ground.

2.3 Before You Begin

2.3.1 Site Preparation

Each ECLIPSE Model 706 transmitter/probe is built to match the physical specifications of the required installation. Ensure that the probe process connection is correct for the threaded or flanged mounting on the vessel where the transmitter will be placed. See Mounting, Section 2.4.

Ensure that all local, state, and federal regulations and guidelines are observed. See Wiring, Section 2.5.

Ensure that the wiring between the power supply and ECLIPSE transmitter is complete and correct for the type of installation. See Specifications, Section 3.6.

2.3.2 Equipment and Tools

No special equipment or tools are required to install the ECLIPSE transmitter. The following items are recommended:

- Open-end wrenches (or adjustable wrench) to fit the process connection size and type.
  - Coaxial probe: 1 1/2" (38 mm)
  - Single Rod probe: 1 7/8" (47 mm)
  - Transmitter 1 1/2" (38 mm)

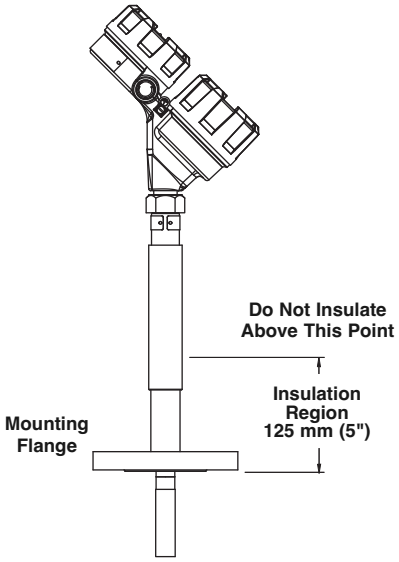
  A torque wrench is highly desirable.
- Flat-blade screwdriver
- Cable cutter and 3/32" hex wrench (for flexible cable probes only)
- Digital multimeter or digital volt/ammeter
- 24 VDC power supply, 23 mA minimum

2.3.3 Operational Considerations

Operating specifications vary based on probe model number. See Specifications, Section 3.6.

2.4 Mounting

An ECLIPSE Model 706 GWR probe can be mounted on to a tank using a variety of process connections. Generally, either a threaded or flanged connection is used. For information about the sizes and types of connections available, see Probe Model Numbers, Section 3.7.2.



Model 7yS Probe

NOTE: Do not place insulating material around any part of the ECLIPSE Model 706 transmitter as this may cause excessive heat buildup. The figure to the left shows an example of properly installed insulation. Insulation is critical in high temperature applications where condensation can occur at the top of the probe.

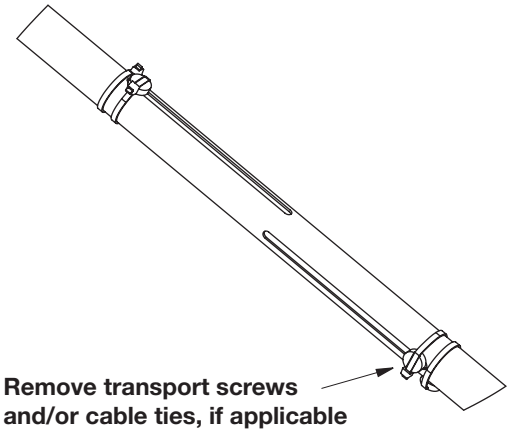
Ensure that all mounting connections are properly in place on the tank before installing the probe.

Compare the nameplate on the probe and transmitter with the product information to confirm that the ECLIPSE probe is correct for the intended installation.

WARNING! Overfill-capable probes such as the Model 7yD, 7yG, 7yJ, 7yL, 7yP, or 7yT should be used for all Safety Shutdown/Overfill applications.

The Model 706 transmitter, when used with an overfill coaxial or caged probe, is capable of measuring true liquid level to within specification all the way up to the face of the flange or NPT connection. This is a very unique advantage as compared to other Guided Wave Radar (GWR) devices that may infer level at the top of the probe when signals are lost or uncertain. Refer to Section 3.2.6 for additional information on overfill capability.

All other ECLIPSE probes should be installed so the maximum overfill level is a minimum of 150 mm (6") below the flange or NPT connection. This may include utilizing a nozzle or spool piece to raise the probe. Consult factory to ensure proper installation and operation.



Remove transport screws and/or cable ties, if applicable

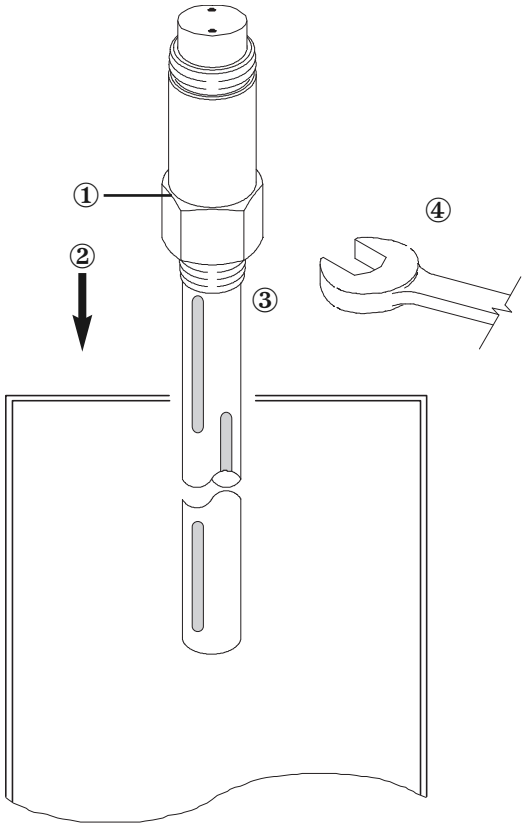
WARNING! Do not disassemble probe when in service and under pressure.

NOTE: Models 7yD, 7yJ, 7yL, 7yM, 7yN, 7yP and 7yS High Temperature/High Pressure probes (containing a glass ceramic alloy process seal) should be handled with extra care. Only handle these probes by the flanges or NPT connections. Remove transport hardware as shown at left.

2.4.1 Installing a Coaxial Probe (Models 7yD, 7yP, 7yS, and 7yT)

Before installing, ensure that:

- The model and serial numbers shown on the nameplates of the ECLIPSE probe and transmitter are identical. For optimal performance (and correlation to the Calibration Certificate included with all units), transmitters and probes should be installed as a matched set.



NOTE: For applications using the Model 7yS Steam Probe, it is mandatory to keep the transmitter and probe matched as a set. Refer to Section 3.2.5 for additional information regarding saturated steam applications.

- Probe has adequate room for installation and has unobstructed entry to the bottom of the vessel.
- Process temperature, pressure, dielectric, and viscosity are within the probe specifications for the installation. See Specifications, Section 3.6.

2.4.1.1 To install a coaxial probe:

1. Ensure that the process connection is the correct threaded or flanged mounting.
2. Carefully place the probe into the vessel. Properly align the gasket on flanged installations.
3. Align the probe process connection with the threaded or flanged mounting on the vessel.
4. For threaded connections, tighten the hex nut of the probe process connection. For flanged connections, tighten flange bolts.

NOTE: If the transmitter is to be installed at a later time, do not remove the protective cap from the probe.

NOTE: Do not use sealing compound or TFE tape on probe connection to transmitter as this connection is sealed by a Viton® o-ring.

2.4.2 Installing a Segmented Coaxial Probe

1. Use the large installation plate with the 1.88" slot (provided with the order) to hold the lower section of the outer tube. Using two 2" wrenches, tighten couplings. Threads will be self-locking.

   Repeat for the second outer tube section.
2. Use the smaller installation plate to hold the lower section of the extension shaft, resting one of the spacers on the plate. Using two 1/2" wrenches, tighten extension shaft coupling. Secure with set screws.

   Repeat for the second extension shaft section.
3. Using two 1/2" wrenches, attach the middle extension shaft segment to the top segment (built into the probe head). The flange gasket should be in place before assembling this joint. It may be taped to the probe flange to hold it out of the way.
4. Remove the smaller installation plate from the extension shaft and assemble the middle outer tube segment to the coupling on the probe head. Remove the large installation plate, and assemble the flanges.

2.4.3 Installing a Caged Probe Models 7yG, 7yL and 7yJ

Before installing, ensure that the:

- The model and serial numbers shown on the nameplates of the ECLIPSE probe and transmitter are identical. For optimal performance (and correlation to the Calibration Certificate included with all units), transmitters and probes should be installed as a matched set.
- Probe has adequate room for installation and has unobstructed entry to the bottom of the vessel.
- Process temperature, pressure, dielectric, and viscosity are within the probe specifications for the installation. See Specifications, Section 3.6.

NOTE: Model 7yL and 7yJ probes (High Pressure/High Temperature probes (containing a glass ceramic alloy process seal) should be handled with extra care. Only handle these probes by the flanges or NPT connection. Do not lift probes by the shaft.

2.4.3.1 To install a caged probe:

1. Ensure that the process connection is the correct flanged mounting.
2. Carefully place the probe into the vessel. Properly align the gasket on flanged installations.

NOTE: A metallic gasket must be used to ensure an adequate electrical connection between the probe flange and the cage (chamber). This connection is critical to obtain true overfill performance.

3. Align the probe process connection flanged mounting on the cage.
4. Tighten flange bolts.

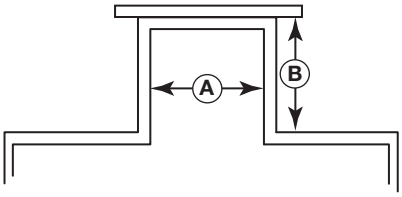
NOTES: If the transmitter is to be installed at a later time, do not remove the protective cap from the probe.

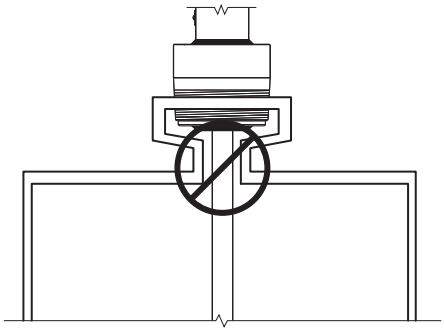
Do not use sealing compound or TFE tape on probe connection to transmitter as this connection is sealed by a Viton® o-ring.

2.4.4 Installing a Single Rod Probe
Rigid Models 7yF, 7yG, 7yJ, 7yL, 7yM and 7yN
Flexible Models 7y1, 7y2, 7y3 and 7y6

Before installing, ensure that the:

- The model and serial numbers shown on the nameplates of the ECLIPSE probe and transmitter are identical. For optimal performance (and correlation to the Calibration Certificate included with all units), transmitters and probes should be installed as a matched set.
- Probe has adequate room for installation and has unobstructed entry to the bottom of the vessel.
- Process temperature, pressure, dielectric, and viscosity are within the probe specifications for the installation. See Specifications, Section 3.6.





For standard Non-Overfill-Capable Single Rod probes installed directly into a vessel:

NOTE: If using a removable rod, ensure that all pieces are assembled and connected before installation.

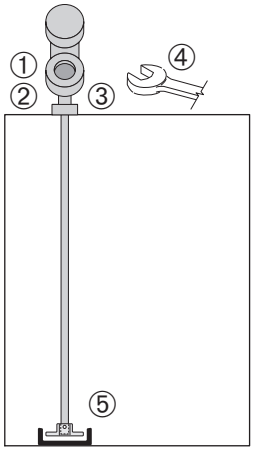
1. Ensure that the nozzle does not restrict performance by ensuring the following:

- Nozzle is > 50 mm (2") diameter.
- Ratio of Diameter: Length (A:B) is 1:1 or greater; any ratio <1:1 (e.g., a 2"× 6" nozzle = 1:3) may require a Blocking Distance and/or DIELECTRIC RANGE adjustment.

2. No pipe reducers (restrictions) are used.
3. Probe is kept away from conductive objects to ensure proper performance.

- See Probe Clearance Table below. A lower gain (increase in DIELECTRIC RANGE setting) may be necessary to ignore certain objects
- This table is only a recommendation. These distances can be improved by optimizing the transmitter configuration with PACT*ware*™.

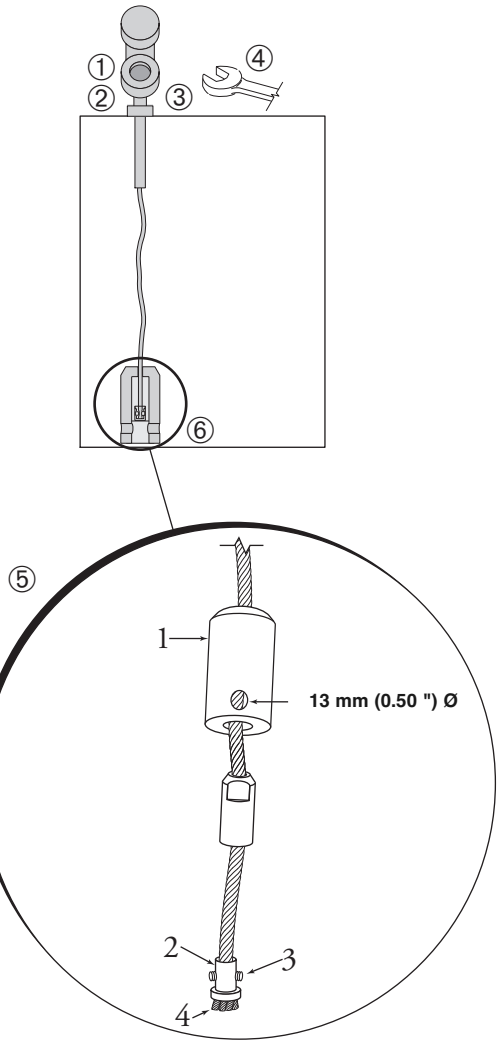
Distance to Probe	Acceptable Objects
<15 cm (6")	Continuous, smooth, parallel conductive surface, for example a metal tank wall; important that probe does not touch wall
>15 cm (6")	<25 mm (1") diameter pipe and beams, ladder rungs
>30 cm (12")	<75 mm (3") diameter pipe and beams, concrete walls
>46 cm (18")	All remaining objects



2.4.4.1 To install a rigid single rod probe:

1. Ensure that the process connection is at least 1" NPT or a flanged mounting.
2. Carefully place the probe into the vessel. Align the gasket on flanged installations.
3. Align the probe process connection with the threaded or flanged mounting on the vessel.
4. For threaded connections, tighten the hex nut of the probe process connection. For flanged connections, tighten flange bolts.
5. When mounted directly into vessels, the probe can be stabilized by placing the tip of the probe into a non-metallic cup or bracket at the bottom of the probe.

   A bottom spacer option is offered for mounting into a metallic cup or bracket or for centering within a pipe/chamber. Please refer to Replacement Parts, Section 3.8 for additional information.



NOTE: If the transmitter is to be installed at a later time, do not remove the protective cap from the probe. Do not use sealing compound or TFE tape on probe connection to transmitter as this connection is sealed by a Viton® O-ring.

2.4.4.2 To install a flexible single rod probe for liquids:

1. Make sure the process connection is at least 1" NPT or a flanged mounting.
2. Carefully place the probe into the vessel. Align the gasket on flanged installations.
3. Align the probe process connection with the threaded or flanged mounting on the vessel.
4. For threaded connections, tighten the hex nut of the probe process connection. For flanged connections, tighten flange bolts.
5. Probe can be shortened in field:
   a. Raise TFE weight (1) exposing securing device (2).
   b. Loosen both #10–32 set screws (3) using 3/32" hex wrench and remove securing device.
   c. Cut and remove needed cable (4) length.
   d. Reattach securing device and tighten screws.
   e. Enter new probe length (in the appropriate units) into the transmitter.
6. Probe can be attached to the tank bottom using the 13 mm (0.50") hole provided in the TFE weight. Cable tension should not exceed 23 Kgs (50 lbs).

2.4.4.3 To install a flexible single rod probe for solids:

The Model 7y2 Single Flexible Bulk Solids probe is designed for a 1360 kg (3000 lb.) pull-down force for use in applications such as sand, plastic pellets and grains. It is offered with a maximum 30.5 meter (100 foot) probe length.

Model 7y2 Single Rod — dielectric ≥4 probe length dependent.

Applications

- Salts: Dielectric constant 4.0–7.0
- Metallic powder, coal dust: Dielectric constant >7

NOTE: Contact the factory for those applications requiring additional pull down forces such as cement, heavy gravel, etc.

Mounting recommendations

- To reduce forces, utilize the standard 2.3 kg (5 lb.) weight at the bottom of the probe instead of securing the probe to the vessel.
- Mount the probe at least 30 cm (12 inches) from the wall. Ideal location is 1/4 to 1/6 the diameter to average the angle of repose.
- A metal flange must be used when mounting on plastic vessels.

1. Ensure the process connection is at least 2" NPT or a flanged mounting.
2. Carefully place the probe into the vessel. Align the gasket on flanged installations.
3. Align the probe process connection with the threaded or flanged mounting on the vessel.
4. For threaded connections, tighten the hex nut of the probe process connection. For flanged connections, tighten flange bolts.
5. Probe can be shortened in field:
6. a. Loosen and remove the two cable clamps.

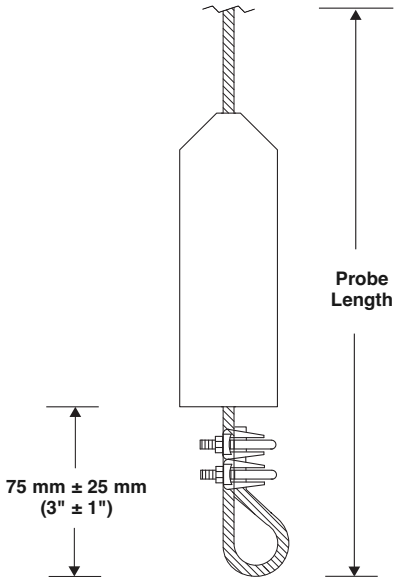
   b. Slide the weight off of the probe.

   c. Cut the cable to the required length plus 165 mm (6.5 inches).

   d. Slide the weight back on to the probe.

   e. Reinstall the two cable clamps and tighten.

   f. Enter the new probe length (in the appropriate level units) into the transmitter.



Model 7y2 Single Rod Bulk Solids Probe

2.4.5 Installing the ECLIPSE Model 706 Transmitter

The transmitter can be ordered for installation in three configurations;

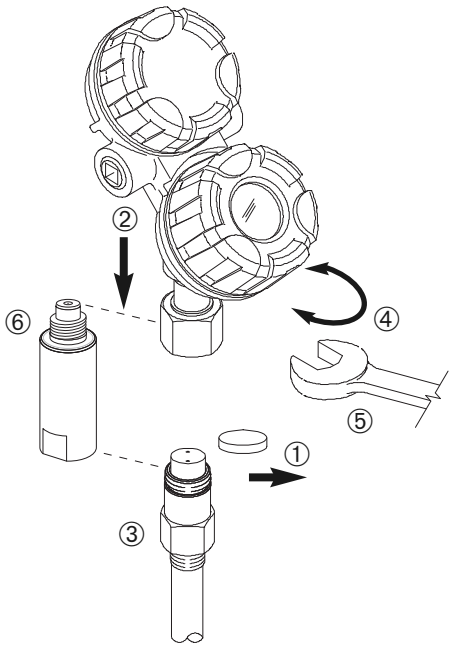
1) As an Integral version, mounted directly on to the probe.

2) As a Remote version, with the transmitter separated from the probe by a distance of 84 cm (3 feet).

3) As a Remote version, with the transmitter separated from the probe by a distance of 366 cm (12 feet).

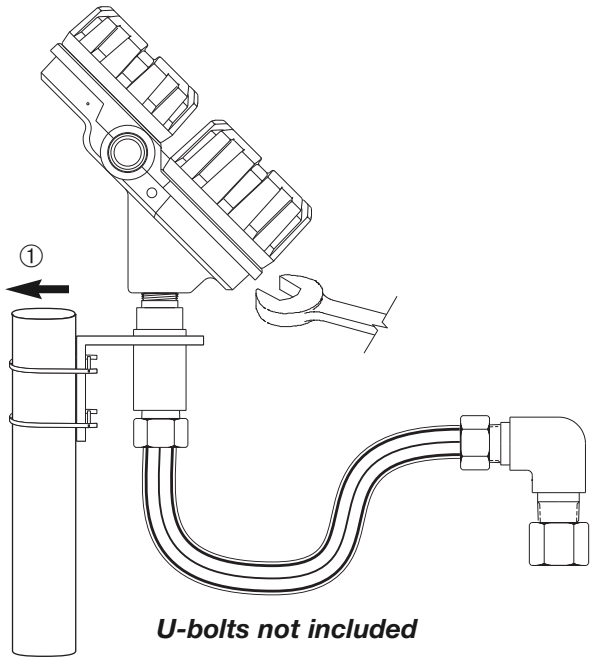
NOTE Due to their extra weight, remote mounted transmitter Model Number 706-5xxx-x2x is recommended for:

- All applications utilizing the cast 316 SS enclosure
- Those applications having potential vibration



2.4.5.1 Integral Mount

1. Remove the protective plastic cap from the top of the probe. Store the cap in a safe place in case the transmitter has to be removed later.
2. Place the transmitter on the probe. Do not allow the gold pin in the high frequency connector or the gold socket on the probe to get dirty.
3. Align the universal connection at the base of the transmitter housing with the top of the probe. Only hand-tighten the connection at this time.
4. Rotate the transmitter to face the most convenient direction for wiring, configuration, and viewing.
5. When the transmitter is facing the desired direction, use a 1 1/2" wrench to tighten the universal connection on the transmitter to 60 Nm (45 ft-lbs). A torque wrench is highly recommended. This is a critical connection. DO NOT LEAVE HAND-TIGHT.
6. If applicable, install optional adapter for use with Model 705 probes. As this is a critical connection, a torque wrench is highly recommended to obtain 60 Nm (45 ft-lbs).

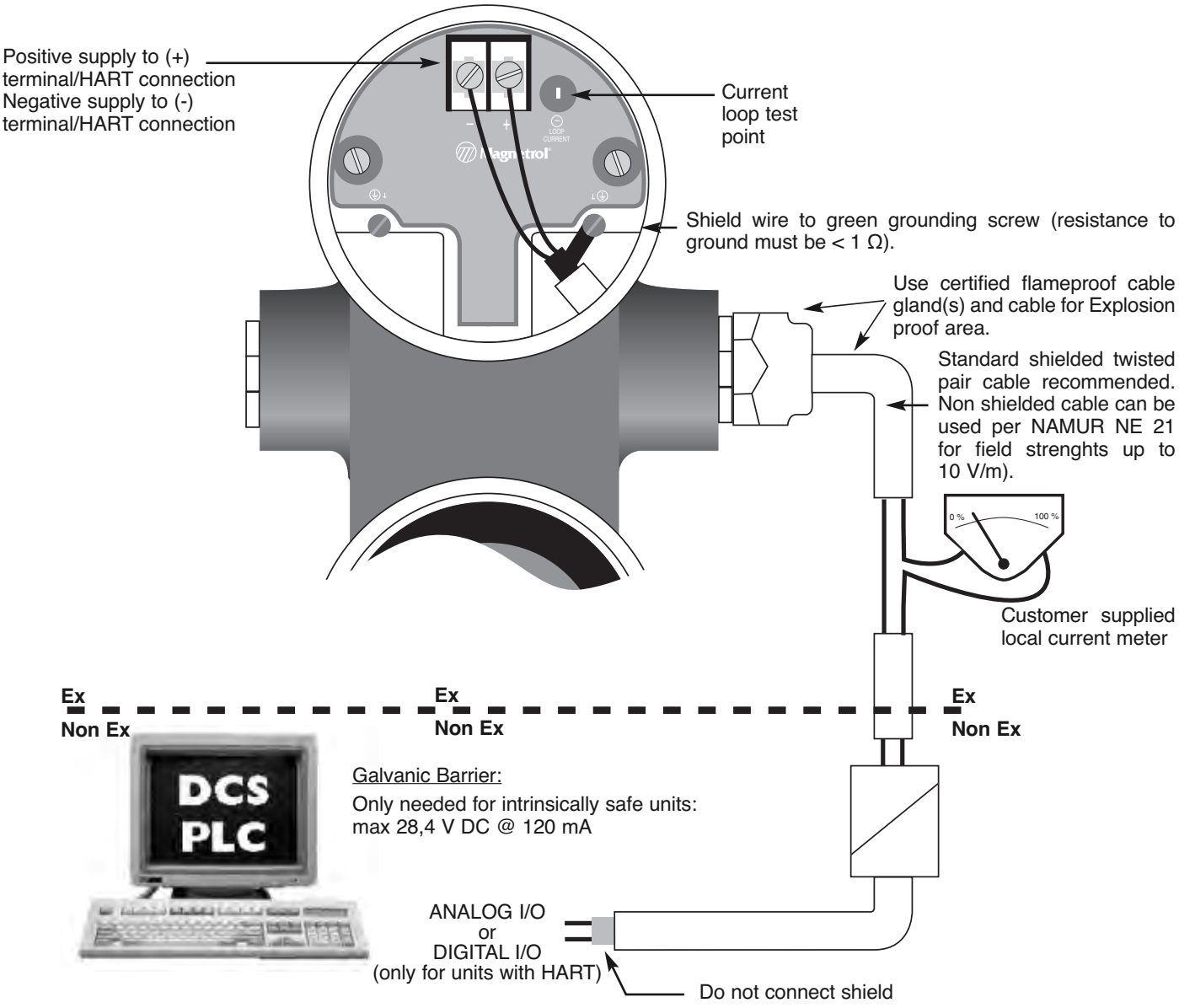


2.4.5.2 Remote Mount

1. Mount the transmitter/remote bracket as an assembly within 84 or 366 cm (33" or 144") of the probe. DO NOT REMOVE TRANSMITTER OR REMOTE CABLE FROM THE MOUNTING BRACKET.
2. Remove the protective plastic cap from the top of the probe. Store the cap in a safe place in case the transmitter has to be removed later.
3. Align the universal connection at the end of the remote assembly with the top of the probe. Using a 1 1/2" wrench, tighten the universal connection on the transmitter to 60 Nm (45 ft-lbs). A torque wrench is highly recommended. This is a critical connection. DO NOT LEAVE HAND-TIGHT.

2.5 Wiring

CAUTION: power must be switched OFF before wiring the unit.



IMPORTANT:

The shield wire should only be grounded at ONE side only. It is recommended to connect the shield to ground in the field (at the transmitter side - as shown above) but connecting in the control room is also allowed.

2.6 Configuration

Although the ECLIPSE Model 706 transmitter can be delivered pre-configured from the factory, it can also be easily reconfigured in the shop or at the installation using the local LCD/Keypad or PACT*ware*/DTM. Bench configuration provides a convenient and efficient way to set up the transmitter before going to the tank site to complete the installation.

Before configuring any transmitter, collect all operating parameters information (refer to Section 1.1.2).

Apply power to the transmitter and follow the step-by-step procedures below for the menu-driven transmitter display. Refer to Sections 2.6.2 and 2.6.4.

Information on configuring the transmitter using a HART communicator is given in Section 2.7, Configuration Using HART.

Refer to I/O manuals:

- BE 57-646 for information on FOUNDATION Fieldbus™ output.
- BE 57-658 for information on PROFIBUS PA output.
- 41-621 for information on Modbus output.

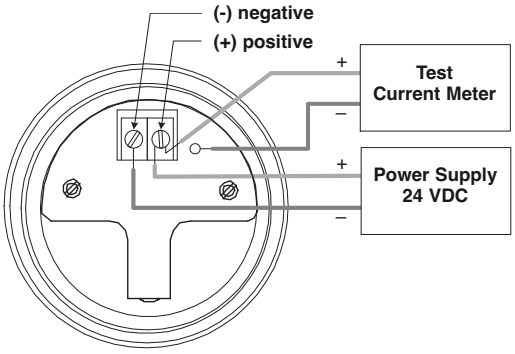
2.6.1 Bench Configuration

The ECLIPSE Model 706 transmitter can be easily configured at a test bench by connecting a standard 24 VDC power supply directly to the transmitter terminals as shown in the accompanying diagram. An optional digital multimeter is shown in the event that mA current measurements are desired.

NOTE: Current measurements taken at these test points are an approximate value. Accurate current readings should be taken with the digital multimeter directly in series with the loop.

NOTE: When using a HART communicator for configuration, a minimum 250-ohm line load resistance is required. Refer to your HART communicator manual for additional information.

NOTE: The transmitter can be configured without the probe. Please disregard the “No Probe” diagnostic indicator that will appear.



G.P./I.S./Explosion Proof Model

2.6.2 Menu Traversal and Data Entry

The four push buttons offer various forms of functionality for navigation and data entry.

The Model 706 user interface is hierarchical in nature, best described as a tree structure. Each level in the tree contains one or more items. Items are either menu labels or parameter names.

- Menu labels are presented in all capital letters
- Parameters are capital words

2.6.2.1 Navigating the Menu

⇧ **UP** moves to the previous item in the menu branch.

⇩ **DOWN** moves to the next item in the menu branch.

⇦ **BACK** moves back one level to the previous (higher) branch item.

⇨ **ENTER** enters into the lower level branch or switches to the entry mode. Holding the ENTER down on any highlighted menu name or parameter will show help text for that item.

2.6.2.2 Data Selection

This method is used for selecting configuration data from a specific list.

⇧ **UP** and ⇩ **DOWN** to navigate the menu and highlight the item of interest

⇨ **ENTER** allows modification of that selection

⇧ **UP** and ⇩ **DOWN** to choose new data selection

⇨ **ENTER** to confirm selection

Use ⇦ **BACK** (Escape) key at any time to abort the procedure and escape to previous branch item

2.6.2.3 Entering Numeric Data Using Digit Entry

This method is used to input numeric data, e.g., Probe Length, set 4mA and set 20mA.

Push button		Keystroke Action
	Up	Moves up to the next highest digit (0,1,2,3,....,9 or decimal point). If held down the digits scroll until the push button is released.
	Down	Moves up to the next lowest digit (0,1,2,3,....,9 or decimal point). If held down the digits scroll until the push button is released.
	Back	Moves the cursor to the left and deletes a digit. If the cursor is already at the leftmost position, then the screen is exited without changing the previously saved value.
	Enter	Moves the cursor to the right. If the cursor is located at a blank character position, the new value is saved.

All numeric values are left-justified, and new values are entered from left to right. A decimal point can be entered after the first digit is entered, such that .9 is entered as 0.9.

Some configuration parameters can have a negative value. In this case, the leftmost position is reversed for the sign (either "-" for a negative value, or "+" for a positive value).

2.6.2.4 Entering Numeric Data Using Increment/Decrement

Use this method to input the following data into parameters such as Damping and Failure Alarm.

Push button		Keystroke Action
	Up	Increments the displayed value. If held down the digits scroll until the push button is released. Depending on which screen is being revised, the increment amount may increase by a factor of 10 after the value has been incremented 10 times.
	Down	Decrements the displayed value. If held down the digits scroll until the push button is released. Depending on which screen is being revised, the decrement amount may increase by a factor of 10 after the value has been decremented 10 times.
	Back	Returns to the previous menu without changing the original value, which is immediately redisplayed.
	Enter	Accepts the displayed value and returns to the previous menu.

2.6.2.5 Entering Character Data

This method is used for parameters requiring alphanumeric character entry, such as for entering tags, etc.

General Menu Notes:

Push button		Keystroke Action
	Up	Moves to the previous character (Z...Y...X...W). If held down, the characters scroll until the push button is released.
	Down	Moves to the next item character (A...B...C...D). If held down, the characters scroll until the push button is released.
	Back	Moves the cursor back to the left. If the cursor is already at the leftmost position, then the screen is exited without changing the original tag characters.
	Enter	Moves the cursor forward to the right. If the cursor is at the rightmost position, then the new tag is saved.

2.6.3 Password Protection

The ECLIPSE Model 706 transmitter has three levels of password protection to restrict access to certain portions of the menu structure that affect the operation of the system. The user password can be changed to any numerical value up to 59999. When the transmitter is programmed for password protection, a password is required whenever configuration values are changed.

User Password

The User Password allows the customer to limit access to the basic configuration parameters.

The default User Password installed in the transmitter at the factory is 0. With a password of 0, the transmitter is no longer password protected and any value in the basic user menus can be adjusted without entering a confirming password.

NOTE: If a User Password is not known or has been misplaced, the menu item New Password in the DEVICE SETUP/ADVANCED CONFIG menu displays an encrypted value representing the present password. Contact Technical Support with this encrypted password to retrieve the original User Password.

Advanced Password

Certain portions of the menu structure that contain more advanced parameters are further protected by an Advanced Password.

This password will be provided, when necessary, by Factory technical support.

Factory Password

Calibration-related and other factory settings are further protected by a Factory Password.

2.6.4 Model 706 Menu: Step-By-Step Procedure

The following tables provide a complete explanation of the software menus displayed by the ECLIPSE transmitter. The menu layout is similar between the local Keypad/LCD interface, the DD, and the DTM.

Use these tables as a step-by-step guide to configure the transmitter based on the desired measurement type from the following selections:

- **Level Only**
- **Interface & Level**
- **Interface & Volume**
- **Level & Volume**
- **Flow**

HOME SCREEN

The Home Screen consists of a "slide show" sequence of Measured Values screens which are rotated at 2-second intervals. Each Home Measured Value screen can present up to four information items:

- **HART® Tag**
- **Measured Value**
  Label, Numerical Value, Units
- **Status**
  Will be displayed as text or optionally with NAMUR NE 107 symbol
- **Primary Value Bar Graph** (shown in %)

The Home Screen presentation can be customized by viewing or hiding some of these items. See DISPLAY CONFIG under the DEVICE SETUP menu in Section 2.6.5 — Configuration Menu.

At left is an example of a Home Screen for a Model 706 configured for a Level Only application.

MAIN MENU

Pressing any key on the Home Screen will present the Main Menu, consisting of three basic menu labels shown in all capital letters.

- **DEVICE SETUP**
- **DIAGNOSTICS**
- **MEASURED VALUES**

As shown, the reverse video represents a cursor identifying the selected item, which will appear in reverse video on the LCD. The actions of the keys at this point are:

Push button		Keystroke Action
↑	Up	No action as the cursor is already at the first item in the MAIN MENU
↓	Down	Moves the cursor to DIAGNOSTICS
←	Back	Moves back to HOME SCREEN, the level above MAIN MENU
→	Enter	Presents the selected item, DEVICE SETUP

NOTES:
1. Items and parameters that are shown in lower level menus will depend on the Measurement Type chosen. Those parameter not applicable to the present Measurement Type will be hidden.
2. Holding down the Enter key when the cursor is highlighted over a parameter or menu will provide additional information about that item.

DEVICE SETUP

Choosing DEVICE SETUP from the MAIN MENU will result in an LCD presentation as shown at left.

The small down arrow shown at the right hand side of the screen is the indication that more items are available below and can be accessed by pressing the DOWN key.

Section 2.6.5 shows the entire tree menu for the Model 706 DEVICE SETUP Menu.

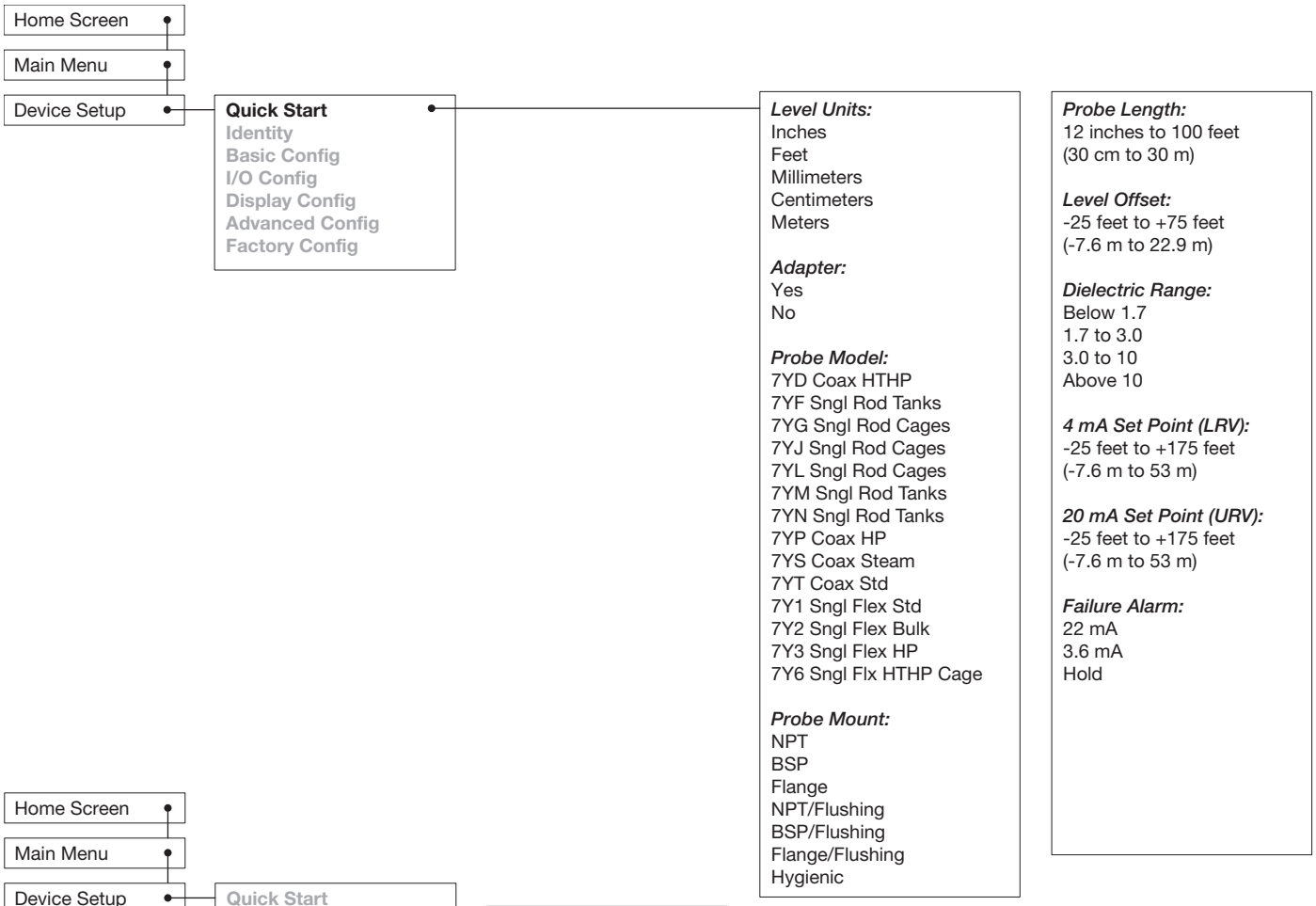
DIAGNOSTICS

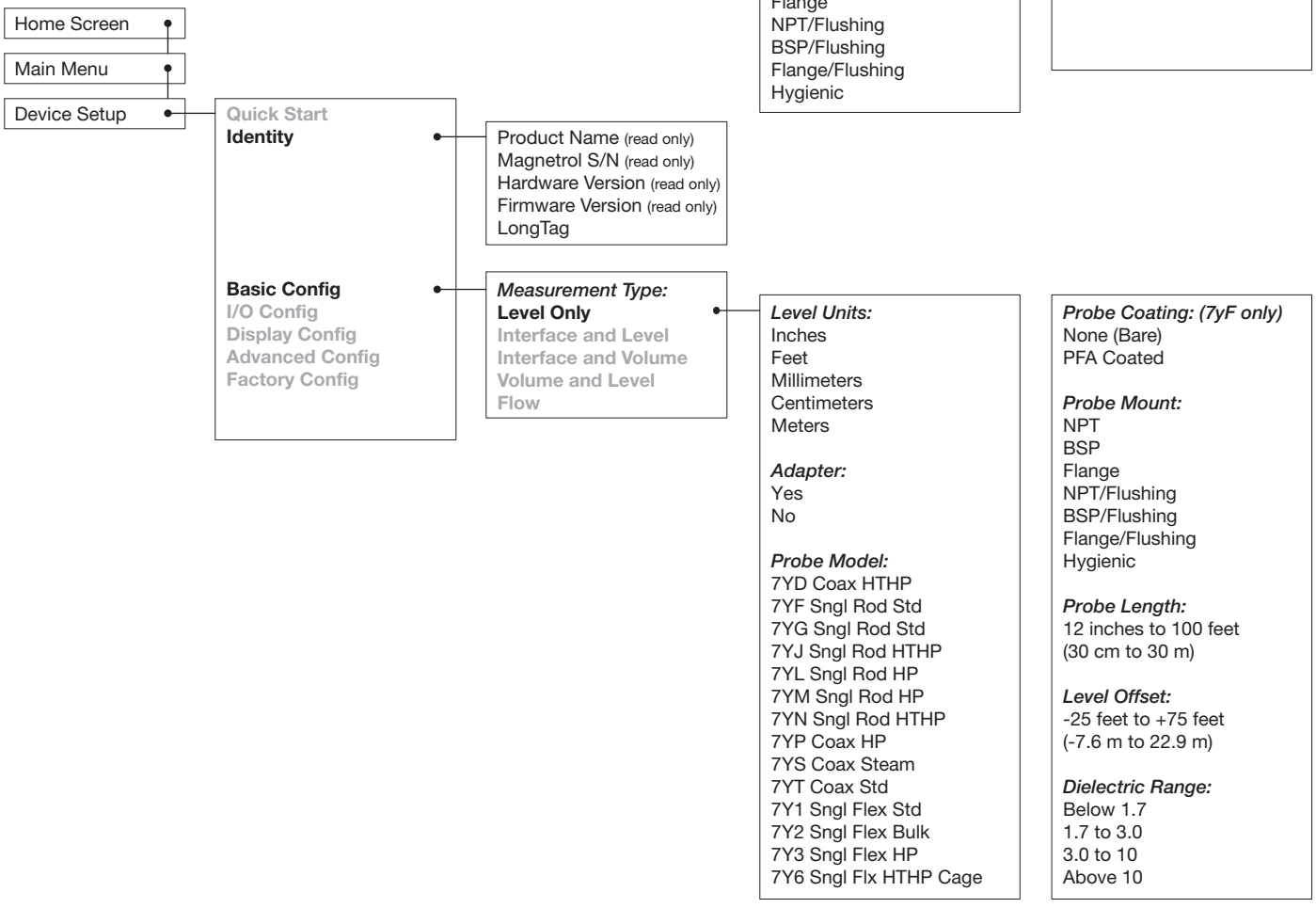
Refer to Section 3.3.4

MEASURED VALUES

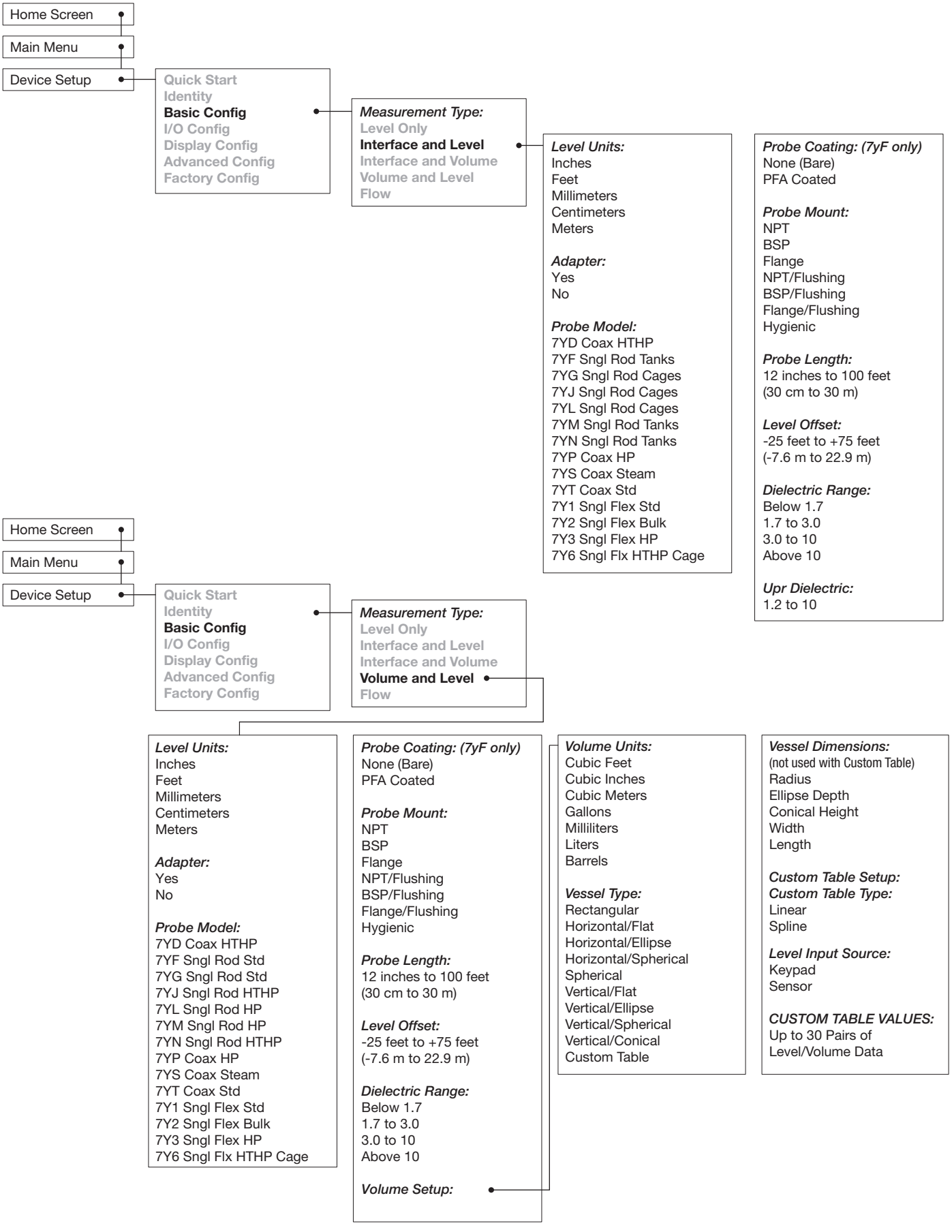
Allows the user to scroll through all of the available measured values for the measurement type chosen.

2.6.5 Model 706 Configuration Menu — Device Setup

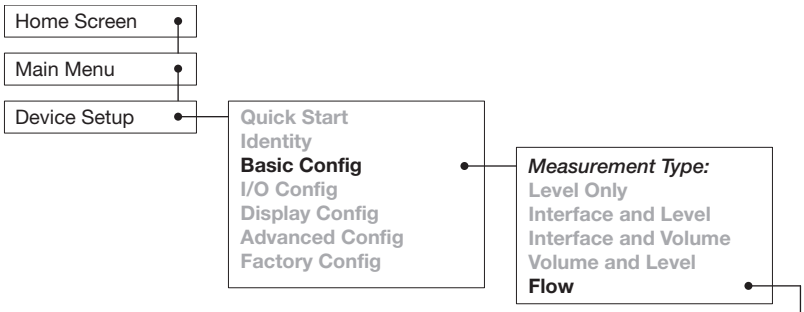




2.6.5 Model 706 Configuration Menu — Device Setup



2.6.5 Model 706 Configuration Menu — Device Setup



Level Units:
Inches
Feet
Millimeters
Centimeters
Meters

Adapter:
Yes
No

Probe Model:
7YD Coax HTHP
7YF Sngl Rod Std
7YG Sngl Rod Std
7YJ Sngl Rod HTHP
7YL Sngl Rod HP
7YM Sngl Rod HP
7YN Sngl Rod HTHP
7YP Coax HP
7YS Coax Steam
7YT Coax Std
7Y1 Sngl Flex Std
7Y2 Sngl Flex Bulk
7Y3 Sngl Flex HP
7Y6 Sngl Flx HTHP Cage

Probe Mount:
NPT
BSP
Flange
NPT/Flushing
BSP/Flushing
Flange/Flushing
Hygienic

Probe Coating:
None (Bare)
PFA Coated

Probe Length:
12 inches to 100 feet
(30 cm to 30 m)

Level Offset:
-25 feet to +75 feet
(-7.6 m to 22.9 m)

Dielectric Range:
Below 1.7
1.7 to 3.0
3.0 to 10
Above 10

Flow Setup:

Flow Units:
Cubic Ft/Second
Cubic Ft/Minute
Cubic Ft/Hour
Gallons/Minute
Gallons/Hour
Mil Gallons/Day
Liters/Second
Liters/Minute
Liters/Hour
Cubic Meters/Hour

Flow Element:
Palmer-Bowlus Flume
Flume Channel Width:
4 inches
6 inches
8 inches
10 inches
12 inches
15 inches
18 inches
21 inches
24 inches
27 inches
30 inches

Parshall Flume
Flume Channel Width:
1 inch
2 inches
3 inches
6 inches
9 inches
12 inches
18 inches
24 inches
36 inches
48 inches
60 inches
72 inches
96 inches
120 inches
144 inches

V-notch Weir
V-notch Weir Angle:
22.5°
30°
45°
60°
90°
120°

Rect Weir with Ends
0 to 215.0 feet
(0 to 65 m)

Rect Weir w/o Ends
0 to 215.0 feet
(0 to 65 m)

Cipolletti Weir
0 to 215.0 feet
(0 to 65 m)

Generic Equation
K
L
C
n

Custom Table
Custom Table Type:
Linear
Spline

CUSTOM TABLE VALUES:
Up to 30 Pairs of
Head/Flow Data

Reference Distance:
11.8 inches to 100 feet
(30 cm to 30 m)

Maximum Head
The *Maximum Head* value can be revised depending on the value of the *Reference Distance*, or for end user preference.

Maximum Flow
(calculated, read only)

Low Flow Cutoff:
0 to 9999999 cubic ft/min

TOTALIZER SETUP:
Units:
Cubic Feet
Gallons
Mil Gallons
Liters
Mil Liters
Cubic Meters

NON-RESET TOTALIZER:
Multiplier:
1
10
100
1,000
10,000
100,000

Value (read only)
RunTime (read only)

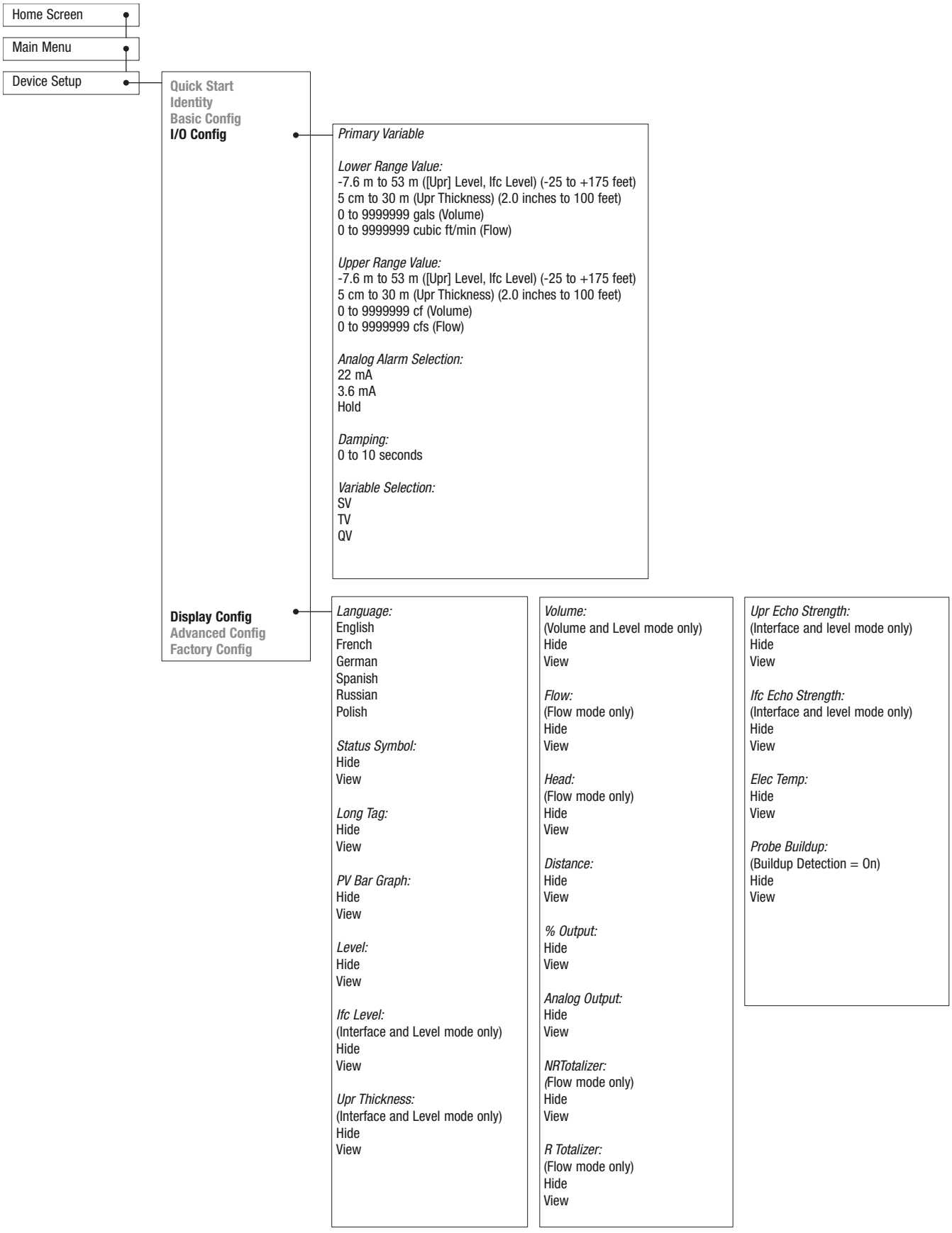
RESETTABLE TOTALIZER:
Mode:
Disabled
Enabled

Multiplier:
1
10
100
1,000
10,000
100,000

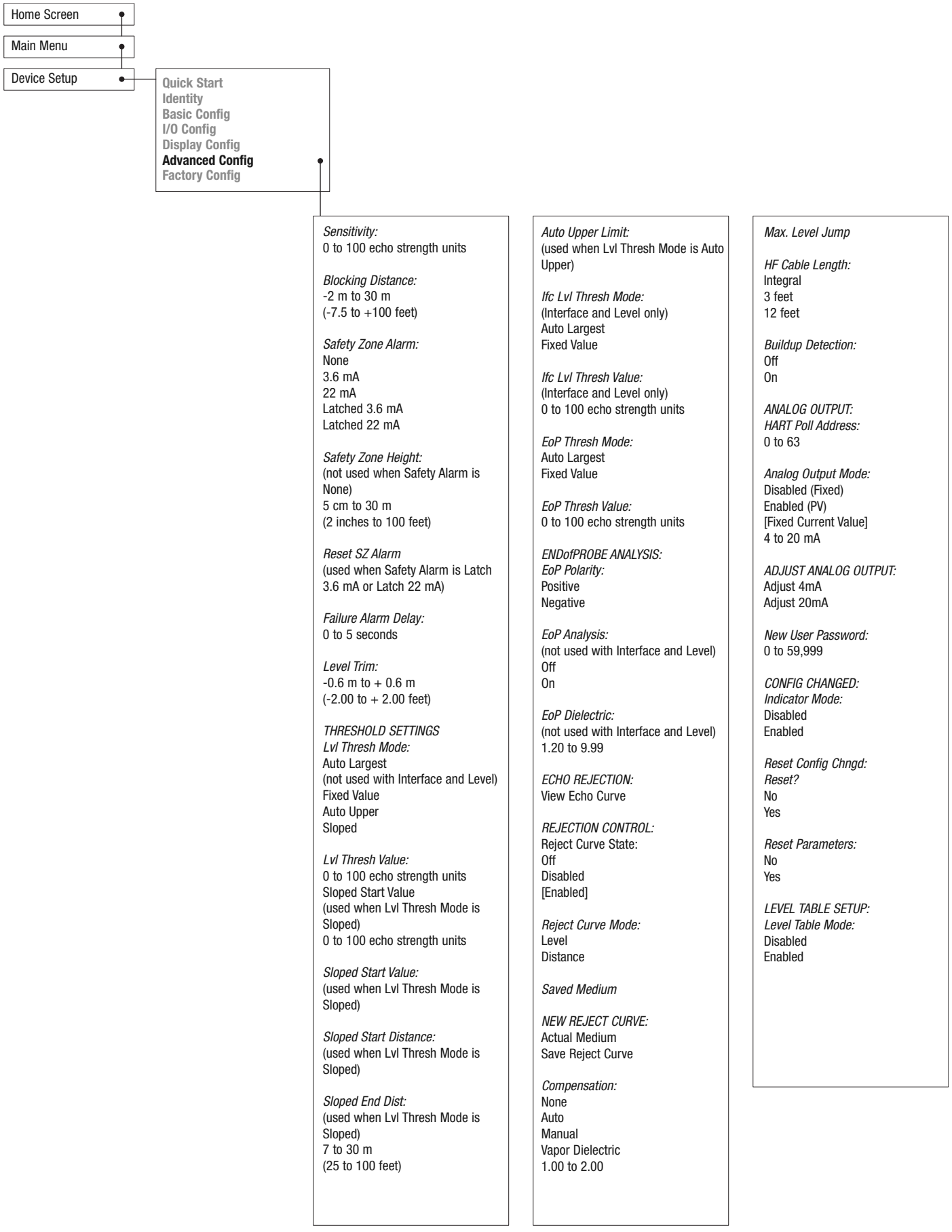
Value (read only)
RunTime (read only)

Reset

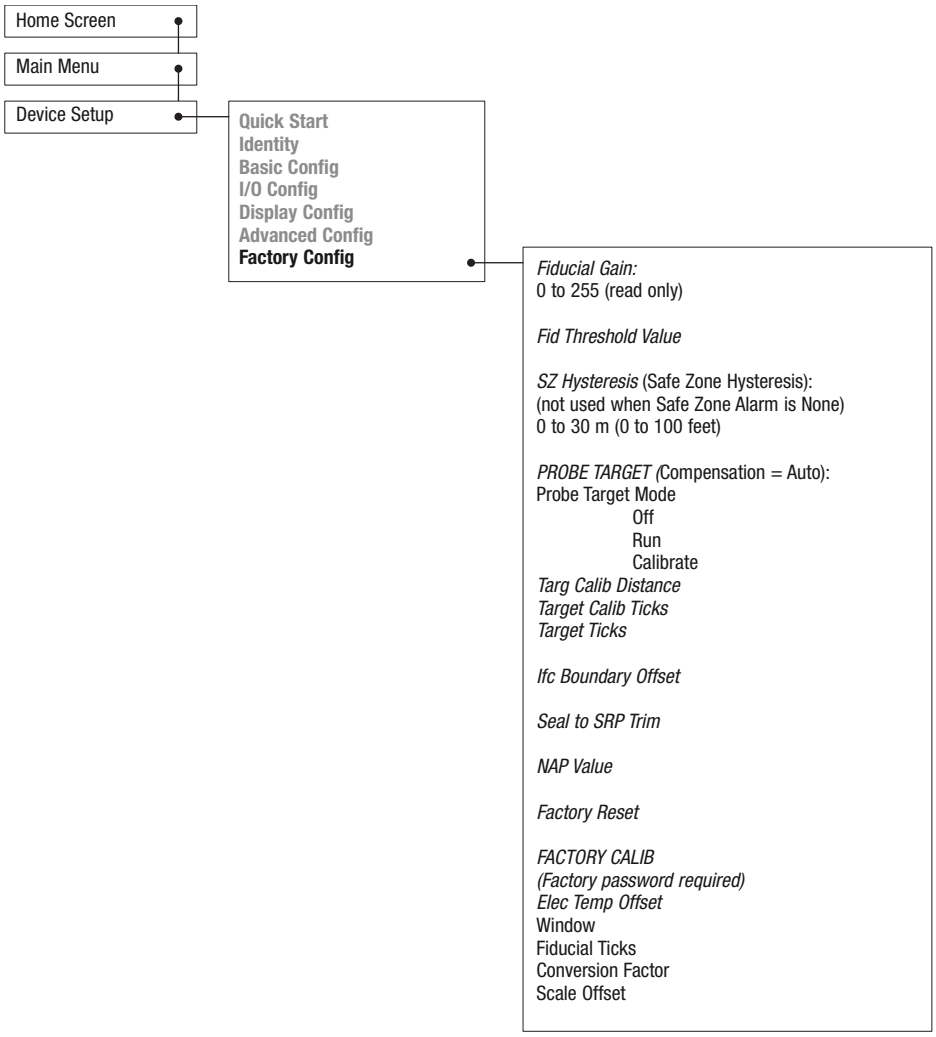
2.6.5 Model 706 Configuration Menu — Device Setup



2.6.5 Model 706 Configuration Menu — Device Setup



2.6.5 Model 706 Configuration Menu — Device Setup

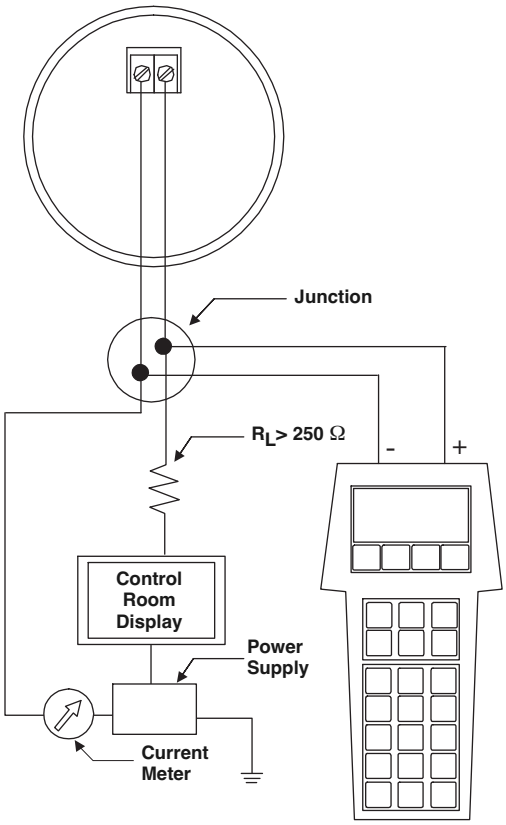


2.7 Configuration Using HART

A HART (Highway Addressable Remote Transducer) remote unit, such as a HART communicator, can be used to provide a communication link to the ECLIPSE Model 706 transmitter. When connected to the control loop, the same system measurement readings shown on the transmitter are also shown on the communicator. The communicator can also be used to configure the transmitter.

The HART communicator may need to be updated to include the ECLIPSE Model 706 software (Device Descriptions). Refer to your HART Communicator Manual for update instructions.

One can also access configuration parameters using PACT*ware* and the Model 706 DTM, or using the AMS with EDDL.



2.7.1 Connections

A HART communicator can be operated from a remote location by connecting it to a remote junction or by connecting it directly to the terminal block in the wiring compartment of the ECLIPSE transmitter.

HART uses the Bell 202 frequency shift keying technique of high-frequency digital signals. It operates on the 4–20 mA loop and requires 250 Ω load resistance. A typical connection between a communicator and the ECLIPSE transmitter is shown at left.

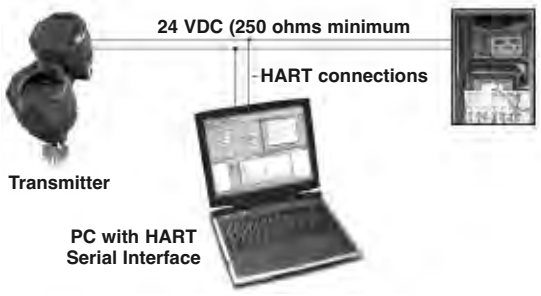
2.7.2 HART Communicator Display

A typical communicator display is an 8-line by 21-character LCD. When connected, the top line of each menu displays the model (Model 706) and its tag number or address. For detailed operating information, refer to the instruction manual provided with the HART communicator.

2.7.3 HART Revision Table

Model 706 1.x

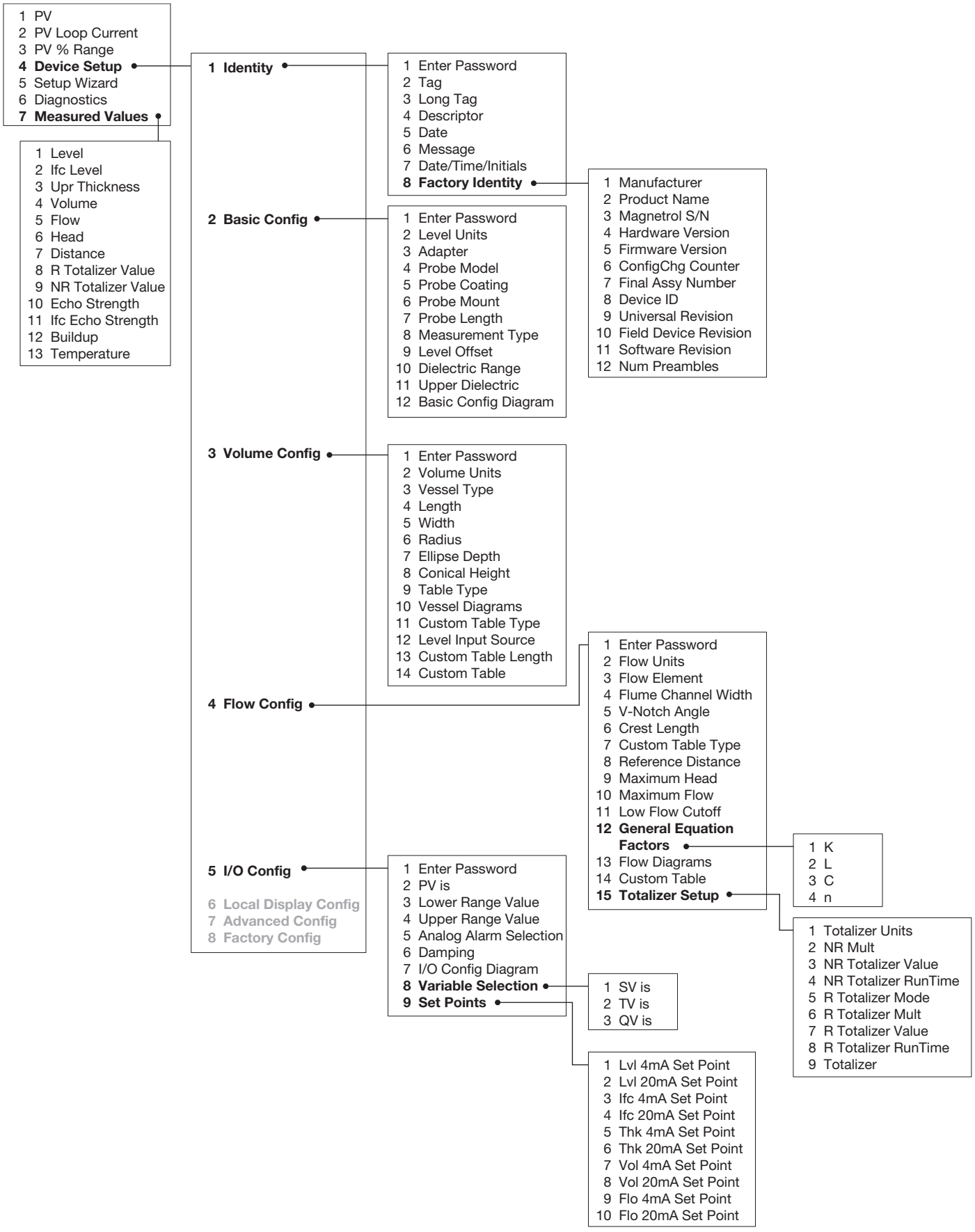
HART Version	HCF Release Date	Compatible with 706 Software
Dev Rev 2, DD Rev 1	August 2019	Version 1.1d and later



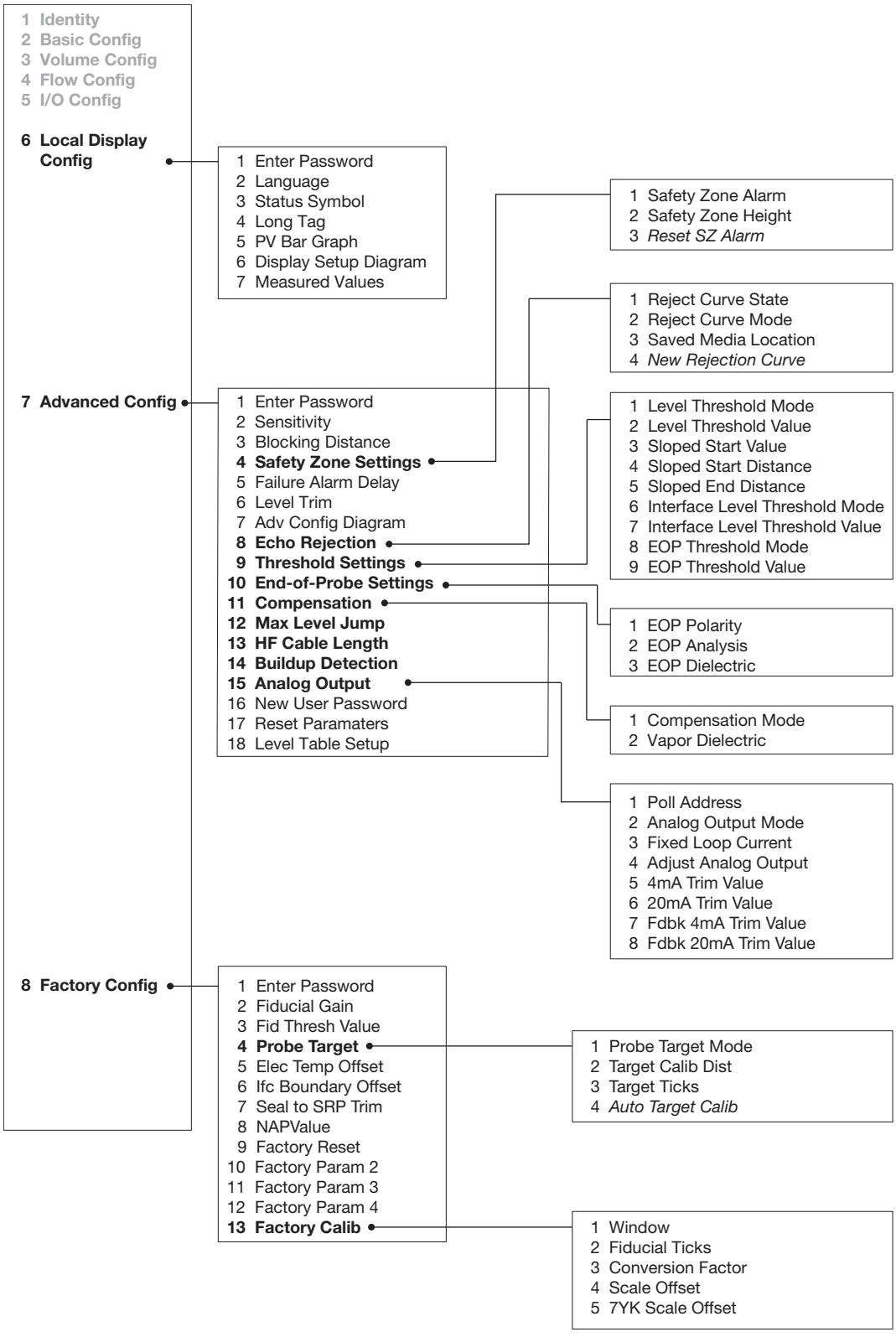
2.7.4 HART Menu – Model 706

The ECLIPSE transmitter HART menu trees are shown in the following pages. Open the menu by pressing the alphanumeric key 4, then Device Setup, to display the second-level menu.

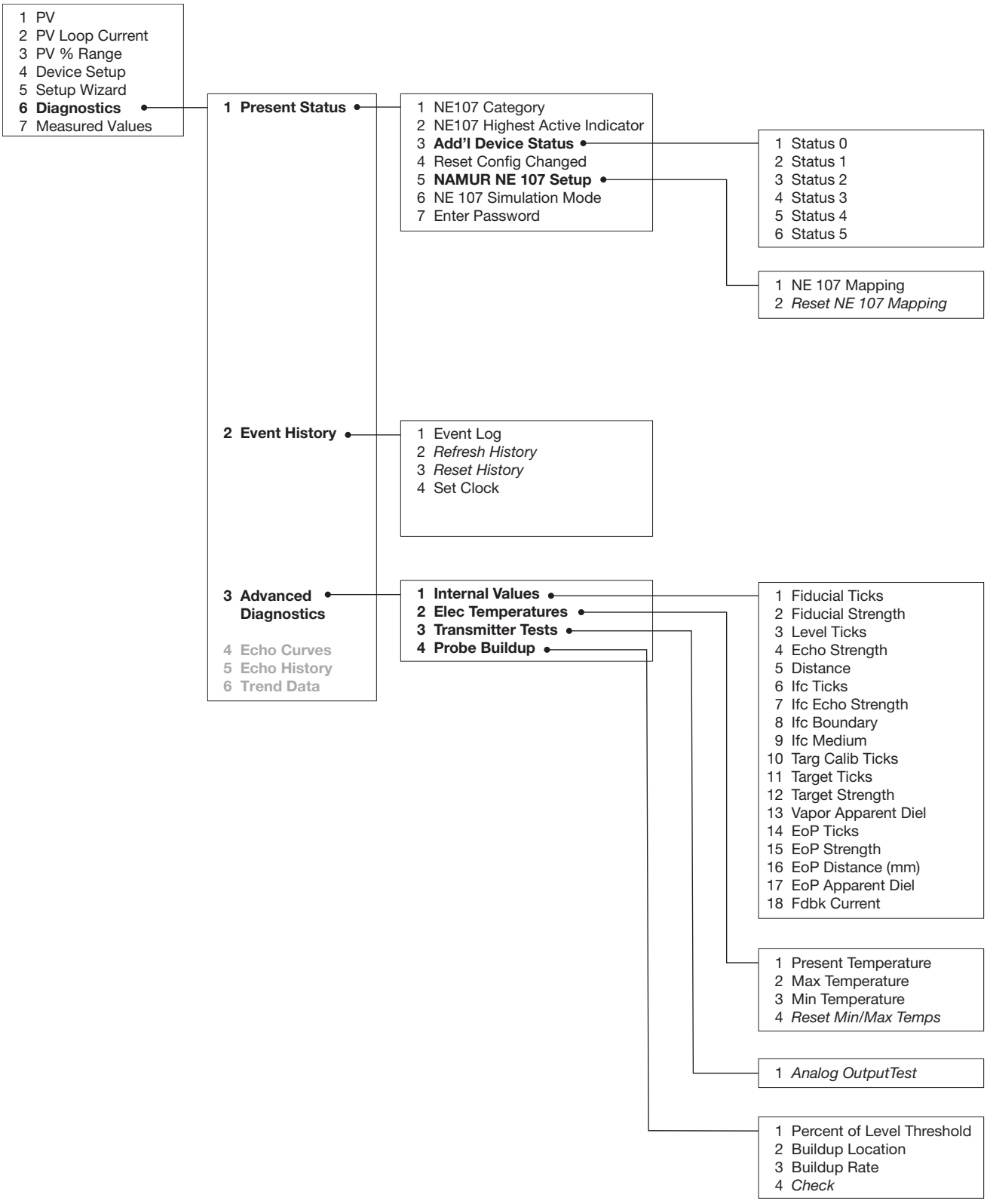
2.7.4 HART Menu – Model 706



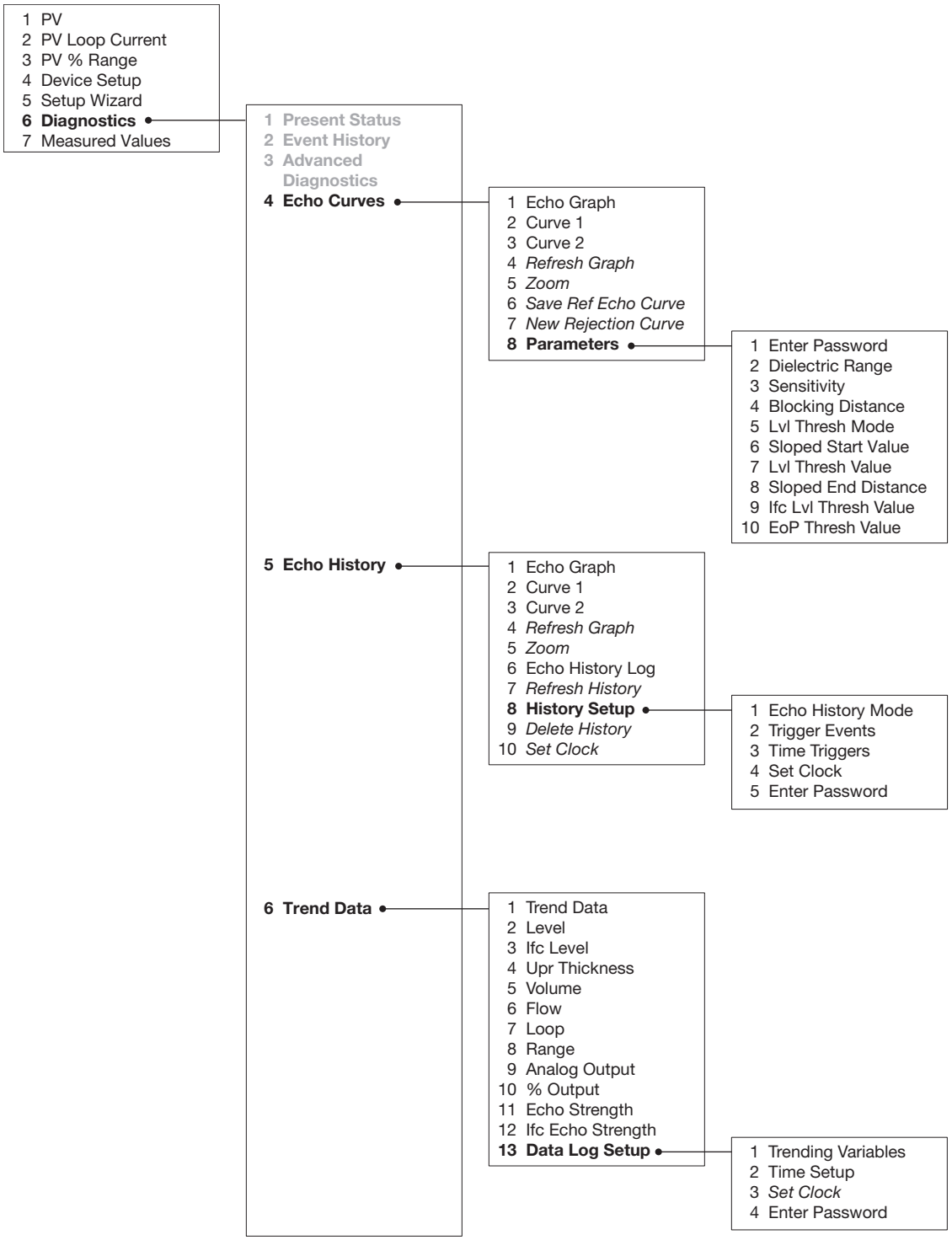
2.7.4 HART Menu – Model 706



2.7.4 HART Menu – Model 706



2.7.4 HART Menu – Model 706



3.0 Reference Information

This section presents an overview of the operation of the ECLIPSE Model 706 Guided Wave Radar Level Transmitter, information on troubleshooting common problems, listings of agency approvals, lists of replacement and recommended spare parts, and detailed physical, functional, and performance specifications.

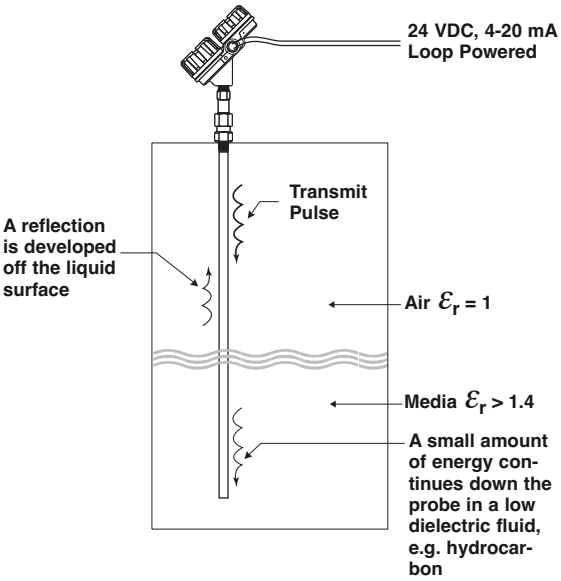
3.1 Transmitter Description

The ECLIPSE Model 706 is a loop-powered two-wire, 24 VDC, level transmitter based on the concept of Guided Wave Radar.

The ECLIPSE Model 706 electronics are housed in an ergonomic housing comprised of two tandem compartments angled at a 45-degree angle for ease of wiring and calibration. These two compartments connect via a watertight feedthrough.

3.2 Theory of Operation

3.2.1 Guided Wave Radar



Guided Wave Radar (GWR) combines Time Domain Reflectometry (TDR), Equivalent Time Sampling (ETS) and modern low power circuitry. This synthesis of technologies brings to the level market a high-speed radar circuit (speed of light transmission). The electromagnetic pulses are propagated via a waveguide that yields a system many times more efficient than through-air radar.

3.2.2 Time Domain Reflectometry (TDR)

TDR uses pulses of electromagnetic (EM) energy to measure distances or levels. When a pulse reaches a dielectric discontinuity (created by the surface of a process medium), part of the energy is reflected. The larger the dielectric discontinuity, the larger the amplitude (strength) of the reflection.

Although TDR is relatively new to the industrial level measurement industry, it has been used for decades in the telephone, computer, and power transmission industries. In these industries, TDR is used to successfully find wire or cable breaks and shorts. An EM pulse is sent through the wire, traveling unimpeded until it finds line damage due to a break or short. A reflection is then returned from the damaged area of the wire, enabling a timing circuit to pinpoint the location.

In the ECLIPSE transmitter, a waveguide with a characteristic impedance in air is used as a probe. When part of the probe is immersed in a material other than air, there is lower impedance due to the fact that a liquid will have a higher dielectric constant than air. When an EM pulse is sent down the probe and meets the dielectric discontinuity that occurs at the air/liquid surface, a reflection is generated.

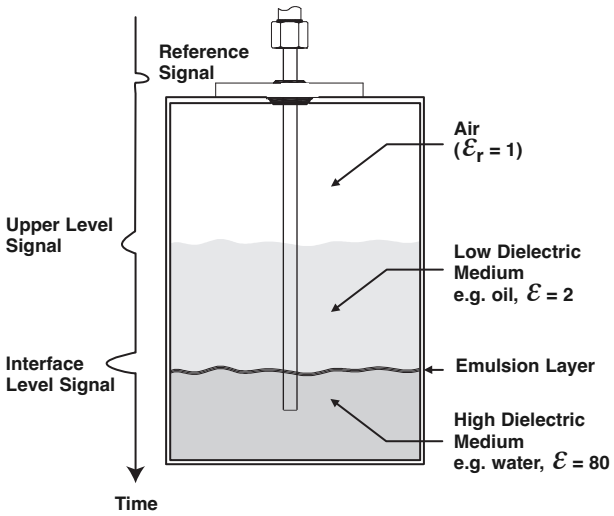
3.2.3 Equivalent Time Sampling (ETS)

ETS (Equivalent Time Sampling) is used to measure the high speed, low power EM energy. ETS is a critical key in the application of TDR to vessel level measurement technology. The high speed EM energy 305 m/s (1000 ft/s) is difficult to measure over short distances and at the resolution required in the process industry. ETS captures the EM signals in real time (nanoseconds) and reconstructs them in equivalent time (milliseconds), which is much easier to measure with today's technology.

ETS is accomplished by scanning the waveguide to collect thousands of samples. Approximately 5 scans are taken per second; each scan gathers more than 50,000 samples.

3.2.4 Interface Detection

The ECLIPSE Model 706, when used with the appropriate probes, is a transmitter capable of measuring both an upper level and an interface level. It is required that the upper liquid have a dielectric constant between 1.4 and 10 and the two liquids have a difference in dielectric constants greater than 10. A typical application would be oil over water, with the upper layer of oil being non-conductive with a dielectric constant of approximately 2 and the lower layer of water being very conductive with a dielectric constant of approximately 80. This interface measurement can only be accomplished when the dielectric constant of the upper medium is lower than the dielectric constant of the lower medium.



Interface Detection

As mentioned above ECLIPSE Guided Wave Radar is based upon the technology of TDR, which utilizes pulses of electromagnetic energy transmitted down a wave guide (probe). When the transmitted pulse reaches a liquid surface that has a higher dielectric constant than the air (dielectric constant of 1) in which it is traveling, the pulse is reflected and ultra high speed timing circuitry provides an accurate measure of liquid level. Even after some of the pulse is reflected from the upper surface, energy continues down the length of the probe through the upper liquid. The pulse is again reflected when it reaches the higher dielectric lower liquid (refer to figure at left). Since the propagation speed of the signal through the upper liquid is dependent on the dielectric constant of the

medium in which it is traveling, the dielectric constant of the upper liquid must be known to accurately determine the interface level.

The thickness of the upper layer can be determined by knowing the time between the first and second reflections as well as the upper layer dielectric constant.

In order to properly process the reflected signals, the Model 706 is specified for those applications where the thickness of the upper layer is greater than 5 cm (2 inches). The maximum upper layer is typically limited to the length of the probe.

Emulsion Layers

As emulsion (rag) layers can decrease the strength of the reflected signal, GWR offers best performance in applications having clean, distinct layers. However, the ECLIPSE Model 706 transmitter will operate in most emulsions and tend to read the top of the emulsion layer. Contact the factory for application assistance and questions regarding emulsion layers.

3.2.5 Saturated Steam Applications

(Boilers, Feedwater Heaters, etc.)

As the temperature of a saturated steam application increases, the dielectric constant of the steam vapor space also increases. This increase in vapor space dielectric causes a delay in the GWR signal propagation as it travels down the probe, causing the liquid level to appear lower than actual.

NOTE: The measurement error associated with this propagation delay does depend on temperature and is a function of the square root of the vapor space dielectric constant. For example, with no compensation, a +230 °C (+450 °F) application would show a level error of about 5.5 %, while a +315 °C (+600 °F) application would show an error approaching 20 %!

The ECLIPSE Model 706 transmitter and Model 7yS Coaxial Steam probe provide a unique solution to this application. The effects of the changing steam conditions can be compensated for by utilizing a mechanical steam target placed inside and near the top of the Model 7yS coaxial probe.

Knowing exactly where the target is located at room temperature, and then continuously monitoring its apparent location, the vapor space dielectric can be back-calculated. Knowing the vapor space dielectric, accurate compensation of the actual liquid level reading is accomplished.

This is a patented technique with two US Patents (US 6642801 and US 6867729) issued for both the mechanical target concept and the associated software algorithm.

Contact the factory for additional information relating to saturated steam applications.

3.2.6 Overfill Capability

Although agencies like WHG or VLAREM certify Overfill proof protection, defined as the tested, reliable operation when the transmitter is used as overfill alarm, it is assumed in their analysis that the installation is designed in such a way that the vessel or side mounted cage cannot physically overfill.

However, there are practical applications where a GWR probe can be completely flooded with level all the way up to the process connection (face of the flange). Although the affected areas are application dependent, typical GWR probes have a transition zone (or possibly dead zone) at the top of the probe where interacting signals can either affect the linearity of the measurement or, more dramatically, result in a complete loss of signal.

While some manufacturers of GWR transmitters may use special algorithms to "infer" level measurement when this undesirable signal interaction occurs and the actual level signal is lost, the ECLIPSE Model 706 offers a unique solution by utilizing a concept called Overfill-Safe Operation.

An Overfill-safe probe is defined by the fact that it has a predictable and uniform characteristic impedance all the way down the entire length of the waveguide (probe). These probes allow the ECLIPSE Model 706 to measure accurate levels up to the process flange without any non-measurable zone at the top of the GWR probe.

Overfill-safe GWR probes are unique to ECLIPSE GWR, and coaxial probes can be installed at any location on the vessel. Overfill-safe probes are offered in a variety of Coaxial and Caged designs.

3.3 Troubleshooting and Diagnostics

The ECLIPSE Model 706 transmitter is designed and engineered for trouble-free operation over a wide range of operating conditions. The transmitter continuously runs a series of internal self-tests and displays helpful messages on the large graphic liquid crystal display (LCD) when attention is required.

The combination of these internal tests and diagnostics messages offer a valuable proactive method of troubleshooting. The device not only tells the user what wrong, but also, and more importantly, offers suggestions on how to solve the problem.

All of this information can be obtained directly from the transmitter on the LCD, or remotely by using a HART communicator or PACT*ware* and the ECLIPSE Model 706 DTM.

PACTware™ PC Program

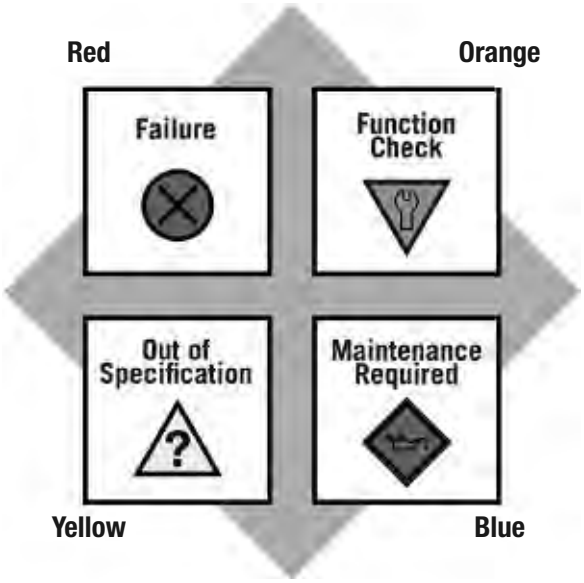
The ECLIPSE Model 706 offers the ability to perform more advanced diagnostics such as Trending and Echo Curve analysis using a PACT*ware* DTM. This is a powerful troubleshooting tool that can aid in the resolution of any diagnostic indicators that may appear.

Please refer to section 4.0 “Advanced Configuration/ Troubleshooting Techniques” for additional information.

3.3.1 Diagnostics (Namur NE 107)

The ECLIPSE Model 706 transmitter includes an exhaustive list of Diagnostic Indicators which follow the NAMUR NE 107 guidelines.

NAMUR is an international user association of automation technology in process industries, whose goal is to promote the interest of the process industry by pooling experiences among its member companies. In doing so, this group promotes international standards for devices, systems, and technologies.



The objective of NAMUR NE 107 was essentially to make maintenance more efficient by standardizing diagnostics information from field devices. This was initially integrated via FOUNDATION Fieldbus™, but the concept applies regardless of the communication protocol.

According to the NAMUR NE107 recommendation, "Self Monitoring and Diagnosis of Field Devices," fieldbus diagnostic results should be reliable and viewed in the context of a given application. The document recommends categorizing internal diagnostics into four standard status signals:

- Failure
- Function Check
- Out of Specification
- Maintenance required

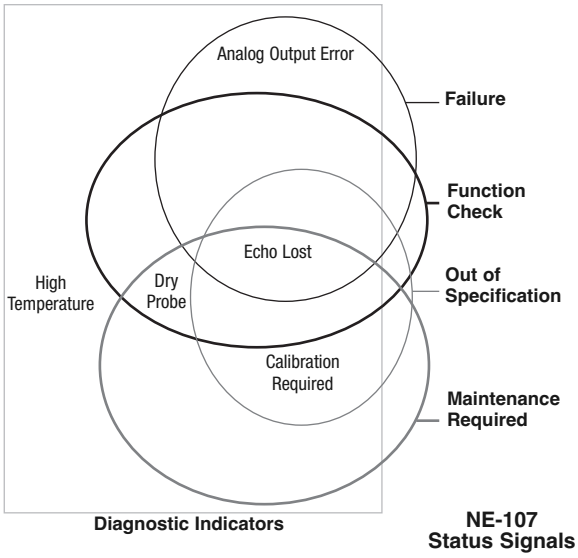
These categories are shown by both symbols and colors, depending on the display capability.

In essence, this approach ensures that the right diagnostic information is available to the right person-at the right time. In addition, it allows diagnostics to be applied, as most appropriate, for a particular plant application (such as process control engineering or asset management maintenance). Customer specific mapping of diagnostics to these categories allows for flexible configuration depending on the user's requirements.

From an external Model 706 transmitter perspective, diagnostic information includes measurement of process conditions, in addition to detection of internal device or system anomalies.

As mentioned above, the indicators can be assignable (via the a DTM or host system) by the user to any (or none) of the NAMUR recommended Status Signal categories: Failure, Function Check, Out of Specification, and Maintenance Required.

The FOUNDATION Fieldbus™ transmitter version of the Model 706 was implemented according to the Field Diagnostics Profile, which is consistent with the objectives of NE 107.



In the FOUNDATION Fieldbus™ version, diagnostic indicators can be mapped to multiple categories, an example is shown in the diagram at left.

In this example, “Calibration Required” is mapped to both the Out of Specification and Maintenance Required status signals, and the diagnostic indicator named “High Temperature” is mapped to none of the signals.

Indicators that are mapped to the Failure category will normally result in a current loop alarm output. The alarm state for HART transmitters is configurable as high (22 mA), Low (3.6 mA), or Hold (last value).

Users will not have the ability to unassign certain indicators from the Failure signal category as the Model 706 user interfaces will prohibit or reject such re-assignment entries). This is to ensure that current loop alarms are asserted in situations where the device is not able to provide measurements due to critical failures. (For example, if the alarm selection has not been set to Hold, or a fixed current mode is in effect.)

A default mapping of all diagnostic indicators will be applied initially, and can be re-applied through use of a reset function.

Refer to the table below for a complete listing of the Model 706 diagnostic indicators, along with their explanations, default categories, and recommended remedies.

NOTES: 1) The remedies shown in this table can also be seen on the transmitter LCD by viewing the present status screen when the device is in a diagnostic condition.
2) Those indicators showing failure as the default result in an alarm condition.

3.3.2 Diagnostic Indication Simulation

The DD and DTM allow for the ability to manipulate diagnostic indicators. Intended as a means to verify the configuration of the diagnostic parameters and connected equipment, a user can manually change any indicator to and from the active state.

3.3.3 Diagnostic Indicator Table

Below is a listing of the Model 706 diagnostic indicators, showing their priority, explanations and recommended remedies. (Priority 1 is highest priority.)

Priority	Indicator Name	Default Category	Explanation	Remedy (Context Sensitive Help)
1	Software Error	Failure	Unrecoverable error occurred in stored program.	Contact MAGNETROL Technical Support.
2	RAM Error	Failure	RAM (read/write) memory failing.	
3	ADC Error	Failure	Analog-to-digital converter failure.	
4	EEPROM Error	Failure	Non-volatile parameter storage failing.	
5	Analog Board Error	Failure	Unrecoverable hardware failure.	
6	Analog Output Error	Failure	Actual loop current deviates from commanded value. Analog output is inaccurate.	Perform Adjust Analog Output maintenance procedure.
7	Spare Indicator 1	OK	Reserved for future use.	
8	Default Parameters		Saved parameters are set to default values.	Perform complete Device Configuration.
9	No Probe	Failure	No Probe Connected.	Attach a probe. Torque HF nut. Clean gold pin on transmitter and socket on probe. Ensure Model 705 adapter is properly secured. Contact MAGNETROL Technical Support.
10	No Fiducial	Failure	Reference signal too weak to detect.	Torque HF nut. Clean gold pin on transmitter and socket on probe. Check settings: Fiducial Gain HF Cable Length Window Increase Fid Gain. Contact MAGNETROL Technical Support.

3.3.3 Diagnostic Indicator Table

Priority	Indicator Name	Default Category	Explanation	Remedy
11	No Echoes	Failure	No signal detected anywhere on probe.	Check settings: Dielectric Range Sensitivity EoP Thresh Value Increase Sensitivity. Lower EoP Thresh. View Echo Curve.
12	Upr Echo Lost	Failure	Signal from upper liquid too weak to detect.	Check settings: Upper Dielectric, Blocking Distance, Sensitivity Ensure Upr Level is below blocking distance. View Echo Curve.
13	Spare Indicator 2	OK	Reserved for future use.	
14	EoP Above ProbeEnd	Failure	End of Probe appears above Probe Length	Check settings: Probe Length Decrease Sensitivity Increase Blocking Distance View Echo Curve.
15	Lvl Below ProbeEnd	Failure	Level signal appears beyond Probe Length. (Possible water bottom situation)	Check settings: Probe Model, Probe Length, Level Threshold = Fixed Increase Sensitivity View Echo Curve.
16	EoP Below ProbeEnd	Failure	End of Probe appears beyond Probe Length.	Check settings: Probe Length Dielectric Range Sensitivity View Echo Curve.
17	Safety Zone Alarm	Failure	Risk of echo loss if liquid rises above Blocking Distance.	Ensure that liquid cannot reach Blocking Distance.
18	Config Conflict	Failure	Measurement type and primary variable selection parameters are inconsistent.	Confirm proper configuration. Check Measurement Type.
19	High Volume Alarm	Failure	Volume calculated from Level reading exceeds capacity of vessel or custom table.	Check settings: Vessel Dimensions, Custom Table entries
20	High Flow Alarm	Failure	Flow calculated from Distance reading exceeds capacity of flow element or custom table.	Check settings: Flow Element Reference Distance Gen Eqn Factors Custom Table entries
21	Spare Indicator 3	OK	Reserved for future use	
22	Initializing	Function Check	Distance measurement is inaccurate while internal filters are settling.	Standard start-up message. Wait for up to 10 seconds.
23	Analog Output Fixed	Function Check	Loop current not following PV. May be caused by existing alarm condition, ongoing Loop Test or Trim Loop operations.	If unexpected, check Loop Current Mode. Ensure device is not in Loop Test.
24	Config Changed	Function Check	A parameter has been modified from the User Interface.	If desired, reset Config Changed indicator in ADVANCED CONFIG menu.
25	Spare Indicator 4	OK	Reserved for future use.	
26	Spare Indicator 5	OK	Reserved for future use.	

3.3.3 Diagnostic Indicator Table

Priority	Indicator Name	Default Category	Explanation	Remedy
27	Spare Indicator 6	OK	Reserved for future use.	
28	Ramp Interval Error	Out of Spec	Internal signal timing out of limits causing inaccurate distance measurement.	Check accuracy of Level reading. Replace transmitter electronics. Contact MAGNETROL Technical Support.
29	High Elec Temp	Out of Spec	Electronics too hot. May compromise level measurement or damage instrument.	Shield transmitter from heat source or increase air circulation. Locate transmitter remotely in a cooler area.
30	Low Elec Temp	Out of Spec	Electronics too cold. May compromise level measurement or damage instrument.	Insulate transmitter. Locate transmitter remotely in a warmer area.
31	Calibration Req'd	Out of Spec	Factory calibration has been lost. Measurement accuracy may be diminished.	Return transmitter to factory for recalibration.
32	Echo Reject Invalid	Out of Spec	Echo Rejection inoperative. May report erroneous Level readings. Upr Echo may be lost near top of probe.	Save a fresh Echo Rejection Curve.
33	Spare Indicator 7	OK	Reserved for future use.	
34	Inferred Level	Out of Spec	Distance measurement calculated indirectly from probe elongation. Level reading is only approximate.	Verify Level reading. If incorrect, compare Dielectric Range against EoP Dielectric reading.
35	Adjust Analog Out	Out of Spec	Loop current is inaccurate.	Perform Adust Analog Output maintenance procedure.
36	Totalizer Data Lost	Out of Spec	Non-volatile Totalizer Data storage failing.	Contact MAGNETROL Technical Support.
37	No Probe Target	Out of Spec	Not actively compensating	Check settings: Probe Model Sensitivity
38	Low Supply Voltage	Out of Spec	Loop current may be incorrect at higher values. Analog output is inaccurate.	Verify loop resistance. Replace loop power supply.
39	Dry Probe	OK	No liquid is contacting probe. Level at unknown distance beyond probe.	If unexpected, verify proper probe length for application.
40	Bad Target Location	Maintenance Required	Incorrect steam target location.	Contact MAGNETROL Technical Support.
41	Low Echo Strength	Maintenance Required	Risk of Echo Lost due to weak signal.	Check settings: Dielectric Range Sensitivity View Echo Curve.
42	Low Ifc Echo Str	Maintenance Required	Risk of Interface Echo Lost due to weak signal.	Check settings: Dielectric Range Sensitivity View Ifc Echo Curve.
43	Max Jump Exceeded	Maintenance Required	Transmitter has jumped to an echo at location that exceeds "Max Level Jump" from previous echo location.	Check settings: Dielectric Range Sensitivity View Echo Curve.
44	Spare Indicator 10	OK	Reserved for future use.	
45	Sequence Record	OK	A Sequence Record number has been stored in Event Log.	If desired, report Sequence Record number to factory.

The ECLIPSE Model 706 offers the ability to do Trending and Echo Curve analysis via the local graphical LCD or by using PACT*ware* and the Model 706 DTM. The Model 706 DTM is a power troubleshooting tool that can aid in the resolution of some of the Diagnostic Indicators shown above.

3.3.4 Diagnostic Help

Selecting DIAGNOSTICS from the MAIN MENU presents a list of five ITEMS from the top level of the DIAGNOSTICS tree.

When Present Status is highlighted, the highest MAGNETROL priority active diagnostic indicator (numerically lowest in Table 3.3.3) is displayed on the bottom LCD line, which is "OK" as shown at left. Pressing the ENTER key moves the active diagnostic indicator to the top line outdented and presents in the lower area of the LCD a brief explanation of and possible remedies for the indicated condition. A blank line separates the explanation from the remedies. Additional active diagnostic indicators, if any, appear with their explanations in descending priority order. Each additional active indicator name-explanation pair is separated by a blank line from the one above.

If the explanation and remedy text (and additional name-explanation pairs) exceeds the available space, a ⇩ appears in the rightmost column of the last line indicating more text below. In this situation, the DN key scrolls text up one line at a time. Similarly, while text exists above the upper line of the text field, a ⇧ appears in the rightmost column of the top (text) line. In this situation, the UP key scrolls the text down one line at a time. Otherwise the DN and UP keys are inoperative. In all cases the ENT or DEL key reverts to the previous screen.

When the transmitter is operating normally and the highlight cursor is positioned on Present Status, the bottom LCD line displays "OK" because no diagnostic indicators are active.

EVENT HISTORY – This menu displays the parameters related to diagnostic event logging.

ADVANCED DIAGNOSTICS – This menu displays parameters related to some of the advanced diagnostics available within the Model 706.

INTERNAL VALUES – Displays read-only internal parameters.

ELEC TEMPERATURES – Displays temperature information as measured in the potted module in degrees F or C.

TRANSMITTER TESTS – Allows the user to manually set the output current to a constant value. This is a method for the user to verify operation of the other equipment in the loop.

ECHO CURVES – This menu allows the user to display the various Echo Curves on the LCD.

ECHO HISTORY SETUP – The Model 706 contains the unique and powerful feature that allows waveforms to be automatically captured based on Diagnostic Events, Time or both. This menu contains those parameters that configure that feature.

Eleven (11) waveforms can be saved directly into the transmitter.

- Nine (9) Troubleshooting Curves
- One (1) Echo Rejection Curve
- One (1) Reference Curve

TREND DATA – A 15-minute trend of the PV can be displayed on the LCD.

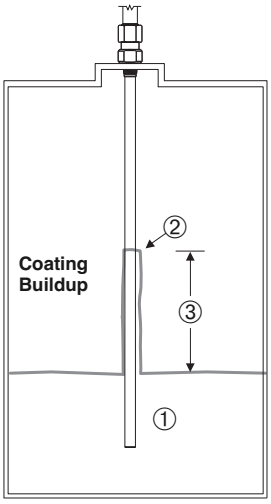
3.3.5 Troubleshooting Application Issues

There can be numerous reasons for application-related issues. Media buildup on the probe is covered here.

Media buildup on the probe is typically not a problem in most cases—ECLIPSE circuitry works very effectively. Media buildup should be viewed as two types:

- Continuous Film Coating
- Bridging

3.3.5.1 Model 706 (Single Rod Probe)



The Model 706 and Single Rod probe were designed to operate effectively in the presence of media building up. Some expected error may be generated based upon the following factors:

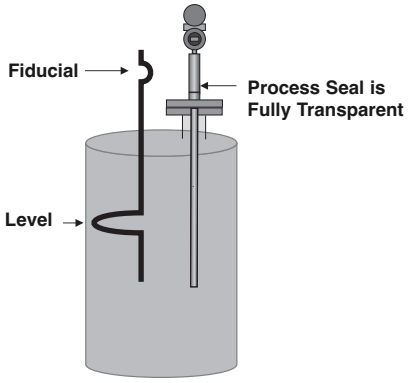
1. Dielectric of the media that created the coating
2. Thickness of the coating
3. Amount (length) of the coating above the present level

Although more immune to thick, viscous, buildup, performance of Single Rod GWR probes is always dependent on the installation and application. The electromagnetic field surrounding a single rod probe makes it more vulnerable to influence from objects in the vicinity of the probe.

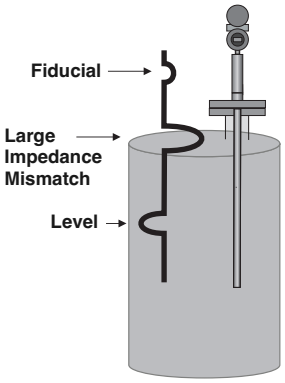
NOTE: It is important to note that this influence from the installation/application also depends on the configuration of the transmitter. Those devices configured with lower gain will be less affected by external objects.

Nozzles

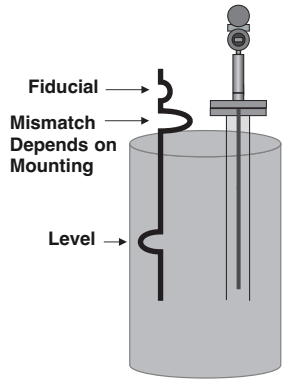
Due to the impedance mismatch that takes place at the end of a nozzle, they can create false echoes that can cause diagnostic indicators and/or errors in measurement.



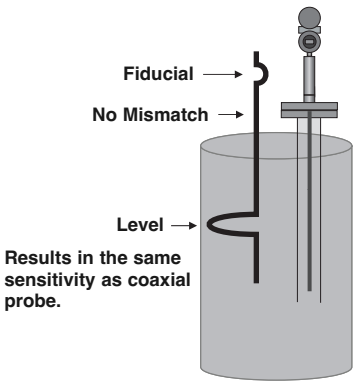
Coaxial Probe



Standard Single Rod Probe



Single Rod Probe in a Stillwell



Caged Probe
(waveform is similar to that of a coaxial probe)

As mentioned above, by virtue of the pure physics of the technology, all single rod GWR probes are influenced by the application and installation. Mismatches in impedance along the length of the probe, whether they be expected (liquid level) or unexpected (metal in close proximity), will result in reflections.

To better illustrate this, a comparison between a coaxial probe and single rod probe mounted in the same application is shown at left.

Since the outer tube of the coaxial probe is grounded, there are no proximity affects and there is no influence from the nozzle. The only reflections along the length of the probe are expected. Those being the fiducial (reference signal) and the return signal from the process.

On the other hand, a single rod probe mounted in the exact same nozzle will have additional (unwanted) reflections where the probe enters and exits the nozzle. These reflections are a result of the impedance changes that occur at those points:

- The large reflection is due to the impedance developed between the rod and nozzle ID as compared to the impedance developed between the rod and the tank ID. (The larger the nozzle ID, the smaller the reflection).

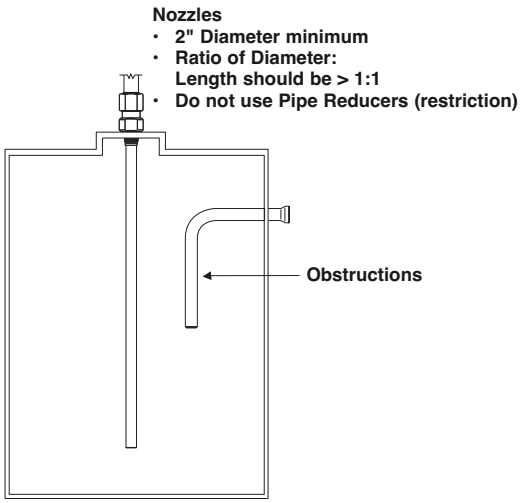
One way to eliminate the reflection at the bottom of the nozzle is to use a continuous stillwell in conjunction with a caged GWR probe. In doing so, there will be no impedance changes all the way down the probe.

Refer to Section 3.2.6 for a discussion on overfill-capable probes for suggestions on how to eliminate these unwanted single rod reflections. MAGNETROL is unique in the fact that we offer a special caged probe that, when installed properly, has no unwanted reflections.

Obstructions

Metallic obstructions in the vicinity of a single rod probe can also affect the performance. If the level reading repeatedly locks on to a specific level higher than the actual level, it may be caused by a metallic obstruction. Obstructions in the vessel (e.g., pipes, ladders) that are located close to the probe may cause the instrument to show them as level.

Refer to the Probe Clearance Table for recommended clearance distances. The distances shown in this table can be dramatically reduced by utilizing the Echo Rejection feature (within the transmitter or) in PACT*ware* and the ECLIPSE Model 706 DTM.



NOTE: Use caution when rejecting large negative going signals as the negative going level signal will also be partially rejected at this position and can be lost.

PROBE CLEARANCE TABLE

Distance to Probe	Acceptable Objects
<15 cm (6")	Continuous, smooth, parallel conductive surface, for example a metal tank wall; important that probe does not touch wall
>15 cm (6")	<25 mm (1") diameter pipe and beams, ladder rungs
>30 cm (12")	<75 mm (3") diameter pipe and beams, concrete walls
>46 cm (18")	All remaining objects

3.4 Configuration Information

This section is intended to offer additional configuration-related details with respect to some of the parameters shown in the Menu in Section 2.6.

3.4.1 Level Offset Description

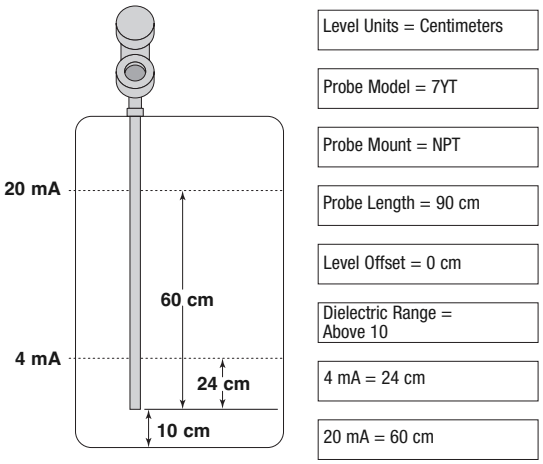
The parameter referred to as Level Offset in the ECLIPSE Model 706 DEVICE SETUP/BASIC CONFIG menu is defined as the desired level reading when liquid surface is at the tip of the probe.

The ECLIPSE Model 706 transmitter is shipped from the factory with Level Offset set to 0. With this configuration, all measurements are referenced from the bottom of the probe. See Example 1.

Example 1 (Level Offset = 0 as shipped from factory):

Application calls for a 90-cm Model 7yT coaxial probe with an NPT process connection. The process medium is water with the bottom of the probe 10 cm above the bottom of the tank.

The user wants the 4 mA Set Point (LRV) at 24 cm and the 20 mA Set Point (URV) at 60 cm **as referenced from the bottom of the probe**.

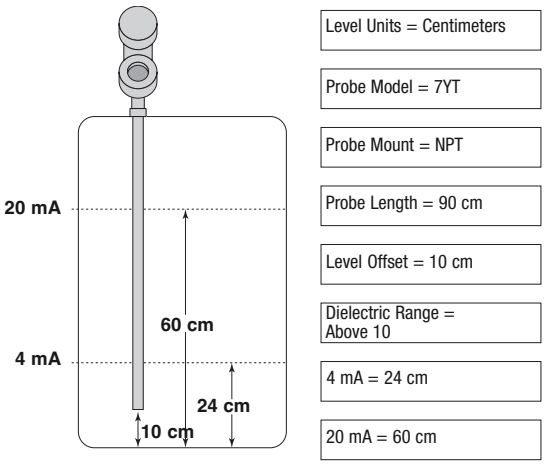


Example 1

In those applications in which it is desired to reference all measurements from the bottom of the vessel, the value of Level Offset should be changed to the distance between the bottom of the probe and the bottom of the vessel as shown in Example 2.

Example 2:

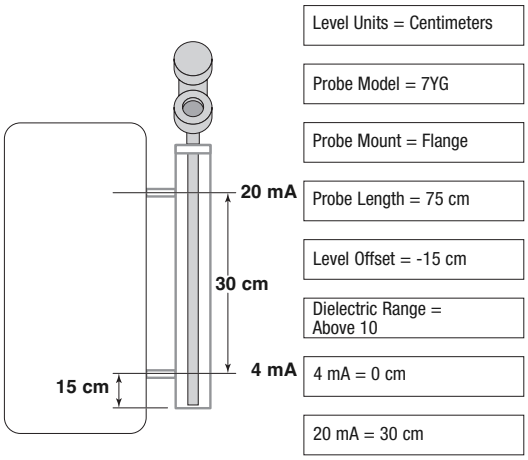
Application calls for a 90-cm Model 7yT coaxial probe with an NPT process connection. The process medium is water with the bottom of the probe 10 cm above the bottom of the tank.



Example 2

The user wants the 4 mA Set Point (LRV) at 24 cm and the 20 mA Set Point (URV) at 60 cm **as referenced from the bottom of the tank**.

When the ECLIPSE transmitter is mounted in a chamber/bridle, it is usually desirable to configure the unit with the 4 mA Set Point (LRV) at the lower process connection and the 20 mA Set Point (URV) at the upper process connection. The measuring range then becomes the center-to-center dimension. In this case, a negative Level Offset needs to be entered. In doing so, all measurements are then referenced at a point up on the probe, as shown in Example 3.



Example 3

Example 3:

Application calls for a 75-cm Model 7yG caged-coaxial flanged probe measuring water in a chamber with the bottom of the probe extending 15 cm below the lower process connection. The user wants the 4 mA point to be 0 cm at the bottom process connection and the 20 mA point to be 30 cm at the top process connection.

3.4.2 End-of-Probe Analysis

A new addition to the Model 706 ECLIPSE transmitter is a feature called End-of-Probe Analysis (EoPA).

Located in the DEVICE SETUP/ADVANCED CONFIG Menu, this feature is patterned after the "Tank-Bottom Following" algorithms of the early Non-Contact radar transmitters. When the return signal from the level is lost, this feature allows the Model 706 transmitter to infer level measurement based on the apparent location of the end-of-probe (EoP) signal.

Due to the fact that the propagation of the GWR signal is affected by the dielectric constant of the medium in which it is traveling, signals along the probe are delayed in proportion to the dielectric constant. By monitoring the location of the (delayed) EoP signal and knowing the dielectric constant of the medium, the level signal can be back-calculated, or inferred.

The End-of-Probe Analysis feature is located in the Advanced Config menu and requires an Advanced Password to activate. Several additional parameters will need to be configured for optimum performance.

NOTE: The accuracy of this level measurement mode is not that of detecting true product level, and can vary depending on the process. MAGNETROL recommends that this feature be used only as last resort for measuring levels in those rare applications in which the level signals are inadequate, even after the common troubleshooting techniques of gain increase and threshold adjustment are implemented.

Please refer to section 4.0 “Advanced Configuration/ Troubleshooting Techniques” or contact MAGNETROL Technical Support for additional instructions.

3.4.3 Echo Rejection

Due to the fact that GWR transmitters are less susceptible to obstructions in a vessel (as compared with Non-Contact Radar transmitters), early versions of the ECLIPSE Model 705 transmitters did not have Echo Rejection capability.

However, due to our vast experience in the field, we have found that there are (albeit rare) occasions when it is desirable to have the ability to “ignore” unwanted signals along the probe.

The Model 706 transmitter Echo Rejection feature is located in the DEVICE SETUP/ADVANCED CONFIG menu, and requires an Advanced Password to activate. It is highly recommended that this feature be used with the waveform capture capability of the Model 706 DTM and PACT*ware*™.

Refer to Section 4.0 “Advanced Configuration/Troubleshooting Techniques” or contact MAGNETROL Technical Support for additional instructions.

3.4.4 Volumetric Capability

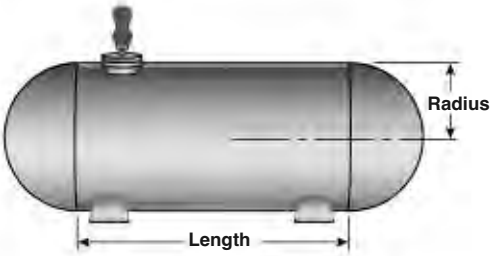
Selecting Measurement Type = Volume and Level allows the Model 706 transmitter to measure volume as the Primary Measured Value.

3.4.4.1 Configuration using built-in Vessel Types

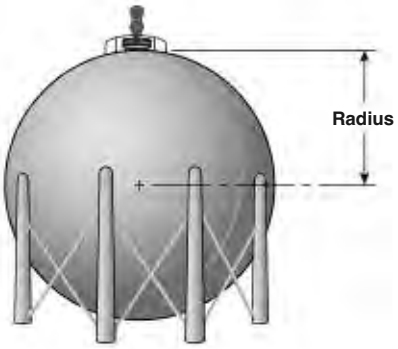
The following table provides an explanation of each of the System Configuration parameters required for volume applications that use one of the nine Vessel Types.

Configuration Parameter	Explanation
Volume Units	A selection of Gallons (factory default Volume Unit), Milliliters, Liters, Cubic Feet, or Cubic Inches, is provided.
Vessel Type	Select either Vertical/Flat (factory default Vessel Type), Vertical/Elliptical, Vertical/Spherical, Vertical/Conical, Custom Table, Rectangular, Horizontal/Flat, Horizontal/Elliptical, Horizontal/Spherical, or Spherical. Note: Vessel Dims is the next screen only if a specific Vessel Type was selected. If Custom Table was selected. Refer to section 3.4.4.2 to select the Cust Table Type and Cust Table Vals.
Vessel Dims	See the vessel drawings on the following page for relevant measuring areas.
Radius	Used for all Vessel Types with the exception of Rectangular.
Ellipse Depth	Used for Horizontal and Vertical/Elliptical vessels.
Conical Height	Used for Vertical/Conical vessels.
Width	Used for Rectangular vessels.
Length	Used for Rectangular and Horizontal vessels.

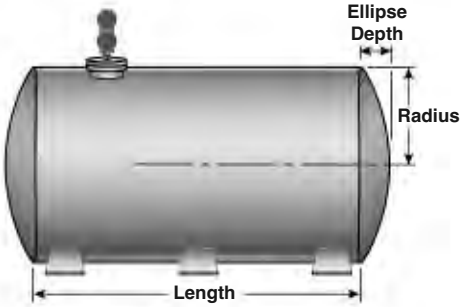
Vessel Types



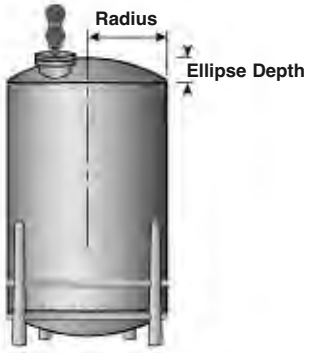
HORIZONTAL/SPHERICAL



SPHERICAL

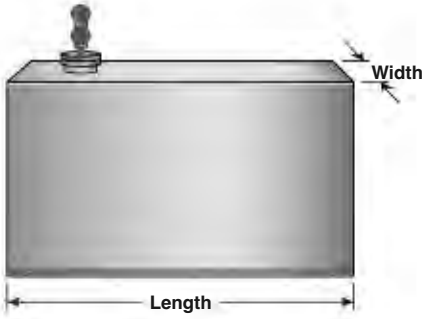


HORIZONTAL/ELLIPTICAL



VERTICAL/ELLIPTICAL

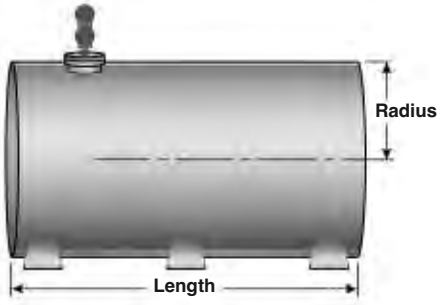
VERTICAL/SPHERICAL



RECTANGULAR

VERTICAL/FLAT

VERTICAL/CONICAL

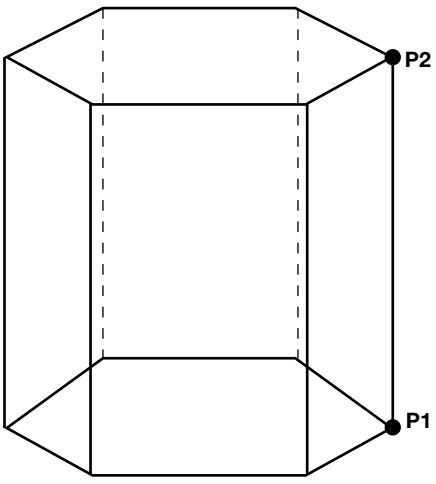


HORIZONTAL/FLAT

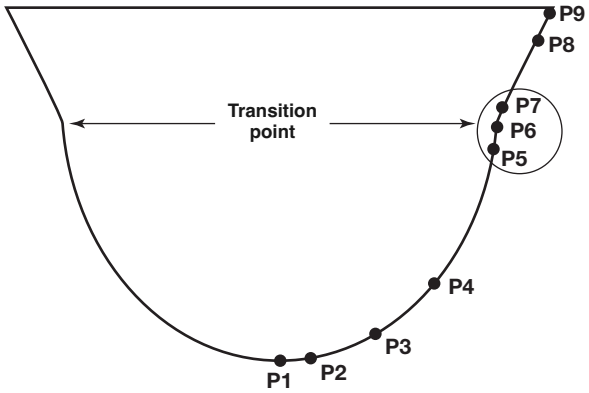
3.4.4.2 Configuration using Custom Table

If none of the nine ***Vessel Types*** shown can be used, a ***Custom Table*** can be created. A maximum of 30 points can be used to establish the level to volume relationship. The following table provides an explanation of each of the System Configuration parameters for volume applications where a Custom Table is needed.

Configuration Parameter	Explanation (Custom Volumetric Table)
Volume Units	A selection of **Gallons** (factory default *Volume Unit*), **Milliliters**, **Liters**, **Cubic Feet**, or **Cubic Inches**, is provided.
Vessel Type	Select **Custom Table** if none of the nine *Vessel Types* can be used.
Cust Table Type	The *Custom Table* points can be a **Linear** (straight line between adjacent points) or **Spline** (can be a curved line between points) relationship. See below drawing for more information.
Cust Table Vals	A maximum of 30 points can be used in building the *Custom Table*. Each pair of values will have a level (height) in the units chosen in the *Level Units* screen, and the associated volume for that level point. The values must be monotonic, i.e. each pair of values must be greater than the previous level/volume pair. The last pair of values should have the highest level value and volume value associated with the level in the vessel.



LINEAR

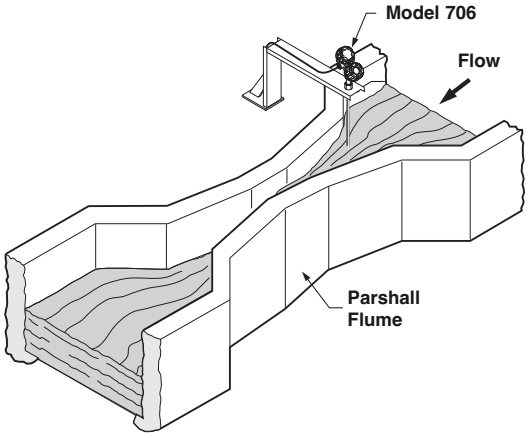


Use where walls are not perpendicular to base.

Concentrate at least two points at beginning (P1) and end (P9); and three points at either side of transition points.

SPLINE

3.4.5 Open Channel Flow Capability



Open Channel Flow Measurement
Parshall Flume

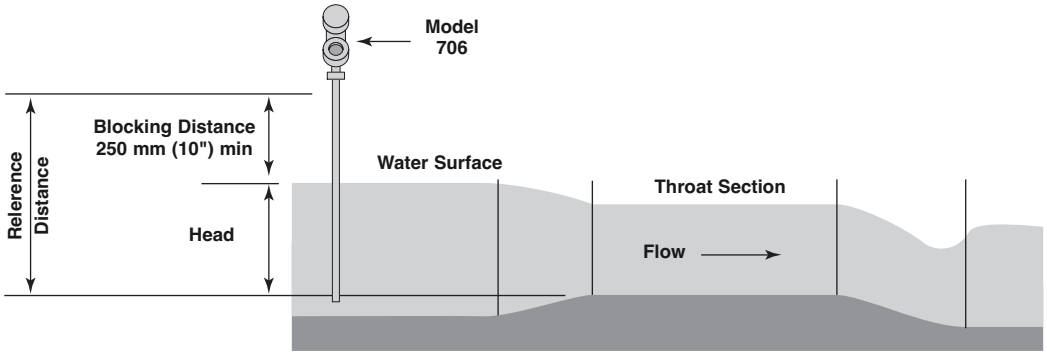
Selecting Measurement Type = Flow allows the Model 706 transmitter to measure flow as the Primary Measured Value.

Open channel flow is performed by using the ECLIPSE Model 706 to measure the Head in a hydraulic structure. The hydraulic structure is the primary measuring element, of which the two most common types are weirs and flumes.

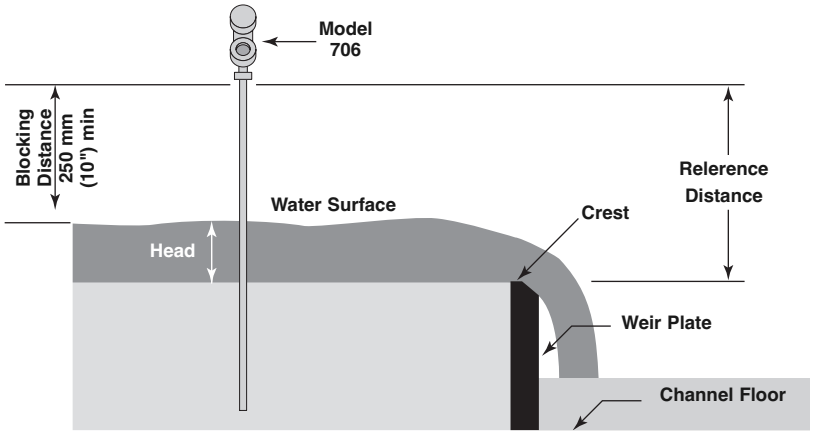
Since the primary element has a defined shape and dimensions, the rate of flow through the flume or over the weir is related to the Head at a specified measurement location.

The ECLIPSE Model 706 is the secondary measuring device, which measures the Head of the liquid in the flume or weir. Open channel flow equations stored in the transmitter firmware convert the measured Head into units of flow (volume/time).

NOTE: Proper positioning of the Model 706 should be per the recommendation of the flume or weir manufacturer.



Flume (side view)



Weir (side view)

3.4.5.1 Configuration using Flume/Weir Equations

The following table provides an explanation of each of the System Configuration parameters required for open channel flow applications using one of the Flow Elements that are stored in the firmware.

Configuration Parameter	Explanation
Flow Units	A selection of **Gallons/Minute** (factory default *Flow Unit*), **Gallons/Hour, Mil Gallons/Day, Liters/Second, Liters/Minute, Liters/Hour, Cubic Meter/Hour, Cubic Ft/Second, Cubic Ft/Minute,** and **Cubic Ft/Hour** are provided.
Flow Element	Select one of the following primary *Flow Elements* that are stored in the firmware: **Parshall** flume sizes of **1", 2", 3", 6", 9", 12", 18", 24", 36", 48", 60", 72", 96", 120"** and **144". Palmer-Bwls** (Palmer-Bowlus) flume sizes of **4", 6", 8", 10", 12", 15", 18", 21", 24", 27"** and **30"**. **V-notch** weir sizes of **22.5°, 30°, 45°, 60°, 90° and 120°**. **Rect with Ends** (Rectangular Weir with End Contractions), **Rect w/o Ends** (Rectangular Weir without End Contractions), and **Cipoletti** weir. **Custom Table** (refer to section 3.4.5.3) can be selected if none of the stored *Flow Elements* can be used. The table can be built with a maximum of 30 points. The Model 706 also has the capability of using a **Generic Equation** (refer to section 3.4.5.2) for flow calculation.
Weir Crest Length	The *Weir Crest Length* screen only appears when the chosen *Flow Element* is Cipoletti or one of the *Rectangular* weirs. Input this length in the user-selected level units.
Flume Channel Width	Allows for entry of the width of the palmer bowlus flume.
V-Notch Weir Angle	Only appears when flow element is V-Notch weir. It allows for the entry of angle of the V-Notch weir.
Reference Dist	The *Reference Distance* is measured from the sensor reference point to the point of zero flow in the weir or flume. This must be measured very accurately in the user-selected level units.
Maximum Head	*Maximum Head* is the highest liquid level (Head) value in the flume or weir before the flow equation is no longer valid. The *Maximum Head* is expressed in the user-selected *Level Units.* The Model 706 will default to the largest *Maximum Head* value that is allowed for any given flume or weir. The *Maximum Head* value can be revised depending on the value of the *Reference Distance*, or for end user preference.
Maximum Flow	*Maximum Flow* is a read-only value that represents the flow value corresponding to the *Maximum Head* value for the flume or weir.
Low Flow Cutoff	The *Low Flow Cutoff* (in user-selected level units) will force the calculated flow value to zero whenever the *Head* is below this point. This parameter will have a default and minimum value of zero.

3.4.5.2 Configuration using Generic Equation

The following table provides an explanation of each of the System Configuration parameters for Open channel flow applications using the Generic Equation.

Configuration Parameter	Explanation (Open Channel Flow — using the Generic Equation)
Flow Units	A selection of **Gallons/Minute** (factory default *Flow Unit*), **Gallons/Hour, Mil Gallons/Day, Liters/Second, Liters/Minute, Liters/Hour, Cubic Meter/Hour, Cubic Ft/Second, Cubic Ft/Minute,** and **Cubic Ft/Hour** are provided.
Flow Element	Select one of the following primary *Flow Elements* that are stored in the firmware: **Parshall** flume sizes of **1", 2", 3", 6", 9", 12", 18", 24", 36", 48", 60", 72", 96", 120"** and **144". Palmer-Bwls** (Palmer-Bowlus) flume sizes of **4", 6", 8", 10", 12", 15", 18", 21", 24", 27"** and **30"**. **V-notch** weir sizes of **22.5°, 30°, 45°, 60°, 90° and 120°**. **Rect with Ends** (Rectangular Weir with End Contractions), **Rect w/o Ends** (Rectangular Weir without End Contractions), and **Cipoletti** weir. **Custom Table** (refer to section 3.4.5.3) can be selected if none of the stored *Flow Elements* can be used. The table can be built with a maximum of 30 points. The Model 706 also has the capability of using a **Generic Equation** for flow calculation. See example below.
Generic Eqn Factors	*Generic Equation* is a discharge flow equation in the form of $Q = K(L-CH)H^n$, where Q = flow (Cu Ft/Second), H = Head (Feet), K = a constant, and L, C and n are user input factors that depend on which *Flow Element* is being used. Make sure the flow equation is in the form of $Q = K(L-CH)H^n$, and proceed to enter the values of K,L,C,H and n. See example below. **NOTE:** The Generic Equation parameters **must be entered in Cu Ft/Second units**. The resultant flow is converted by the Model 706 into whatever Flow Units are selected above. See example below.
Reference Dist	The *Reference Distance* is measured from the sensor reference point to the point of zero flow in the weir or flume. This must be measured very accurately in the user-selected level units.
Maximum Head	*Maximum Head* is the highest liquid level (Head) value in the flume or weir before the flow equation is no longer valid. The *Maximum Head* is expressed in the user-selected level units. The Model 706 will default to the largest *Maximum Head* value that is allowed for any given flume or weir. The *Maximum Head* value can be revised depending on the value of the *Reference Distance*, or for end user preference.
Maximum Flow	*Maximum Flow* is a read-only value that represents the flow value corresponding to the *Maximum Head* value for the flume or weir.
Low Flow Cutoff	The *Low Flow Cutoff* (in user-selected level units) will force the calculated flow value to zero whenever the *Head* is below this point. This parameter will have a default and minimum value of zero.

Generic Equation Example (using equation for an 8' rectangular weir w/ end contractions)		
Q = **Cubic Ft/Second** flow rate	L = 8' (weir crest length in feet)	H = Head value
K = 3.33 for **Cubic Ft/Second** units	C = 0.2 (constant)	n = 1.5 as an exponent

$$\mathbf{Q = K(L-CH)H^n}$$

Using the factors above the equation becomes:

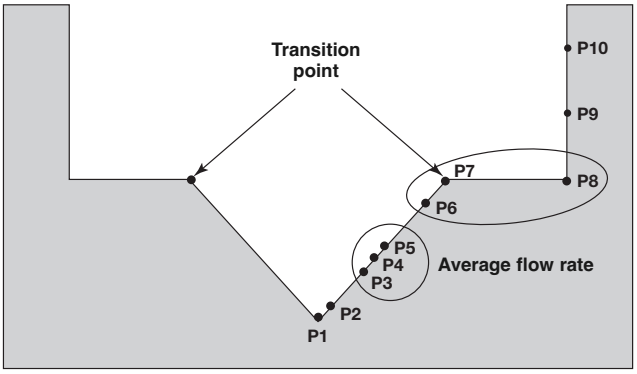
$Q = 3.33\ (8-0.2H)\ H^{1.5}$

The discharge flow value for a Head value of three feet becomes 128.04 **Cubic Ft/Second**. If GPM was selected for the Flow Units, the Model 706 Measured Values screen would display this value converted to 57,490 GPM.

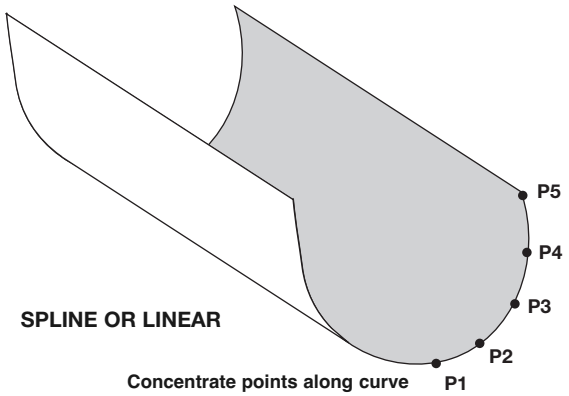
3.4.5.3 Configuration using Custom Table

Concentrate points as follows:
- **A. At least two points at beginning (P1 and P2);**
- **B. At least two points at end (P9 and P10)**
- **C. Three points at approximate average flow rate (for example, P3, P4, P5); and at transition point (P7) and points on either side (P6, P8).**

The following table provides an explanation of each of the System Configuration parameters for open channel flow applications using the Custom Table.



SPLINE



Configuration Parameter	Explanation (Open Channel Flow — Custom Table)
Flow Units	A selection of **Gallons/Minute** (factory default *Flow Unit*), **Gallons/Hour, Mil Gallons/Day, Liters/Second, Liters/Minute, Liters/Hour, Cubic Meters/Hour, Cubic Ft/Second, Cubic Ft/Minute,** and **Cubic Ft/Hour** are provided.
Flow Element	Select one of the following primary *Flow Elements* that are stored in the firmware: **Parshall** flume sizes of **1", 2", 3", 6", 9", 12", 18", 24", 36", 48", 60", 72", 96", 120"** and **144". Palmer-Bwls** (Palmer-Bowlus) flume sizes of **4", 6", 8", 10", 12", 15", 18", 21", 24", 27"** and **30"**. **V-notch** weir sizes of **22.5°, 30°, 45°, 60°, 90° and 120°**. **Rect with Ends** (Rectangular Weir with End Contractions), **Rect w/o Ends** (Rectangular Weir without End Contractions), and **Cipoletti** weir. **Custom Table** (see below) can be selected if none of the stored *Flow Elements* can be used. The table can be built with a maximum of 30 points. The Model 706 also has the capability of using a **Generic Equation** (refer to section 3.4.5.2) for flow calculation.
Custom Table	The *Custom Table* points can be a **Linear** (straight line between adjacent points) or **Spline** (can be a curved line between points) relationship. Refer to the drawing above for more information.
Cust Table Vals	A maximum of 30 points can be used in building the *Custom Table*. Each pair of values will have a Head (height) in the units chosen in the *Level Units* screen, and the associated flow for that Head value. The values must be monotonic, i.e., each pair of values must be greater than the previous Head/flow pair. The last pair of values should have the highest Head value (usually the *Maximum Head* value) and the flow associated with that Head value.
Reference Dist	The *Reference Distance* is measured from the sensor reference point to the point of zero flow in the weir or flume. This must be measured very accurately in the user-selected level units.
Maximum Head	*Maximum Head* is the highest liquid level (Head) value in the flume or weir before the flow equation is no longer valid. The *Maximum Head* is expressed in the user-selected *Level Units*. The Model 706 will default to the largest *Maximum Head* value that is allowed for any given flume or weir. The *Maximum Head* value can be revised depending on the value of the *Reference Distance*, or for end user preference.
Maximum Flow	*Maximum Flow* is a read-only value that represents the flow value corresponding to the *Maximum Head* value for the flume or weir.
Low Flow Cutoff	The *Low Flow Cutoff* (in user-selected level units) will force the calculated flow value to zero whenever the *Head* is below this point. This parameter will have a default and minimum value of zero.

3.4.6 Reset Function

A parameter labeled "Reset Parameter" is located at the end of the DEVICE SETUP/ADVANCED CONFIG menu. In the event a user gets confused during configuration or advanced troubleshooting, this parameter gives the user the ability to reset the Model 706 transmitter configuration.

Unique to the Model 706 transmitter is the ability for MAGNETROL to fully "pre-configure" devices to customer requests. For that reason, the Reset function will return the device back to the state **at which it left the factory**.

It is recommended that MAGNETROL Technical Support be contacted as the Advanced User password will be required for this reset.

3.4.7 Additional Diagnostic/Troubleshooting Capabilities

3.4.7.1 Event History

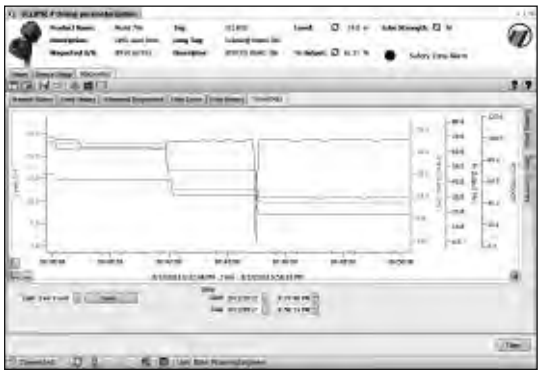
As a means for improved troubleshooting capability, a record of significant diagnostic events is stored with time and date stamps. A real time on board clock (which must be set by the operator), will maintain the current time.

3.4.7.2 Context-sensitive Help

Descriptive information relevant to the highlighted parameter in the menu will be accessible via the local display and remote host interfaces. This will most often be a parameter-related screen, but could also be information about menus, actions (for example, Loop [Analog Output] Test, resets of various types), diagnostic indicators, etc.

For example: Dielectric Range — Selects the range bounding the dielectric constant of the medium in vessel. For interface measurement mode, it selects the range bounding the dielectric constant of the lower liquid medium. Some ranges may not be selectable depending on the probe model.

3.4.7.3 Trend Data



Another new feature to the Model 706 is the the ability to log several measured values (selectable from any of the primary, secondary, or supplemental measured values) at a configurable rate (for example, once every five minutes) for a period ranging from several hours to a number of days (depending on the configured sample rate and number of values to be recorded). The data will be stored in non-volatile memory in the transmitter with date and time information for subsequent retrieval and visualization using the associated Model 706 DTM.

3.5 Agency Approvals


CE These units are in compliance with the EMC-directive 2014/30/EU, the PED-directive 2014/68/EU and the ATEX directive 2014/34/EU.

Explosion Proof (with intrinsically Safe Probe)

US/Canada:
Class I, Div 1, Group B, C and D, T4
Class I, Zone 1 AEx db/ia [ia IIC Ga] IIB + H2 T4 Gb/Ga
Class I, Zone 1 Ex db/ia [ia IIC Ga] IIB + H2 T4 Gb/Ga
Ta = -40 ºC to +70 ºC
Type 4X, IP67

Flame Proof
ATEX – FM14ATEX0041X:
II 2/1 G Ex db/ia [ia IIC Ga] IIB + H2 T6 to T1 Gb/Ga
Ta = -40 ºC to +70 ºC
IP67

IEC- IECEx FMG 14.0018X:
Ex db/ia [ia IIC Ga] IIB + H2 T6 to T1 Gb/Ga
Ta = -40 ºC to +70 ºC
IP67

Non- Incendive

US/Canada:
US: Class I, II, III, Division 2, Group A, B, C, D, E, F, G, T4
Canada: Class I, Division 2, Group A, B, C, D
Class I, Zone 2 AEx nA [ia Ga] IIC T4 Gc
Class I, Zone 2 Ex nA [ia Ga] IIC T4 Gc
Ta = -40 ºC to +70 ºC
Type 4X, IP67

ATEX - FM14ATEX0042X:
II 3 (1) G Ex nA [ia Ga] IIC T4 Gc
Ta = -15 ºC to +70 ºC
IP67

IEC – IECEx FMG 14.00018X:
Ex nA [ia Ga] IIC T4 Ga/Gc
Ta = -15 ºC to + 70 ºC
IP67

Intrinsically Safe

US/Canada:
Class I, II, III, Div 1, Group A, B, C, D, E, F, G, T4
Class I, Zone 0 AEx ia IIC T4 Ga
Class I, Zone 0 Ex ia IIC T4 Ga
Ta =-40 ºC to + 70 ºC
Type 4X, IP67

ATEX – FM14ATEX0041X:
II 1 G Ex ia IIC T4 Ga
Ta = -40 ºC to +70 ºC
IP67

IEC – IECEx FMG 14.0018X:
Ex ia IIC T4 Ga
Ta = -40 ºC to +70 ºC
IP67

Dust Ignition Proof

US/Canada:
Class II, III, Division 1, Group E, F and G, T4
Ta = -40 ºC to +70 ºC
Type 4X, IP67

ATEX – FM14ATEX0041X:
II 1/2 D Ex ia/tb [ia Da] IIIC T85 ºC to T450 ºC Da/Db
Ta = -15 ºC to +70 ºC
IP67

IEC – IECEx FMG 14.0018X:
Ex ia tb [ia Da] IIIC T85 ºC to T450 ºC Db
Ex ia IIIC T85 ºC to T450 ºC Da
Ta = -15 ºC to +70 ºC
IP67

The following approval standards are applicable:
FM3600:2018, FM3610:2010, FM3611:2018, FM3615:2018, FM3616:2011, FM3810:2018, UL60079-0:2019, UL 60079-1:2015, ANSI/ISA 60079-11:2014, ANSI/ISA 60079-15:2012, ANSI/ISA 60079-26:2014, ANSI/NEMA 250:2003, ANSI/IEC 60529:2004, ANSI/UL 61010:2015, CSA-C22.2 No. 0.4:2009, CSA-C22.2 No. 0.5:2008, CSA-C22.2 No. 25:2009, CSA-C22.2 No. 30:2007, CSA- C22.2 No. 94:2001, CSA-C22.2 No. 157:2012, CSA-C22.2 No. 213:2012, CSA-C22.2 No. 1010.1:2009 CAN/CSA 60079-0:2019, CAN/CSA 60079-1:2016 CAN/CSA 60079-11:2011 CAN/CSA 60079-15:2012 C22.2 No. 60529:R2010, ANSI/ISA 12.27.01, EN/IEC60079-0:2018, EN60079-1:2014, EN60079-11:2012, EN60079-15:2010, EN60079-26:2015, EN60079-31:2014, EN60529+A1:1991-2000, IEC60079-0:2017, IEC60079-1:2014, IEC60079-11:2011, IEC60079-15:2010, IEC60079-26:2006, IEC60079-31:2008, ANSI/ISA 12.27.01:2011, ANSI/UL 61010:2015

3.5.1 Special Conditions of Use

1. The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.
2. The risk of electrostatic discharge shall be minimized at installation, following the directions given in the instructions.
3. Contact the original manufacturer for information on the dimensions of the flameproof joints.
4. For installation with ambient temperature of +70 °C, refer to the manufacturer's instructions for guidance on proper selection of conductors.
5. WARNING — Explosion Hazard: Do not disconnect equipment when flammable or combustible atmoshpere is present.
6. For IEC and ATEX: To maintain the T1 to T6 temperature codes, care shall be taken to ensure the enclosure temperature does not exceed +75 °C.
7. For U.S. and Canada: To maintain the T4 temperature code, care shall be taken to ensure the enclosure temperature does not exceed +70 °C.
8. Temperature codes for the ratings Ex db/ia [ia IIC] IIB+H2 and Ex ia/tb [ia] IIIC are defined by the following table:

Process Temperature (PT)	Temperature Code-TCG (GAS)	Temperature Code-TCD (Dust)
Up to 75 °C	T6	TCD= PT+10K=85 °C
From 75°C to 90 °C	T5	TCD= PT+10K=100 °C
From 90 °C to 120 °C	T4	TCD= PT+15K=135 °C
From 125 °C to 185 °C	T3	TCD= PT+15K=200 °C
From 185 °C to 285 °C	T2	TCD= PT+15K=300 °C
From 285 °C to 435 °C	T1	TCD= PT+15K=450 °C

9. Flameproof joints are not intended to be repaired.
10. To maintain FM approval, the Model 706 transmitter with adapter shall be used only on Model 705 assemblies approved by FM Global (includes FM, CSA, Atex and IEC).
11. Provisions shall be made to provide transient over-voltage protection to a level not to exceed 119 V DC.

3.5.2 Agency Specifications – Explosion Proof Installation

Factory Sealed: This product has been approved by Factory Mutual Research (FM) as a Factory Sealed device.

NOTE: Factory Sealed: No Explosion Proof conduit fitting (EY seal) is required within 18" of the transmitter. However, an Explosion Proof conduit fitting (EY seal) is required between the hazardous and safe areas.

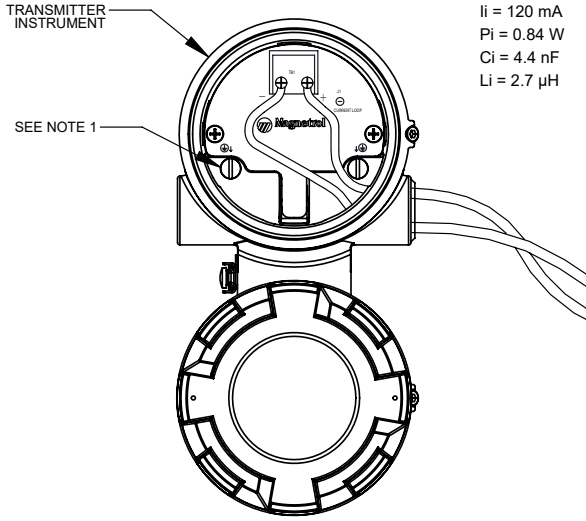
3.5.3 Agency Specifications – FM/CSA Intrinsically Safe Installation

HAZARDOUS LOCATION

MODEL 706 LEVEL TRANSMITTER

INTRINSICALLY SAFE FOR:
CLASS I, II, III DIV. I GROUPS A, B, C, D, E, F, G & T4
CLASS I, ZONE 0 AEx ia IIC
T4 Ga Ta = -40°C TO 70°C

ENTITY
Ui = 28.4 V
Ii = 120 mA
Pi = 0.84 W
Ci = 4.4 nF
Li = 2.7 µH



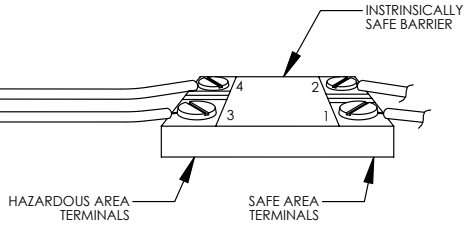
MODEL 706-51XX-XXX

NON-HAZARDOUS LOCATION

LIMITING VALUES

Voc ≤ 28.6V Ca ≥ 4.4nF
Isc ≤ 140 mA La ≥ 2.7µH

THE VOLTAGE (V max) AND CURRENT (I max), WHICH THE TRANSMITTER CAN RECEIVE MUST BE EQUAL TO OR GREATER THAN THE MAXIMUM OPEN. CIRCUIT VOLTAGE (Voc OR V+) AND THE MAXIMUM SHORT CIRCUIT CURRENT (Isc OR IE), WHICH CAN BE DELIVERED BY THE SOURCE DEVICE. IN ADDITION, THE MAXIMUM CAPACITANCE (Ci) AND INDUCTANCE (Li) OF THE LOAD AND THE CAPACITANCE AND INDUCTANCE OF THE INTERCONNECTING WIRING, MUST BE EQUAL TO LESS THAN THE CAPACITANCE (Ca) OR THE INDUCTANCE (La), WHICH CAN BE DRIVEN BY THE SOURCE DEVICE.



SEE NOTE 2

SPECIAL CONDITIONS OF USE:

1. THE ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO PRESENT A POTENTIAL RISK OF IGNITION BY IMPACT OR FRICTION. CARE MUST BE TAKEN DURING INSTALLATION AND USE TO PREVENT IMPACT OR FRICITON.
2. THE RISK OF ELECTROSTATIC DISCHARGE SHALL BE MINIMIZED AT INSTALLATION, FOLLOWING THE DIRECTIONS GIVEN IN THE INSTRUCTIONS.
3. FOR IEC AND ATEX - TO MAINTAIN THE T1 TO T6 TEMPERATURE CODES, CARE SHALL BE TAKEN TO ENSURE THE ENCLOSURE TEMPERATURE DOES NOT EXCEED 70 ºC.
4. FOR US AND CANADA - TO MAINTAIN THE T4 TEMPERATURE CODE, CARE SHALL BE TAKEN TO ENSURE THE ENCLOSURE TEMPERATURE DOES NOT EXCEED 70 ºC.
5. PROVISIONS SHALL BE MADE TO PROVIDE TRANSIENT OVERVOLTAGE PROTECTION TO A LEVEL NOT EXCEEDING 119 Vdc.
6. THE MODEL 706 TRANSMITTER WITH ADAPTOR SHALL BE USED ONLY ON FM APPROVED MODEL 705 ASSEMBLIES.

NOTES:

1. FOR EXPLOSIONPROOF OR DUST-IGNITIONPROOF INSTALLATIONS. THE I.S. GROUND TERMINAL SHALL BE CONNECTED TO APPROPRIATE INTRINSICALLY SAFE GROUND INACCORDANCE WITH THE CANADIAN ELECTRICAL CODE [CEC] [FOR CSA] OR THE NATIONAL ELECTRINCAL CODE [NEC, ANSI/NFPA 70] [FOR FMRC]. FOR INTRINSICALLY SAFE INSTALLATIONS. THE I.S. GROUND TERMINAL DOES NOT REQUIRE GROUNDING.
2. MANUFACTURER'S INSTALLATION INSTRUCTIONS SUPPLIED WITH THE PROTECTIVE BARRIER AND THE CEC [FOR CSA] OR THE NEC AND ANSI/ISA RP 12.6 [FOR FMRC] MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT. BARRIER MUST BE CSA CERTIFIED FOR CANADIAN INSTALLATIONS & FM APPROVED FOR U.S. INSTALLATION.
3. CONTROL EQUIPMENT CONNECTED TO PROTECTIVE BARRIERS MUST NOT USE OR GENERATE MORE THAN 250 VDC OR VRMS.
4. NRTL LISTED DUST-TIGHT SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS II & III ENVIRONMENTS.
5. NO REVISIONS TO THIS DRAWING WITHOUT CSA AND FMRC APPROVAL.
6. FOR CSA: EXIA INTRINSICALLY SAFE/SECURITE INTRINSEQUE.
7. FOR CSA: WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABLITY FOR HAZARDOUS LOCATIONS.
8. FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE. FOR 80º C AMBIENT, USE WIRE WITH A MINIMUM TEMPERATURE RATING OF 85º C.
9. THE TRANSMITTER CAN ALSO BE INSTALLED IN:
   CLASS I, DIVISION 2, GROUPS A, B, C & D
   CLASS II, DIVISION 2, GROUPS E, F & G (F & G ONLY FOR FMRC)
   CLASS III, DIVISION 2, HAZARDOUS LOCATIONS AND DOES NOT REQUIRE CONNECTION TO A PROTECTIVE BARRIER WHEN INSTALLED PER THE CEC (FOR CSA) OR THE NEC (FOR FMRC) AND WHEN CONNECTED TO A POWER SOURCE NOT EXCEEDING 36 VDC.
10. FM APPROVED AND CSA CERTIFIED BARRIERS WITH LINEAR OUTPUT CHARACTERISTICS **MUST BE USED**.

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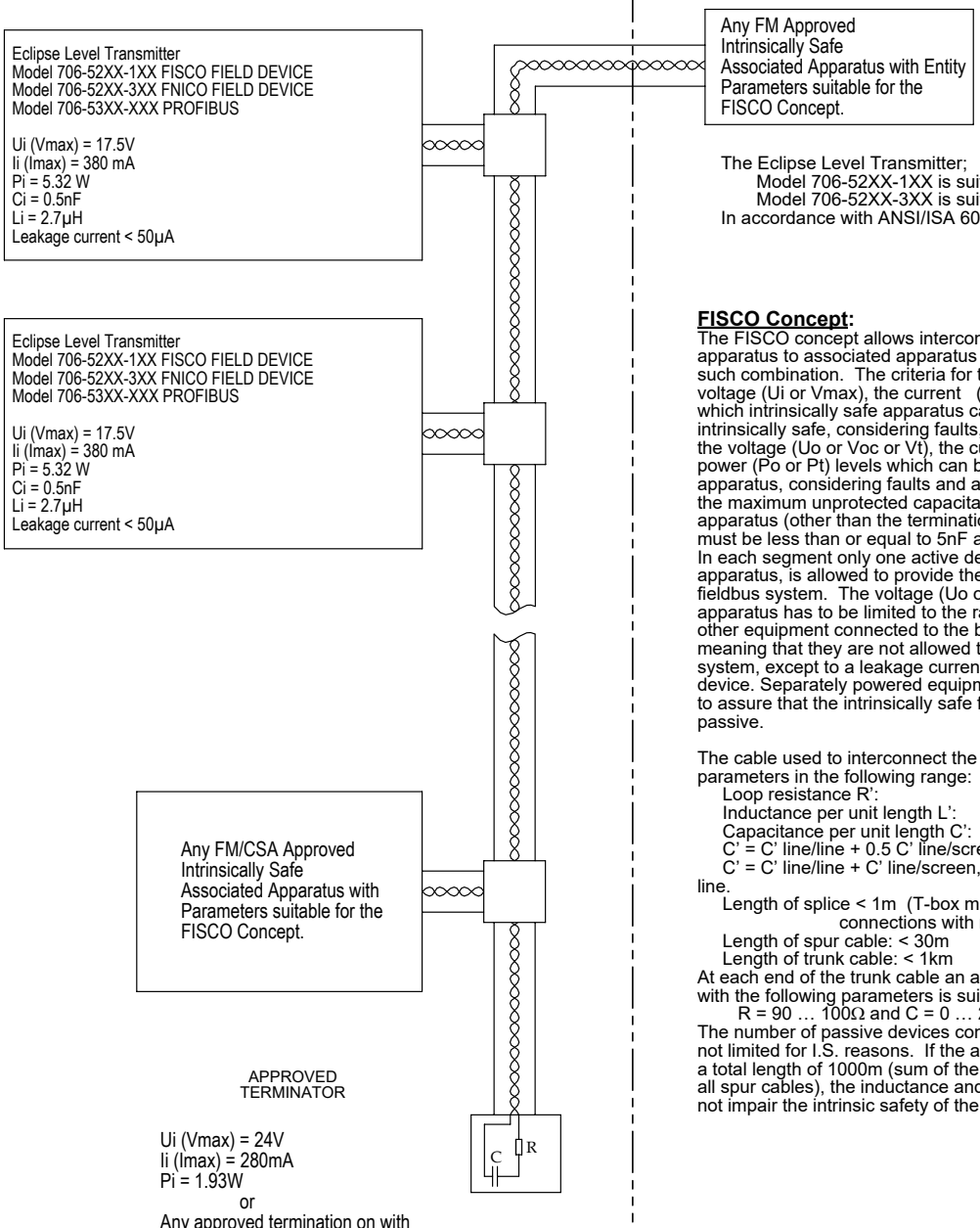
HAZARDOUS (CLASSIFIED) LOCATION

Class I, Division 1, Groups A, B, C, D
Class II, Division 1, Groups E, F, G
Class III, Division 1

UNCLASSIFIED LOCATION



The Eclipse Level Transmitter;
Model 706-52XX-1XX is suitable for use in a FISCO system
Model 706-52XX-3XX is suitable for use in a FNICO system
In accordance with ANSI/ISA 60079-27:2006.

FISCO Concept:
The FISCO concept allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such combination. The criteria for the interconnection is that the voltage (Ui or Vmax), the current (Ii or Imax) and the power (Pi) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, must be equal or greater than the voltage (Uo or Voc or Vt), the current (Io or Isc or It) and the power (Po or Pt) levels which can be delivered by the associated apparatus, considering faults and applicable factors. In addition, the maximum unprotected capacitance (Ci) and (Li) of each apparatus (other than the termination) connected to the fieldbus must be less than or equal to 5nF and 10µH respectively.
In each segment only one active device, normally the associated apparatus, is allowed to provide the necessary energy for the fieldbus system. The voltage (Uo or Voc or Vt), of the associated apparatus has to be limited to the range of 14V to 24V d.c. All other equipment connected to the bus cable has to be passive, meaning that they are not allowed to provide energy to the system, except to a leakage current of 50µA for each connected device. Separately powered equipment needs a galvanic isolation to assure that the intrinsically safe fieldbus circuit remains passive.

The cable used to interconnect the devices needs to have the parameters in the following range:
Loop resistance R': 15 … 150Ω/km
Inductance per unit length L': 0.4 … 1mH/km
Capacitance per unit length C': 80 … 200nF/km
C' = C' line/line + 0.5 C' line/screen, if both lines are floating or
C' = C' line/line + C' line/screen, if screen is connected to one line.
Length of splice < 1m (T-box must only contain terminal connections with no energy storage capability)
Length of spur cable: < 30m
Length of trunk cable: < 1km
At each end of the trunk cable an approved infallible termination with the following parameters is suitable:
R = 90 … 100Ω and C = 0 … 2.2µF
The number of passive devices connected to the bus segment is not limited for I.S. reasons. If the above rules are followed, up to a total length of 1000m (sum of the length of the trunk cable and all spur cables), the inductance and capacitance of the cable will not impair the intrinsic safety of the installation.

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SHEET 3 OF 3

3.6 Specifications

3.6.1 Functional/Physical

System Design		
Measurement Principle		Guided Wave Radar based on Time Domain Reflectometry (TDR)
Input		
Measured Variable		Level, as determined by GWR time of flight
Span		15 cm to 30 m (6" to 100'); Model 7yS Probe 610 cm (20') max.
Output		
Type		4 to 20 mA with HART: 3.8 mA to 20.5 mA useable (per NAMUR NE43)
		FOUNDATION Fieldbus™: H1 (ITK Ver. 6.2.0)
		PROFIBUS PA
		Modbus
Resolution	Analog:	.003 mA
	Digital Display:	1 mm
Loop Resistance		591 ohms @ 24 VDC and 22 mA
Diagnostic Alarm		Selectable: 3.6 mA, 22 mA (meets requirements of NAMUR NE 43), or HOLD last output
Diagnostic Indication		Meets requirements of NAMUR NE107
Damping		Adjustable 0–10 seconds
User Interface		
Keypad		4-button menu-driven data entry
Display		Graphic liquid crystal display
Digital Communication/Systems		HART Version 7—with Field Communicator, AMS, or FDT
		DTM (PACT*ware*™), EDDL
		FOUNDATION Fieldbus™, PROFIBUS PA or Modbus
Menu Languages	Transmitter LCD:	English, French, German, Spanish, Russian, Polish
	HART DD:	English, French, German, Spanish, Russian, Chinese, Portuguese, Polish
		FOUNDATION Fieldbus™, PROFIBUS PA and Modbus Host System: English
Power (at transmitter terminals)		HART: General Purpose (Weather proof)/Intrinsically Safe/Explosion-proof:
		16 to 36 VDC
		11 VDC minimum under certain conditions (refer to I&O Manual BE57-606)
		FOUNDATION Fieldbus™ and PROFIBUS PA: 9 to 32 VDC
		FISCO ia / FNICO ic, Explosion Proof, General Purpose and Weatherproof
		Modbus: 8 to 30 VDC
		Explosion Proof, General Purpose, and Weatherproof
Housing		
Material		IP67/die-cast aluminum A413 (<0.6 % copper); optional 316 stainless steel
Net/Gross Weight	Aluminum:	2,0 kg (4.5 lbs.)
	316 Stainless Steel:	4,50 kg (10.0 lbs.)
Overall Dimensions		H 212 mm (8.34") x W 102 mm (4.03") x D 192 mm (7.56")
Cable Entry		1/2” NPT or M20 x 1,5
SIL 2/3 Capable (Certified)		Safe Failure Fraction = 93 % (HART only)
		Functional Safety to SIL 2/3 in accordance with IEC 61508

3.6.1 Functional/Physical

Environment	
Operating Temperature	-40 to +80 °C (-40 to +175 °F); LCD viewable -20 to +70 °C (-5 to +160 °F)
Storage Temperature	-45 to +85 °C (-50 to +185 °F)
Humidity	0 to 99 %, non-condensing
Electromagnetic Compatibility	Meets CE requirement (EN 61326) and NAMUR NE 21 ①
Surge Protection	Meets CE EN 61326 (1000V)
Shock/Vibration	ANSI/ISA-S71.03 Class SA1 (Shock); ANSI/ISA-S71.03 Class VC2 (Vibration)
Performance	
Reference Conditions ②	Reflection from liquid, with dielectric constant in center of selected range,
	with a 1,8 m (72") coaxial probe at +20 °C (+70 °F), in Auto Threshold Mode
Linearity ③	<0.1 % of probe length or 2,5 mm (0.1"), whichever is greater
Accuracy ④	±0.1 % of probe length or ±2,5 mm (0.1"), whichever is greater
Interface Operation:	±25 mm (1") for an interface thickness greater than 50 mm (2")
Resolution	±0.1 mm or 1"
Repeatability	<2,5 mm (0.1")
Hysteresis	<2,5 mm (0.1")
Response Time	Approximately 1 second
Initialization Time	Less than 10 seconds
Ambient Temperature Effect	Approx. ±0.02 % of probe length/°C (for probes greater than 2,5 m (8'))
Process Dielectric	<7,5 mm (0.3") within selected range
FOUNDATION Fieldbus™	
ITK Version	6.2.0
H1 Device Class	Link Master (LAS)—selectable ON/OFF
H1 Profile Class	31PS, 32L
Function Blocks	(8) AI, (3) Transducer, (1) Resource, (1) Arithmetic, (1) Input Selector,
	(1) Signal Characterizer, (2) PID, (1) Integrator
Quiescent Current	15 mA
Execution Time	15 ms (40 ms PID Block)
Device Revision	02
DD Version	0x01
PROFIBUS PA	
Device Revision	0x101A
Digital Communication Protocol	Version 3.02 MBP (31.25 kbits/sec)
Function Blocks	(1) × Physical Block, (8) × AI Blocks, (3) × Transducer Block
Quiescent Current	15 mA
Execution Time	15 ms
Modbus	
Power Consumption	<0.5W
Signal Wiring	Two-wire half duplex RS-485 Modbus
Ground (common mode) Voltage	±7V
Bus Termination	Per EIA-485

① Single rod probes must be used in metallic vessel or stillwell to maintain CE noise immunity.
② Specifications will degrade in Fixed Threshold mode.
③ Linearity in top 46 cm (18") of Single Rod probes in tanks will be application dependent.
④ Accuracy may degrade when using manual or automatic compensation.

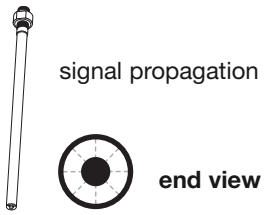
3.6.2 O-ring (Seal) Selection Chart

Code	"O"-Ring/Seal Material	Max. Process Temperature	Min. Process Temperature	Max. Process Pressure	Not Recommended For Applications	Recommended for Applications
0	**Viton® GFLT**	200 °C @ 16 bar (400 °F @ 230 psi)	-40 °C (-40 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Ketones (MEK, acetone), skydrol fluids, amines, anhydrous ammonia, low molecular weight esters and ethers, hot hydrofluoric or chlorosulfuric acids, sour HCs	General purpose, ethylene
1	**EPDM**	120 °C @14 bar (250 °F @ 200 psi)	-50 °C (-60 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Petroleum oils, di-ester base lubricant, steam	Acetone, MEK, skydrol fluids
2	**Kalrez® 4079**	200 °C @ 16 bar (400 °F @ 232 psi)	-40 °C (-40 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Hot water/steam, hot aliphatic amines, ethylene oxide, propylene oxide	Inorganic and organic acids (including hydro fluids and nitric), aldehydes, ethylene, organic oils, blycols, silicone oils, vinegar, sour HCs
3	**HSN** (Highly Saturated Nitrile)	135 °C @ 22 bar (275 °F @ 320 psi)	-20 °C (-4 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Halogenated HCs, nitro HCs, phosphate ester hydraulic fluids, ketones (MEK, acetone), strong acids, ozone, automotive brake fluid, steam	NACE applications
4	**Buna-N**	135 °C @ 22 bar (275 °F @ 320 psi)	-20 °C (-4 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Halogenated HCs, nitro HCs, phosphate ester hydraulic fluids, ketones (MEK, acetone), strong acids, ozone, automotive brake fluid	General purpose sealing, petroleum oils and fluids, cold water, silicone greases and oils, di-ester base lubricants, ethylene glycol base fluids
5	**Neoprene®**	120 °C @ 20 bar (250 °F @ 290 psi)	-55 °C (-65 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Phosphate ester fluids, ketones (MEK, acetone)	Refrigerants, high anline point petroleum oils, silicate ester lubricants
6	**Chemraz® 505**	200 °C @ 14 bar (400 °F @ 200 psi)	-20 °F (-30 °C)	70 bar @ 20 °C (1000 psi @ 70 °F)	Acetaldehyde, ammonia + lithium metal solution, butyraldehyde, di-water, freon, ethylene oxide, liquors, isobutyraldehyde	Inorganic and organic acids, alkalines, ketones, esters, aldehydes, fuels
7	**Polyurethane**	95 °C @ 29 bar (200 °F @ 420 psi)	-55 °C (-65 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Acids, Ketones, chlorinated HCs	Hydraulic systems, petroleum oils, HC fuel, oxygen, ozone
8	**Simriz SZ485** (formerly Aegis PF128) ①	200 °C @ 16 bar (400 °F @ 232 psi)	-20 °C (-4 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Black liquor, freon 43, freon 75, galden, KEL-F liquid, molten potassium, molten sodium	Inorganic and organic acids (including hydro fluids and nitric), aldehydes, ethylene, organic oils, gycols, silicone oils, vinegar, sour HCs, steam, amines, ethylene oxide, propylene oxice, NACE applications
A	**Kalrez® 6375**	200 °C @ 16 bar (400 °F @ 232 psi)	-40 °C (-40 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Hot water/steam, hot aliphatic amines	Inorganic and organic acids (including hydro fluids and nitric), aldehydes, ethylene, organic oils, blycols, silicone oils, vinegar, sour HCs, ethylene oxide, propylene oxide
B	**Kalrez® 6375**	200 °C @ 16 bar (400 °F @ 232 psi)	-40 °C (-40 °F)	70 bar @ 20 °C (1000 psi @ 70 °F)	Hot water/steam, hot aliphatic amines, ethylene oxide, propylene oxide	Hydrofluoric acid
D or N	**Glass Ceramic Alloy**	450 °C @ 248 bar (850 °F @ 3600 psi)	-195 °C (-320 °F)	431 bar @ 20 °C (6250 psi @ 70 °F)	Hot alkaline solutions HF acid, media with ph>12, direct exposure to saturated steam	General high temperature/high pressure applications, hydrocarbons, full vacuum (hermetic), ammonia, chlorine

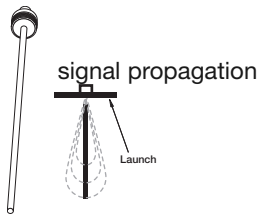
① Maximum +150 °C (+300 °F) for use on steam.

3.6.3 Probe Selection Guide

COAXIAL/CAGED GWR PROBE



SINGLE ROD/CABLE PROBE



GWR Probe①	Description	Application	Installation	Dielectric Range ②③	Temperature Range ④	Max. Pressure	Vacuum ⑤	Overfill Safe	Viscosity cP (mPa.s)
Coaxial GWR Probes—Liquids									
7yT	Standard Temperature	Level/Interface	Tank/Chamber	ε_r 1.4–100	-40 to +200 °C (-40 to +400 °F)	70 bar (1000 psi)	Yes	Yes	500/2000
7yP	High Pressure	Level/Interface	Tank/Chamber	ε_r 1.4–100	-196 to +200 °C (-320 to +400 °F)	431 bar (6250 psi)	Full	Yes	500/2000
7yD	High Temp./ High Press.	Level/Interface	Tank/Chamber	ε_r 1.4–100	-196 to +450 °C (-320 to +850 °F)	431 bar (6250 psi)	Full	Yes	500/2000
7yS	Steam Probe	Saturated Steam	Tank/Chamber	ε_r 10–100	-40 to +425 °C ⑥ (-40 to +800 °F)	207 bar (3000 psi)	Full	No ⑦	500
Caged GWR Probes—Liquids									
7yG	Standard Temperature	Level/Interface	Chamber	ε_r 1.4–100	-40 to +200 °C (-40 to +400 °F)	70 bar (1000 psi)	Yes	Yes	10000
7yL	High Pressure	Level/Interface	Chamber	ε_r 1.4–100	-196 to +200 °C (-320 to +400 °F)	431 bar (6250 psi)	Full	Yes	10000
7yJ	High Temp./ High Press.	Level/Interface	Chamber	ε_r 1.4–100	-196 to +450 °C (-320 to +850 °F)	431 bar (6250 psi)	Full	Yes	10000
Single Rod Rigid GWR Probes—Liquids									
7yF	Standard Temperature	Level/Interface	Tank	ε_r 1.7–100	-40 to +200 °C (-40 to +400 °F)	70 bar (1000 psi)	Yes	No ⑧	10000
7yM	High Pressure	Level/Interface	Tank	ε_r 1.7–100	-196 to +200 °C (-320 to +400 °F)	431 bar (6250 psi)	Full	No ⑧	10000
7yN	High Temp./ High Press.	Level/Interface	Tank	ε_r 1.7–100	-196 to +450 °C (-320 to +850 °F)	431 bar (6250 psi)	Full	No ⑧	10000
Single Cable Flexible GWR Probes—Liquids									
7y1	Standard Temperature	Level/Interface	Tank	ε_r 1.7–100	-40 to +200 °C (-40 to +400 °F)	70 bar (1000 psi)	Yes	No ⑧	10000
7y3	High Pressure	Level/Interface	Tank	ε_r 1.7–100	-196 to +200 °C (-320 to +400 °F)	431 bar (6250 psi)	Full	No ⑧	10000
7y6	High Temp./ High Press	Level/Interface	Chamber	ε_r 1.4–100	-196 to +450 °C (-320 to +850 °F)	431 bar (6250 psi)	Full	No ⑧	10000
Single Cable Flexible GWR Probes—Solids									
7y2	Bulk Solids Probe	Level	Tank	ε_r 1.7–100	-40 to +65 °C (-40 to +150 °F)	Atmos.	No	No ⑧	10000

① 2nd digit A=English, C=Metric
② Minimum ε_r 1.2 with end of probe analysis enabled.
③ Single rod probes mounted directly into the vessel must be within 75–150 mm (3–6") of metal tank wall to obtain minimum dielectric of 1.4, otherwise ε_r min = 1.7.
④ Depends on the probe spacer material. Refer to Model Selection for spacer options.
⑤ ECLIPSE probes containing o-rings can be used for vacuum (negative pressure) service, but only those probes with glass seals are hermetically sealed to $<10^{-8}$ cc/sec @ 1 atmosphere helium.
⑥ When installed in side-mounted chamber.
⑦ Consult factory for overfill applications
⑧ Overfill capability can be achieved with software.

3.6.4 Probe Specifications

Dual-element Probes

Model	Coaxial / Cage (7yG, 7yT)	HP Coaxial/Cage (7yL, 7yP)①	HTHP Coaxial/Cage (7yD, 7yJ)①	Steam (7yS)①
Materials	316/316L SS (Hastelloy C and Monel opt.),TFE spacers, Viton® O-rings	316/316L SS, glass ceramic alloy, Inconel, TFE spacers	316/316L SS, glass ceramic alloy, Inconel, TFE or Peek™ spacers	316/316L SS, Peek™, Iconel, Aegis PF 128 O-ring
Diameter	Small and Medium Coaxial: 8 mm (.3125") diameter rod, 10 mm (.875") diameter tube			10 mm (.875") - 300 °C 32 mm (1.25") - 425 °C
	Enlarged Coaxial: 15 mm (.6") dia. rod, 44 mm (1.75") dia. tube			42 mm (1.62")
	Caged: 13 – 38 mm (0.5" – 1.50") dia. rod			N/A
Process Connection	3/4" NPT, 1" BSP ASME or EN flanges	3/4" NPT, 1" BSP ASME or EN flanges		3/4" NPT, 1" BSP ASME or EN flanges
Transition Zone (Top)	None			200 mm (8") @ ε_r = 80
Transition Zone (Bottom)	150 mm (6") @ ε_r = 1.4 25 mm (1") @ ε_r = 80.0	150 mm (6") @ ε_r = 1.4 25 mm (1") @ ε_r = 80.0		25 mm (1")@ ε_r = 80
Pull Force/Tension	N/A			

NOTE: Transition Zone is dielectric dependent; ε_r = dielectric permittivity. The transmitter still operates but level reading may become nonlinear in Transition Zone.

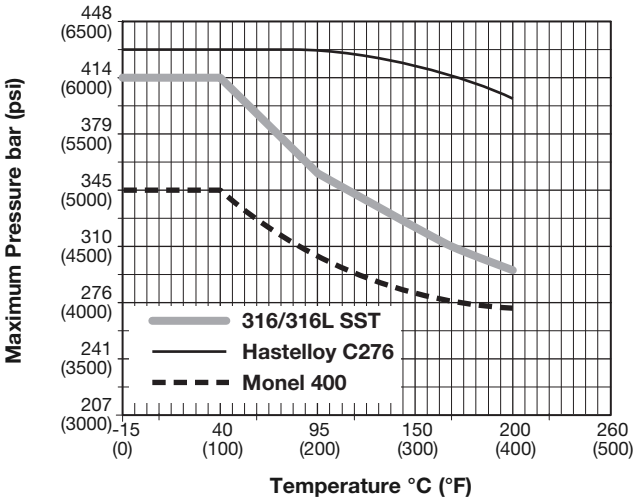
Single Rod Probes

Model	7yF	7yM, 7yN①	7y1 Flexible	7y3, 7y6 Flexible①	7y2 Flexible
Materials	316/316L SS (Hastelloy® C and Monel optional) Viton®/PEEK™ O-rings	316/316L SS, Inconel (Hastelloy® C and Monel optional) Viton®/PEEK™ O-rings	316/316L SS, Viton® O-rings (optional PFA coating)	316/316L SS, Inconel, Viton® O-rings	316/316L SS, Viton® O-rings
Diameter	13 mm (0.5")		6 mm (0.25")		
Blocking Distance - Top	0–91 cm (0–36")–Installation dependent (adjustable)				
Process Connection	1" NPT (7yF) ASME or EN flange		2" NPT ASME or EN flange		
Transition Zone (Top)	Application Dependent				
Transition Zone (Bottom)	150 mm (6") @ ε_r = 1.4 50 mm (2") @ ε_r = 80.0		305 mm (12") minimum		
Pull Force/Tension	N/A		9 kg (20 lbs.)		1360 kg (3000 lbs.)
Side Load	Not more than 7,6 cm (3") deflection at end of 305 cm (120") probe		Cable not to exceed 5° from vertical		

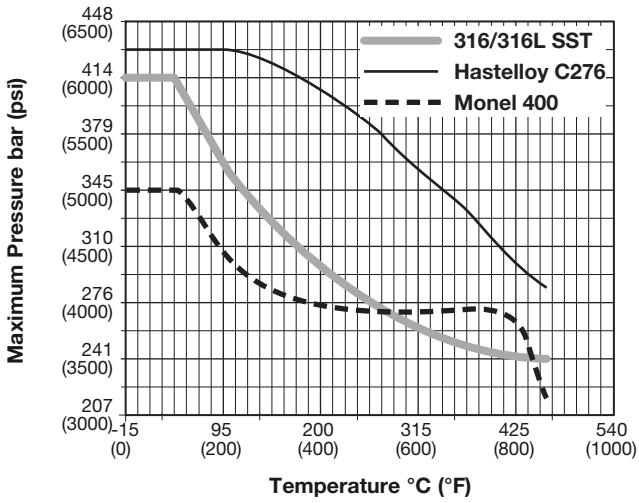
① Probes of Hastelloy C contain an Inconel 625 to Hastelloy C seal weld.

Temperature/Pressure Charts

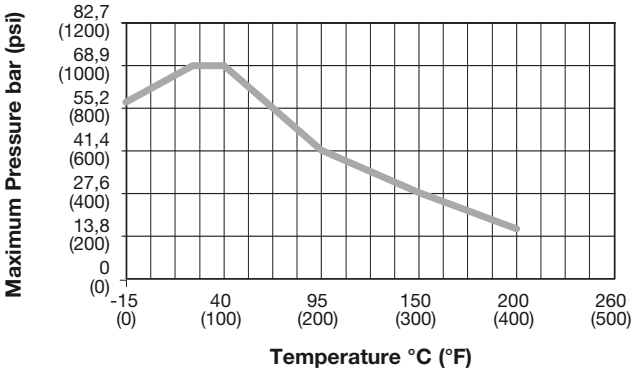
7yL, 7yM and 7yP (high pressure probes)
Temperature/Pressure Ratings



7yD, 7yJ, 7yN, 7y3 and 7y6 (high temp./high pressure probes)
Temperature/Pressure Ratings



7yF, 7yG, 7yT, 7y1
Temperature/Pressure Ratings

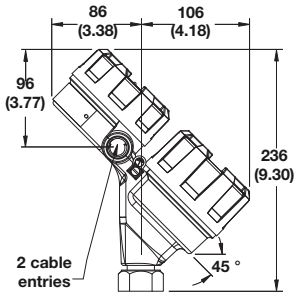


High Pressure Probes				Low Pressure	High Pressure Probes				Low Pressure
Temp. °C (°F)	SST	Hastelloy	Monel	All Materials	Temp. °C (°F)	SST	Hastelloy	Monel	All Materials
-40 (-40)	6000	6250	5000	750	**315 (+600)**	3760	5040	3940	—
20 (+70)	6000	6250	5000	1000	**345 (+650)**	3680	4905	3940	—
40 (+100)	6000	6250	5000	1000	**370 (+700)**	3620	4730	3920	—
95 (+200)	5160	6250	4380	650	**400 (+750)**	3560	4430	3880	—
150 (+300)	4660	6070	4080	400	**425 (+800)**	3520	4230	3820	—
200 (+400)	4280	5820	3940	270	**450 (+850)**	3480	4060	3145	—
260 (+500)	3980	5540	3940	—					

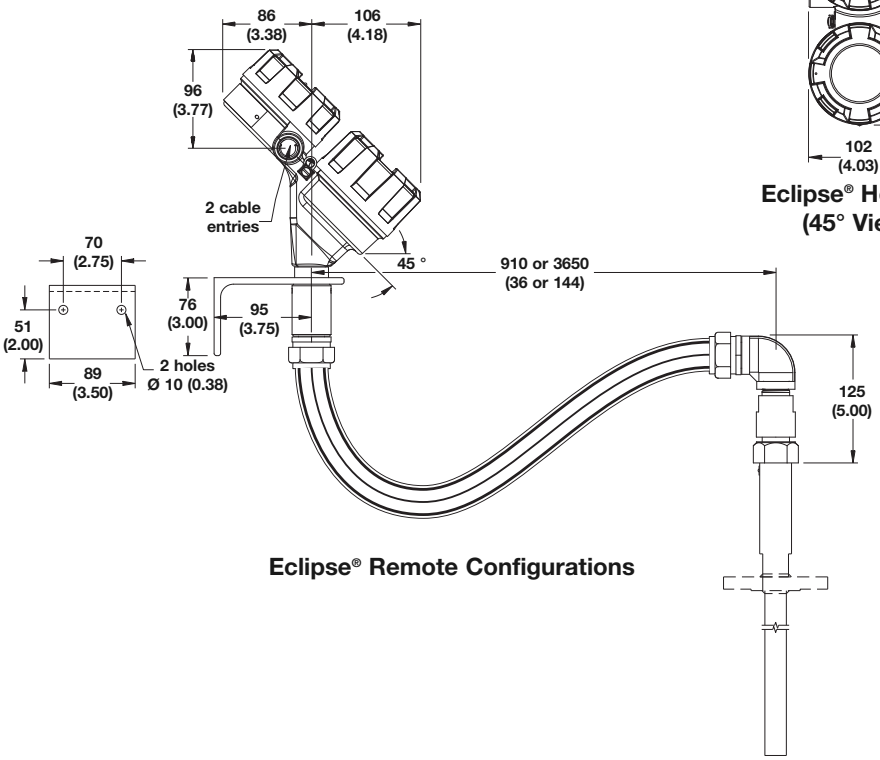
- 7yS steam probes are rated to 3000 psi (207 bar) up to +425 °C (+800 °F) when installed in side-mounted chamber.
- 7y3, 7y6 flexible probes: Pressure is limited by the chamber.
- 7y2 bulk solids probes: 50 psi (3.45 bar) to +65 °C (+150 °F).
- High pressure probes with threaded fittings are rated as follows: 7yD, 7yN, 7yP and 7y3 probes with threaded fittings have 3600 psi (248 bar) rating. 7yM probes with threaded fittings have 2016 psi (139 bar) rating.
- Maximum pressure for 1" NPT or 1" BSP:
  316 SST probe: 139 bar (2016 psi) • Hast. C276 probe: 145 bar (2100 psi) • Monel probe: 116 bar (1680 psi)
- Maximum pressure for 2" NPT or 2" BSP:
  316 SST probe: 414 bar (6000 psi) • Hast. C276 probe: 431 bar (6250 psi) • Monel probe: 345 bar (5000 psi)

3.6.5 Physical Specifications – Transmitter

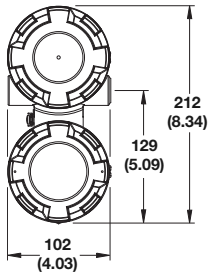
mm (inches)



Integral Electronics



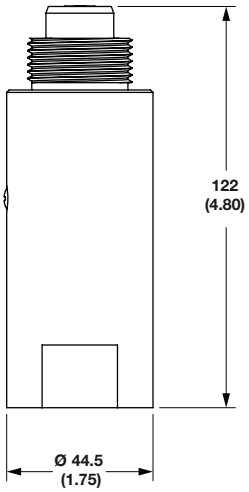
Eclipse® Remote Configurations

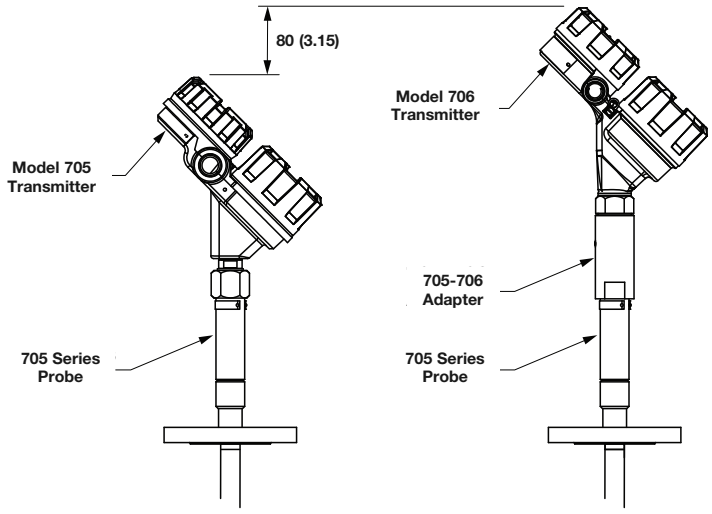


Eclipse® Housing (45° View)

3.6.6 Physical Specifications – Model 705/706 Adapter (032-6923-001)

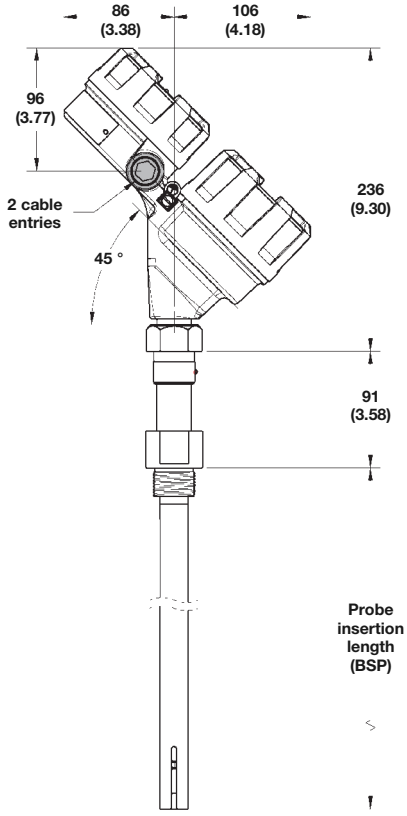
mm (inches)



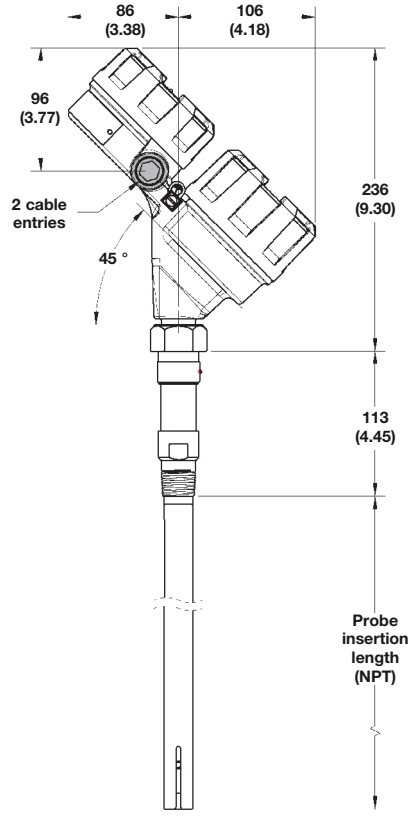


3.6.7 Physical Specifications – Coaxial Probes

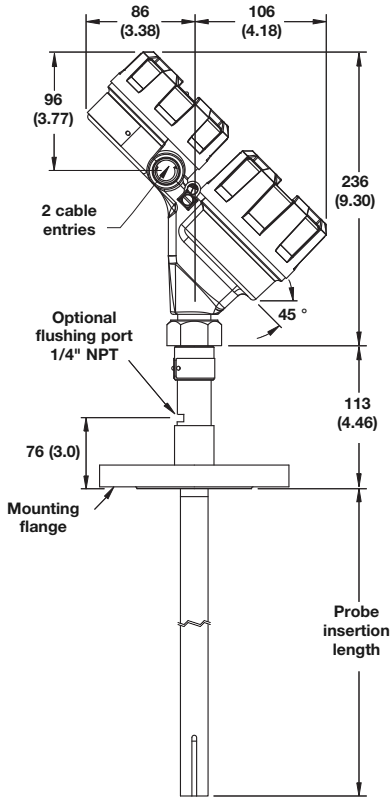
mm (inches)



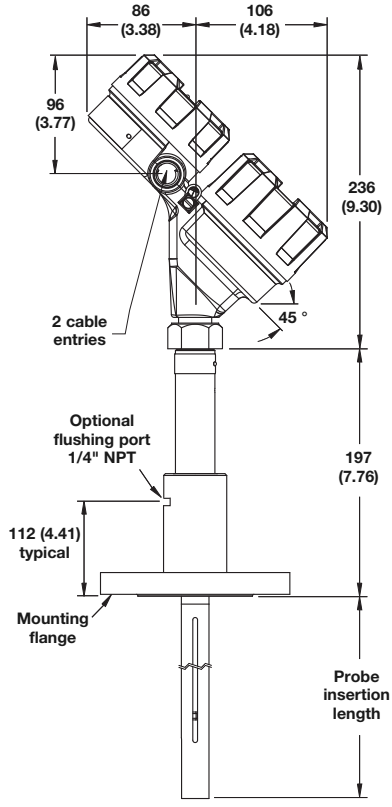
Model 7yT
with BSP threaded connection



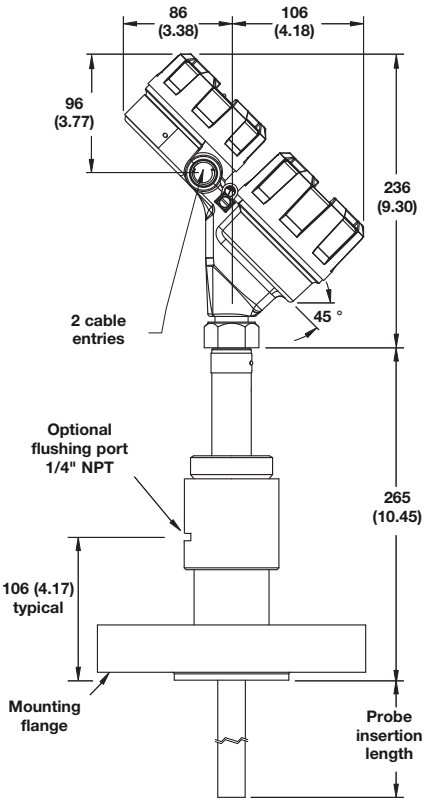
Model 7yT
with NPT threaded connection



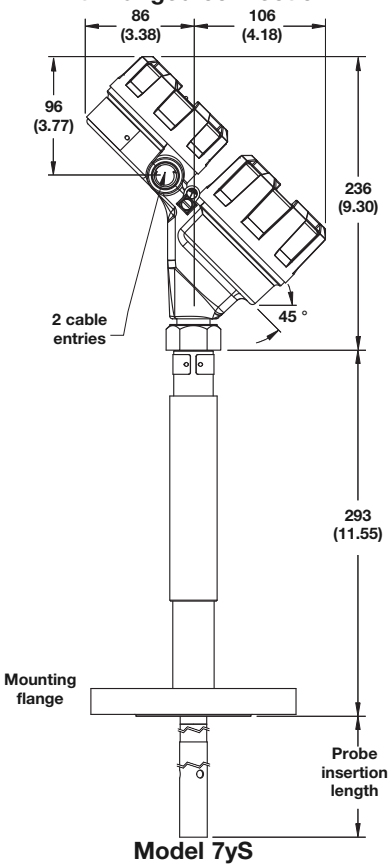
Model 7yT
with flanged connection



Model 7yP
with flanged connection



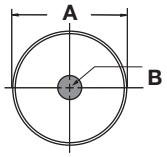
Model 7yD
with flanged connection



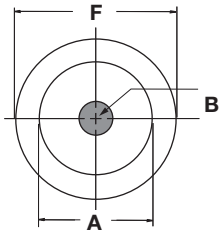
Model 7yS
with flanged connection

3.6.7 Physical Specifications – Coaxial Probes

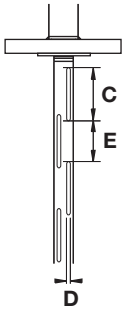
mm (inches)



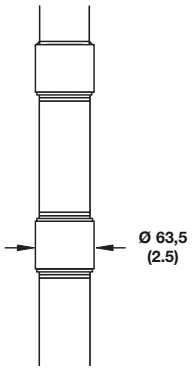
Coaxial GWR Probe, End View



Model 7yS Coaxial GWR Probe, End View



Coaxial Probe Slots



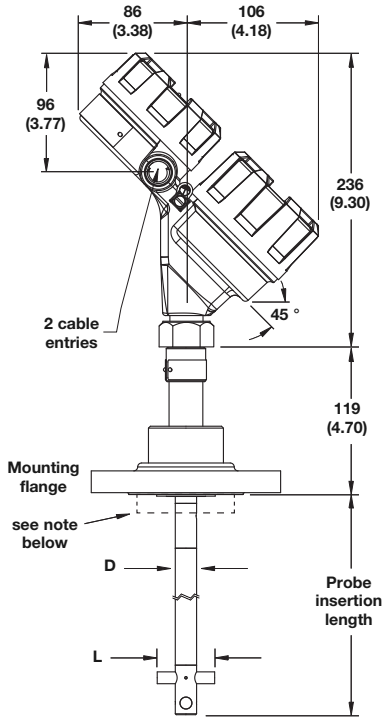
Segmented Enlarged Coaxial Probe

mm (inches)

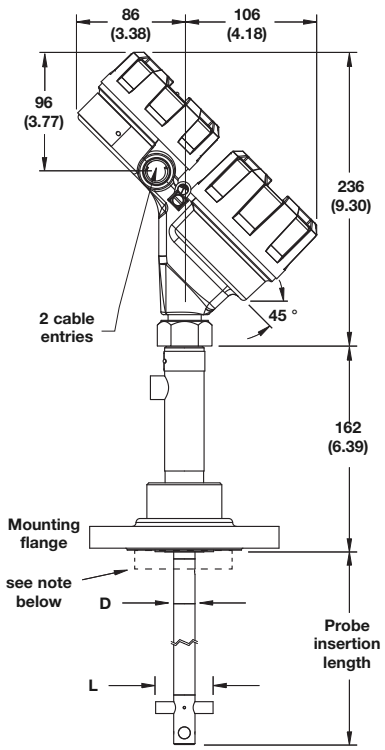
Dim.	Small Diameter	Medium Diameter	Large Diameter	Enlarged (standard)
A	22,5 (0.88)	31,75 (1.25)	41,1 (1.62)	45 (1.75) - SST 49 (1.92) - HC and Monel
B	8 (0.31)	10 (0.38) max.	13 (0.50) max.	16 (0.63) max.
C	100 (4.08)	153 (6.05)	153 (6.05)	153 (6.05)
D	4 (0.15)	8 (0.30)	8 (0.30)	8 (0.30)
E	96 (3.78)	138 (5.45)	138 (5.45)	138 (5.45)
F	31,75 (1.25)	—	—	—

3.6.8 Physical Specifications – Caged Probes

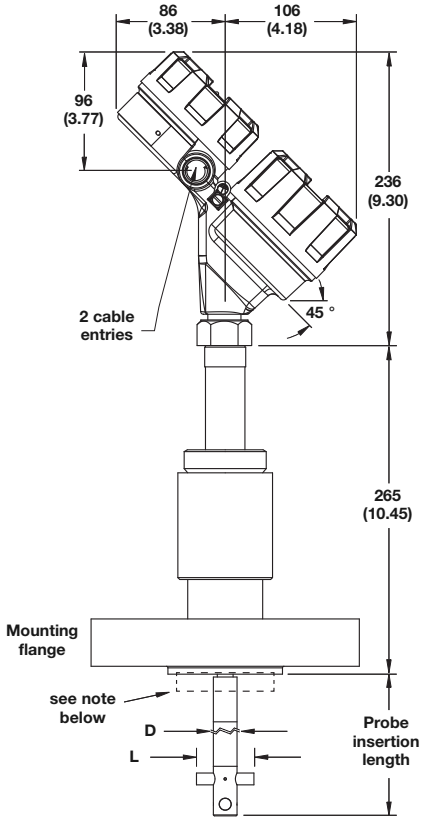
mm (inches)



Model 7yG
with flanged connection



Model 7yL
with flanged connection

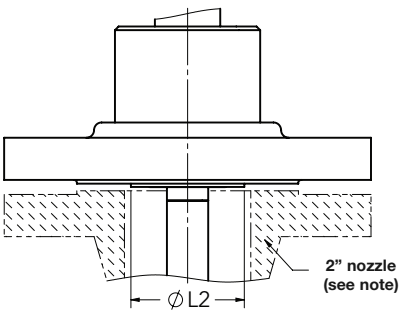


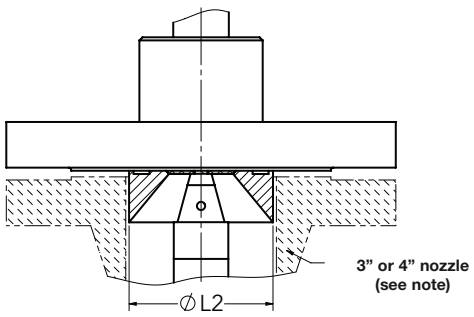
Model 7yJ
with flanged connection

Cage Size	Probe Rod Diameter (D)	Spacer Length (L)
2"	13 to 19 mm (0.5 to 0.75")	46 mm (1.82")
3"	19 to 29 mm (0.75 to 1.13")	67 mm (2.64")
4"	27 to 38 mm (1.05 to 1.50")	91 mm (3.60")

NOTE: Caged Probes (7yG, 7yL, 7yJ) with 2", 3" or 4" (DN50, DN80 or DN100) nozzle are equiped with a fix outer matching ring welded to flange face. Default value is for nozzle sizes SCH 80 or equal. For small inside diameter please specify per below table.

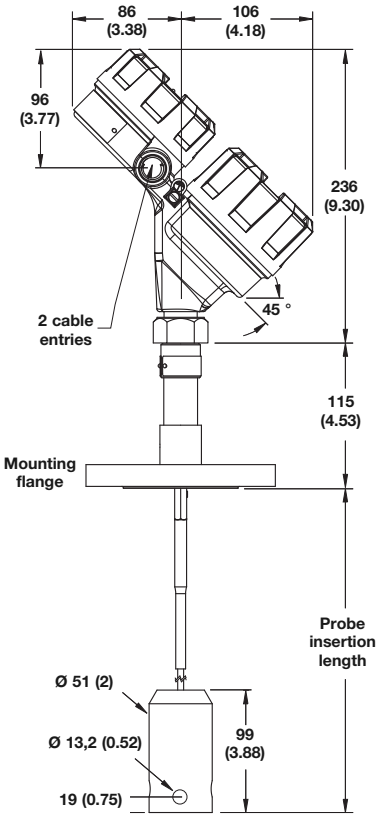
Nozzle Size	ØL2		
	SCH 80 (or smaller)	SCH 160	SCH XXS
2"	47.1 mm	N.A.	N.A.
3"	71 mm	63.5 mm	55.5 mm
4"	94.5 mm	84 mm	76.2 mm
	DEFAULT		



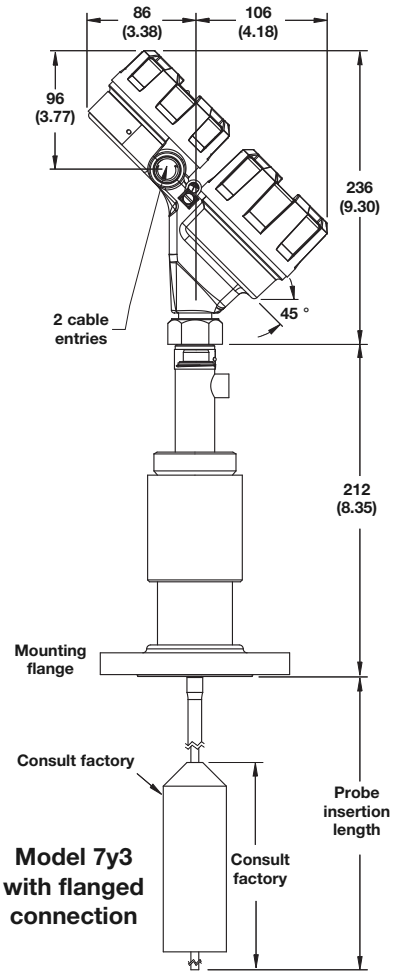


3.6.9 Physical Specifications – Single Cable Flexible Probes

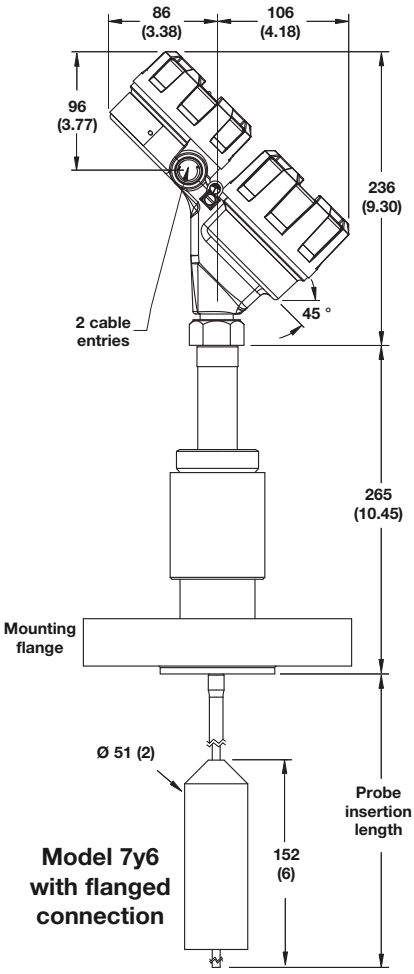
mm (inches)



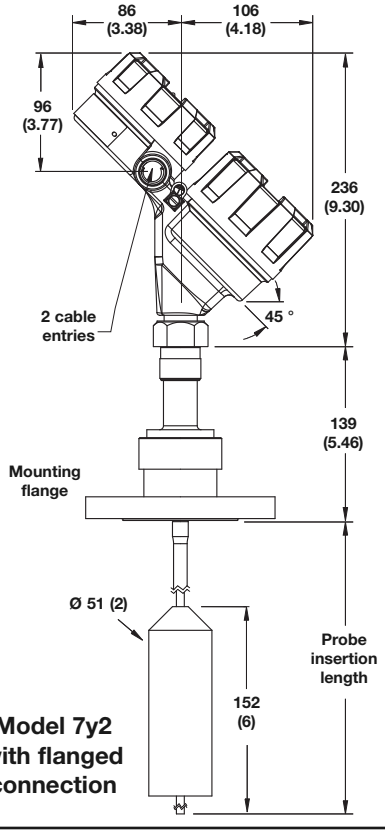
Model 7y1
with flanged connection



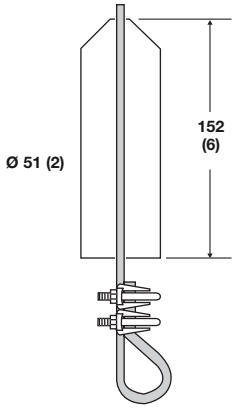
Model 7y3
with flanged connection



Model 7y6
with flanged connection



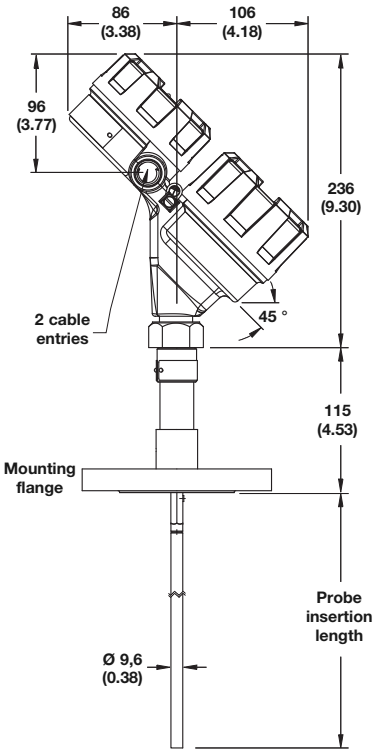
Model 7y2
with flanged connection



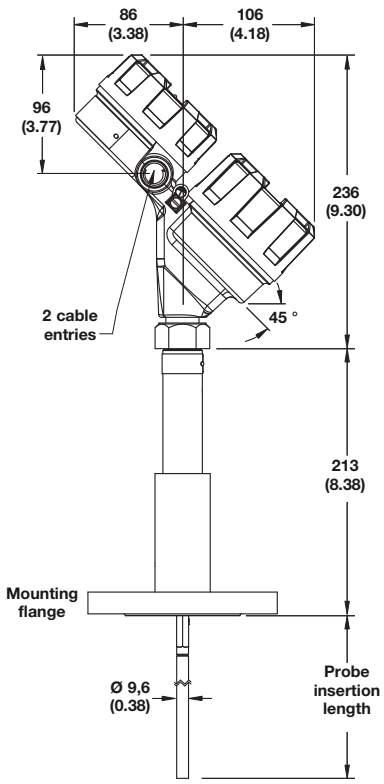
7y2: SST weight
2,25 kg (5 lbs.)

3.6.10 Physical Specifications – Single Rod Rigid Probes

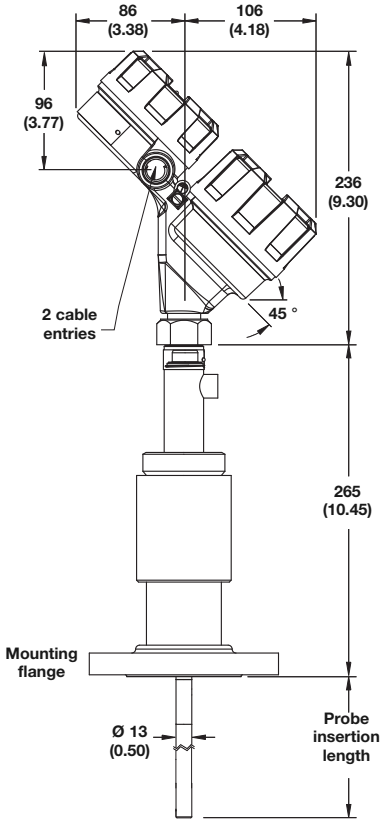
mm (inches)



Model 7yF
with flanged connection



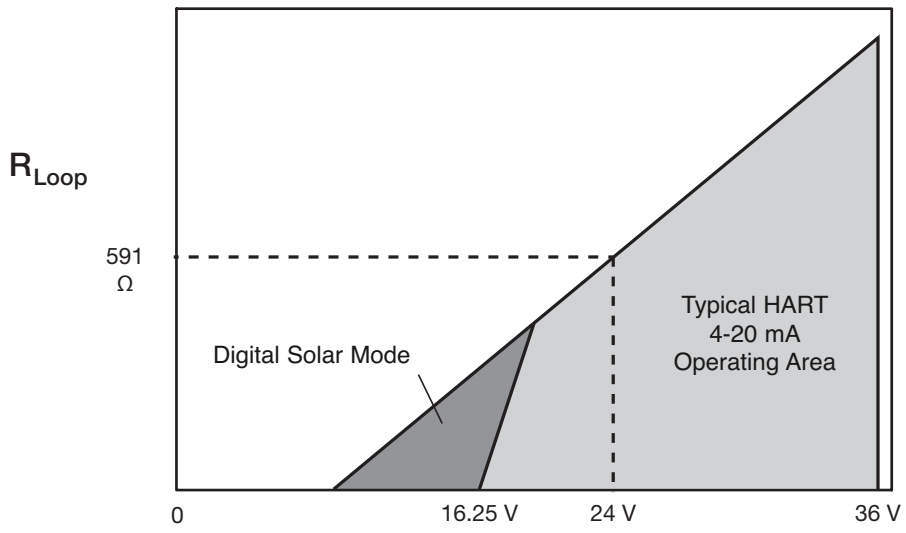
Model 7yM
with flanged connection



Model 7yN
with flanged connection

3.6.11 Power Supply Requirements

3.6.11.1 Safe Operating Area



3.6.11.2 Supply Voltage

Operational Mode		Current Consumption	Vmin	Vmax
HART	General Purpose	4mA 20mA	16,25V 11V	36V 36V
	Intrinsically Safe	4mA 20mA	16,25V 11V	28.6V 28.6V
	Explosion Proof	4mA 20mA	16,25V 11V	36V 36V
Fixed Current-Solar Power Operation (PV transmitter via HART)	General Purpose	10mA ①	11V	36V
	Intrinsically Safe	10mA ①	11V	28,6V
HART Multi-Drop Mode (Fixed Current)	Standard	4mA ①	16.25V	36V
	Intrinsically Safe	4mA ①	16.25V	28,6V
FOUNDATION Fieldbus™ / PROFIBUS PA	General Purpose	15 mA ②	9V	32V
	Intrinsically Safe	15 mA ②	9V	17,5V
	Explosion Proof	15 mA ②	9V	32V

① Start-up current 12 mA minimum.
② Quiescent current.

3.7 Model Number

3.7.1 Transmitter

1 2 3 | BASIC MODEL NUMBER

7 0 6	ECLIPSE 4th Generation Guided Wave Radar (GWR) Level Transmitter

4 | POWER

5	24 VDC, Two-Wire

5 | SIGNAL OUTPUT

1	4–20 mA with HART
2	FOUNDATION Fieldbus™ Communication
3	PROFIBUS PA Communication
4	Modbus Communication (8th Digit = 0 or 3 only)

6 | SAFETY OPTIONS

0	None – FOUNDATION Fieldbus™, PROFIBUS PA and Modbus only (5th digit = 2, 3 or 4)
2	SIL 2/3 Certified - HART only (5th digit = 1)

7 | ACCESSORIES/MOUNTING

0	NoNo Digital Display or Keypad - Integral
A	Digital Display and Keypad - Integral
B	Digital Display and Keypad - 1 m (3') remote
C	Digital Display and Keypad - 3,6 m (12') remote

8 | CLASSIFICATION

0	General Purpose, Weatherproof (IP 67)
1	Intrinsically Safe (FM & CSA CL 1 Div 1, Grps A, B, C, D) (5th digit = 1, 2 or 3)
3	Explosion-proof (FM & CSA CL 1 Div 1, Grps B, C, D)
A	Intrinsically Safe (ATEX/IEC Ex ia IIC T4) (5th digit = 1, 2 or 3)
B	Flame-proof (ATEX/IEC Ex d ia IIB + H2 T6) (5th digit = 1, 2 or 3)
C	Non-sparking (ATEX Ex n IIC T6) / Non-incendive (FM & CSA, CL 1 Div 2) (5th digit = 1, 2 or 3) ①
D	Dust Ex (ATEX II) (5th digit = 1, 2 or 3)

① Consult factory for proper part numbers

9 | HOUSING

1	Die-cast Aluminum, Dual-compartment, 45-degree
2	Investment Cast, 316 SS, Dual-compartment, 45-degree
A	Die-cast Aluminium, Dual-compartment, 45-degree with 705/706 adapter ②
B	Investment Cast, 316 SS, Dual-compartment, 45-degree with 705/706 adapter ②

② Available only with 5th digit = 3

10 | CONDUIT CONNECTION

0	1/2" NPT
1	M20 x 1,5
2	1/2" NPT with sunshade
3	M20 x 1,5 with sunshade

7	0	6	—	5				—			
1	2	3		4	5	6	7		8	9	10

3.7.2 Enlarged Coaxial Probe

1 | TECHNOLOGY

7	ECLIPSE GWR Probes - Model 706

2 | MEASUREMENT SYSTEM

A	English (inches)
C	Metric (centimeters)

3 | CONFIGURATION/STYLE (RIGID)

D	Enlarged Coaxial, High Temp/High Pressure: Overfill w/Glass Seal (+450 °C/+850 °F) — Available only with 10th digit N or D
P	Enlarged Coaxial, High Pressure: Overfill w/Glass Seal (+200 °C/+400 °F) — Available only with 10th digit N or D
T	Enlarged Coaxial, Overfill Standard O-Ring Seal (+200 °C/+400 °F) — Not available with 10th digit N or D

4 5 | PROCESS CONNECTION – SIZE/TYPE (consult factory for other process connections)

Threaded

4 1	2" NPT Thread ①
4 2	2" BSP (G 2") Thread ①

ASME Flanges

4 3	2"	150# ASME RF ①
4 4	2"	300# ASME RF ①
4 5	2"	600# ASME RF ①
4 K	2"	600# ASME RTJ ①
5 3	3"	150# ASME RF
5 4	3"	300# ASME RF
5 5	3"	600# ASME RF
56	3"	900# ASME RF
57	3"	1500# ASME RF
58	3"	2500# ASME RF
5K	3"	600# ASME RTJ
5L	3"	900# ASME RTJ
5M	3"	1500# ASME RTJ
5N	3"	2500# ASME RTJ
6 3	4"	150# ASME RF
6 4	4"	300# ASME RF
6 5	4"	600# ASME RF
6 6	4"	900# ASME RF
6 7	4"	1500# ASME RF
6 8	4"	2500# ASME RF
6K	4"	600# ASME RTJ
6L	4"	900# ASME RTJ
6M	4"	1500# ASME RTJ
6N	4"	2500# ASME RTJ

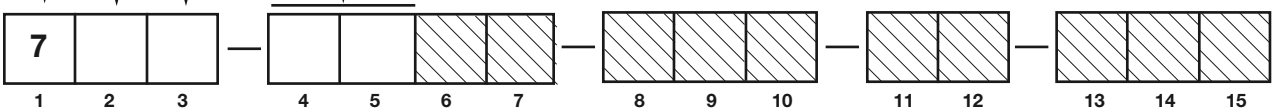
EN Flanges

D A	DN 50, PN 16	EN 1092-1 TYPE A ①
D B	DN 50, PN 25/40	EN 1092-1 TYPE A ①
D D	DN 50, PN 63	EN 1092-1 TYPE B2 ①
D E	DN 50, PN 100	EN 1092-1 TYPE B2 ①
E A	DN 80, PN 16	EN 1092-1 TYPE A
E B	DN 80, PN 25/40	EN 1092-1 TYPE A
E D	DN 80, PN 63	EN 1092-1 TYPE B2
E E	DN 80, PN 100	EN 1092-1 TYPE B2
E F	DN 80, PN 160	EN 1092-1 TYPE B2
E G	DN 80, PN 250	EN 1092-1 TYPE B2
E H	DN 80, PN 320	EN 1092-1 TYPE B2
E J	DN 80, PN 400	EN 1092-1 TYPE B2
F A	DN 100, PN 16	EN 1092-1 TYPE A
F B	DN 100, PN 25/40	EN 1092-1 TYPE A
F D	DN 100, PN 63	EN 1092-1 TYPE B2
F E	DN 100, PN 100	EN 1092-1 TYPE B2
F F	DN 100, PN 160	EN 1092-1 TYPE B2
F G	DN 100, PN 250	EN 1092-1 TYPE B2
F H	DN 100, PN 320	EN 1092-1 TYPE B2
F J	DN 100, PN 400	EN 1092-1 TYPE B2

Torque Tube Mating Flanges ②

T T	600# Fisher (249B/259B) in carbon steel
T U	600# Fisher (249C) in stainless steel
U T	600# Masoneilan flange in carbon steel
U U	600# Masoneilan flange in stainless steel

① Confirm mounting conditions/nozzle diameter to ensure sufficient clearance.
② Always check dimensions if ASME/EN flanges are not used.



6 | CONSTRUCTION CODES

0	Industrial
K	ASME B31.1
L	ASME B31.3
M	ASME B31.3 & NACE MR0175/MR0103 — NOT available with carbon steel flange
N	NACE MR0175/MR0103 — NOT available with carbon steel flange

7 | FLANGE OPTIONS — Offset flanges are available only with small coaxial probes

0	None

8 | MATERIAL OF CONSTRUCTION - FLANGE/NUT/ROD/INSULATION

A	316 SS/316L SS (Probe O.D. 45 mm (1.75"))
B	Hastelloy C (Probe O.D. 49 mm (1.93"))
C	Monel (Probe O.D. 49 mm (1.93"))
R	316 SS/316L SS with Carbon Steel Flange (Probe O.D. 45 mm (1.75"))
S	Hastelloy C with Carbon Steel Flange (Probe O.D. 49 mm (1.93"))
T	Monel with Carbon Steel Flange (Probe O.D. 49mm (1.93"))

9 | SPACER MATERIAL

1	TFE (+200 °C/+400 °F) — Available only with 3rd digit P or T — $\varepsilon_r \geq 1.4$
2	PEEK HT — Available only with 3rd digit D (+345 °C/+650 °F) — $\varepsilon_r \geq 1.4$
3	Ceramic (High Temp. >+425 °C/+800 °F) — Available only with 3rd digit D — $\varepsilon_r \geq 2.0$
4	Duratron® CU60 PBI (+425 °C/+800 °F) — Available only with 3rd digit D — $\varepsilon_r \geq 1.4$
5	None - with metal shorting rod — $\varepsilon_r \geq 1.4$ — Future

10 | O-RING MATERIALS/SEAL OPTIONS

0	Viton® GFLT — Available only with 3rd digit T
2	Kalrez® 4079 — Available only with 3rd digit T
8	Aegis PF 128 (NACE) — Available only with 3rd digit T
A	Kalrez 6375 — Available only with 3rd digit T
B	HF Acid Probe — Available only with 3rd digit T and 8th digit C
D	None/Glass Ceramic Alloy (dual-seal design with annunciator fitting)— Available only with 3rd digit D or P
N	None/Glass Ceramic Alloy — Available only with 3rd digit D, P or S

11 | PROBE SIZE/ELEMENT TYPE/FLUSHING CONNECTION

0	Standard Enlarged Coaxial Probe
1	Standard Enlarged Coaxial Probe with Flushing Port

12 | SPECIAL OPTIONS ①

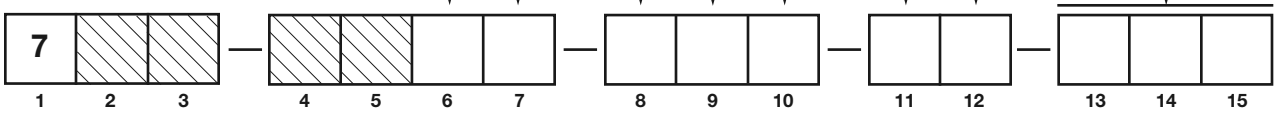
0	Single Length Probe (Non-Segmented)
1	1-piece Segmented Probe OD=64mm (2.5")
2	2-piece Segmented Probe OD=64mm (2.5")
3	3-piece Segmented Probe OD=64mm (2.5")
4	4-piece Segmented Probe OD=64mm (2.5")
5	5-piece Segmented Probe OD=64mm (2.5")
6	6-piece Segmented Probe OD=64mm (2.5")

① Refer to section 3.7.7.

13 14 15 | INSERTION LENGTH

X X X	cm (030 – 999) inches (012 – 396) ①

unit of measure determined by 2nd digit of model number



3.7.3 Smal Coaxial Probe

1 | TECHNOLOGY

7	ECLIPSE GWR Probes - Model 706

2 | MEASUREMENT SYSTEM

A	English (inches)
C	Metric (centimeters)

3 | CONFIGURATION/STYLE (RIGID)

D	Small Coaxial, High Temp/High Pressure: Overfill w/Glass Seal (+450 °C/+850 °F) — Available only with 10th digit N or D
P	Small Coaxial, High Pressure: Overfill w/Glass Seal (+200 °C/+400 °F) — Available only with 10th digit N or D
S	Coaxial, Saturated Steam (up to +425 °C/+800 °F) — Available only with 10th digit N, 9th digit 2, 3 or 5
T	Small Coaxial, Overfill Standard O-Ring Seal (+200 °C/+400 °F) — Available only with 10th digit N or D

4 5 | PROCESS CONNECTION – SIZE/TYPE (consult factory for other process connections)

Threaded

1 1	3/4" NPT Thread – Not available with 3rd Digit D
4 1	2" NPT Thread – Not available with 3rd Digit S

2 2	1" BSP (G 1") Thread – Not available with 3rd Digit D
4 2	2" BSP (G 2") Thread – Not available with 3rd Digit S

ASME Flanges

2 3	1" 150# ASME RF ① ③	3 8	1 1/2" 2500# ASME RF ③	5 3	3" 150# ASME RF	6 3	4" 150# ASME RF
2 4	1" 300# ASME RF ① ③	3 N	1 1/2" 2500# ASME RTJ ③	5 4	3" 300# ASME RF	6 4	4" 300# ASME RF
2 5	1" 600# ASME RF ① ③	4 3	2" 150# ASME RF	5 5	3" 600# ASME RF	6 5	4" 600# ASME RF
2 K	1" 600# ASME RTJ ① ③	4 4	2" 300# ASME RF	5 6	3" 900# ASME RF	6 6	4" 900# ASME RF
3 3	1 1/2" 150# ASME RF ③	4 5	2" 600# ASME RF	5 7	3" 1500# ASME RF	6 7	4" 1500# ASME RF
3 4	1 1/2" 300# ASME RF ③	4 7	2" 900/1500# ASME RF	5 8	3" 2500# ASME RF	6 8	4" 2500# ASME RF
3 5	1 1/2" 600# ASME RF ③	4 8	2" 2500# ASME RF	5 K	3" 600# ASME RTJ	6 K	4" 600# ASME RTJ
3 K	1 1/2" 600# ASME RTJ ③	4 K	2" 600# ASME RTJ	5 L	3" 900# ASME RTJ	6 L	4" 900# ASME RTJ
3 7	1 1/2" 900/1500# ASME RF③	4 M	2" 900/1500# ASME RTJ	5 M	3" 1500# ASME RTJ	6 M	4" 1500# ASME RTJ
3 M	1 1/2" 900/1500# ASME RTJ③	4 N	2" 2500# ASME RTJ	5 N	3" 2500# ASME RTJ	6 N	4" 2500# ASME RTJ

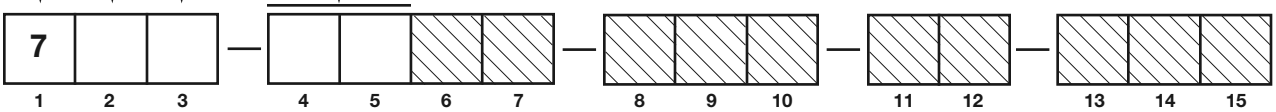
EN Flanges

B B	DN 25, PN 16/25/40	EN 1092-1 TYPE A ① ③	E A	DN 80, PN 16	EN 1092-1 TYPE A
B C	DN 25, PN 63/100	EN 1092-1 TYPE B2 ① ③	E B	DN 80, PN 25/40	EN 1092-1 TYPE A
C B	DN 40, PN 16/25/40	EN 1092-1 TYPE A ③	E D	DN 80, PN 63	EN 1092-1 TYPE B2
C C	DN 40, PN 63/100	EN 1092-1 TYPE B2 ③	E E	DN 80, PN 100	EN 1092-1 TYPE B2
C F	DN 40, PN 160	EN 1092-1 TYPE B2 ③	E F	DN 80, PN 160	EN 1092-1 TYPE B2
C G	DN 40, PN 250	EN 1092-1 TYPE B2 ③	E G	DN 80, PN 250	EN 1092-1 TYPE B2
C H	DN 40, PN 320	EN 1092-1 TYPE B2 ③	E H	DN 80, PN 320	EN 1092-1 TYPE B2
C J	DN 40, PN 400	EN 1092-1 TYPE B2 ③	E J	DN 80, PN 400	EN 1092-1 TYPE B2
D A	DN 50, PN 16	EN 1092-1 TYPE A	F A	DN 100, PN 16	EN 1092-1 TYPE A
D B	DN 50, PN 25/40	EN 1092-1 TYPE A	F B	DN 100, PN 25/40	EN 1092-1 TYPE A
D D	DN 50, PN 63	EN 1092-1 TYPE B2	F D	DN 100, PN 63	EN 1092-1 TYPE B2
D E	DN 50, PN 100	EN 1092-1 TYPE B2	F E	DN 100, PN 100	EN 1092-1 TYPE B2
D F	DN 50, PN 160	EN 1092-1 TYPE B2	F F	DN 100, PN 160	EN 1092-1 TYPE B2
D G	DN 50, PN 250	EN 1092-1 TYPE B2	F G	DN 100, PN 250	EN 1092-1 TYPE B2
D H	DN 50, PN 320	EN 1092-1 TYPE B2	F H	DN 100, PN 320	EN 1092-1 TYPE B2
D J	DN 50, PN 400	EN 1092-1 TYPE B2	F J	DN 100, PN 400	EN 1092-1 TYPE B2

Torque Tube Mating Flanges ②

T T	600# Fisher (249B/259B) in carbon steel
T U	600# Fisher (249C) in stainless steel
U T	600# Masoneilan flange in carbon steel
U U	600# Masoneilan flange in stainless steel

① Confirm mounting conditions/nozzle diameter to ensure sufficient clearance.
② Always check dimensions if ASME/EN flanges are not used.
③ NOT available with 3rd digit 'D' or 'P'



6 | CONSTRUCTION CODES

0	Industrial
K	ASME B31.1 — NOT available with 4th digits T or U
L	ASME B31.3
M	ASME B31.3 & NACE MR0175/MR0103 — NOT available with carbon steel flange
N	NACE MR0175/MR0103 — NOT available with carbon steel flange

7 | FLANGE OPTIONS — Offset flanges are available only with small coaxial probes

0	None
1	Offset (For use with AURORA) — Available only with 3rd digit P, S or T and 4th digit 6
2	Offset with 1/2” NPT Vent (For use with AURORA) — Available only with 3rd digit P, S or T and 4th digit 6
3	Offset with 3/4” NPT Vent (For use with AURORA) — Available only with 3rd digit P, S or T and 4th digit 6

8 | MATERIAL OF CONSTRUCTION - FLANGE/NUT/ROD/INSULATION

A	316 SS/316L SS
B	Hastelloy C
C	Monel — Not available with 3rd Digit S
R	316 SS/316L SS with Carbon Steel Flange
S	Hastelloy C with Carbon Steel Flange
T	Monel with Carbon Steel Flange — Not available with 3rd Digit S

9 | SPACER MATERIAL

1	TFE (+200 °C/+400 °F) — Available only with 3rd digit P or T — $\varepsilon_r \geq 1.4$
2	PEEK HT — Available only with 3rd digit D — $\varepsilon_r \geq 1.4$ (+345 °C/+650 °F) or S (+300 °C/+575 °F)
3	Ceramic (+425 °C/+650 °F) — Available only with 3rd digit D — $\varepsilon_r \geq 2.0$ or with 3rd digit S ①
5	None - Single bottom metal spacer — Available only with 3rd digit S ①

① Not available with 5th digit 1 or 2.

10 | O-RING MATERIALS/SEAL OPTIONS

0	Viton® GFLT — Available only with 3rd digit T
2	Kalrez® 4079 — Available only with 3rd digit T
8	Aegis PF 128 (NACE) — Available only with 3rd digit T
A	Kalrez 6375 — Available only with 3rd digit T
B	HF Acid Probe — Available only with 3rd digit T and 8th digit C
D	None/Glass Ceramic Alloy (dual-seal design with annunciator fitting)—Available only with 3rd digit D or P
N	None/Glass Ceramic Alloy — Available only with 3rd digit D, P or S

11 | PROBE SIZE/ELEMENT TYPE/FLUSHING CONNECTION

2	Small Coaxial (22 mm/0.875 inches)
A	Medium Coaxial (32 mm/ 1.62 inches) ②
B	Large Coaxial (42 mm/1.62 inches) ③

② 244 cm (96 inches) maximum length
③ 305 cm (120 inches) maximum length

12 | SPECIAL OPTIONS

0	Single Length Probe (Non-Segmented)

13 14 15 | INSERTION LENGTH

X X X	cm (030 – 610) inches (012 – 240)

unit of measure determined by 2nd digit of model number

1	2	3		4	5	6	7		8	9	10		11	12		13	14	15
7			—					—				—		0	—			

3.7.4 Caged Probe

1 | TECHNOLOGY

7	ECLIPSE GWR Probes - Model 706

2 | MEASUREMENT SYSTEM

A	English (inches)
C	Metric (centimeters)

3 | CONFIGURATION/STYLE (RIGID)

G	Overfill Caged Rigid Probe for use in chambers +200 °C (+400 °F)
J	Overfill Caged High Temp/High Pressure Probe with Glass Seal for use in chambers +450 °C (+850 °F)
L	Overfill Caged High Pressure Probe with Glass Seal for use in chambers +200 °C (+400 °F)

4 5 | PROCESS CONNECTION – SIZE/TYPE (consult factory for other process connections) ①

ASME Flanges

4 3	2"	150# ASME RF	5 4	3"	300# ASME RF	6 3	4"	150# ASME RF
4 4	2"	300# ASME RF	5 5	3"	600# ASME RF	6 4	4"	300# ASME RF
4 5	2"	600# ASME RF	5 6	3"	900# ASME RF	6 5	4"	600# ASME RF
4 7	2"	900/1500# ASME RF	5 7	3"	1500# ASME RF	6 6	4"	900# ASME RF
4 8	2"	2500# ASME RF	5 8	3"	2500# ASME RF	6 7	4"	1500# ASME RF
4 K	2"	600# ASME RTJ	5 K	3"	600# ASME RTJ	6 8	4"	2500# ASME RF
4 M	2"	900/1500# ASME RTJ	5 L	3"	900# ASME RTJ	6 K	4"	600# ASME RTJ
4 N	2"	2500# ASME RTJ	5 M	3"	1500# ASME RTJ	6 L	4"	900# ASME RTJ
5 3	3"	150# ASME RF	5 N	3"	2500# ASME RTJ	6 M	4"	1500# ASME RTJ
						6 N	4"	2500# ASME RTJ

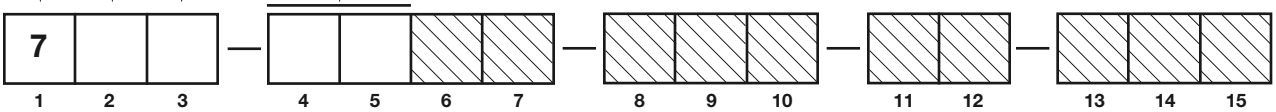
EN Flanges

D A	DN 50, PN 16	EN 1092-1 TYPE A	E F	DN 80, PN 160	EN 1092-1 TYPE B2
D B	DN 50, PN 25/40	EN 1092-1 TYPE A	E G	DN 80, PN 250	EN 1092-1 TYPE B2
D D	DN 50, PN 63	EN 1092-1 TYPE B2	E H	DN 80, PN 320	EN 1092-1 TYPE B2
D E	DN 50, PN 100	EN 1092-1 TYPE B2	E J	DN 80, PN 400	EN 1092-1 TYPE B2
D F	DN 50, PN 160	EN 1092-1 TYPE B2	F A	DN 100, PN 16	EN 1092-1 TYPE A
D G	DN 50, PN 250	EN 1092-1 TYPE B2	F B	DN 100, PN 25/40	EN 1092-1 TYPE A
D H	DN 50, PN 320	EN 1092-1 TYPE B2	F D	DN 100, PN 63	EN 1092-1 TYPE B2
D J	DN 50, PN 400	EN 1092-1 TYPE B2	F E	DN 100, PN 100	EN 1092-1 TYPE B2
E A	DN 80, PN 16	EN 1092-1 TYPE A	F F	DN 100, PN 160	EN 1092-1 TYPE B2
E B	DN 80, PN 25/40	EN 1092-1 TYPE A	F G	DN 100, PN 250	EN 1092-1 TYPE B2
E D	DN 80, PN 63	EN 1092-1 TYPE B2	F H	DN 100, PN 320	EN 1092-1 TYPE B2
E E	DN 80, PN 100	EN 1092-1 TYPE B2	F J	DN 100, PN 400	EN 1092-1 TYPE B2

Torque Tube Mating Flanges ②

T T	600# Fisher (249B/259B) in carbon steel
T U	600# Fisher (249C) in stainless steel
U T	600# Masoneilan flange in carbon steel
U U	600# Masoneilan flange in stainless steel

① Confirm mounting conditions/nozzle diameter to ensure sufficient clearance.
② Always check dimensions if ASME/EN flanges are not used.



6 | CONSTRUCTION CODES

0	Industrial
K	ASME B31.1
L	ASME B31.3
M	ASME B31.3 & NACE MR0175/MR0103 — NOT available with carbon steel flange
N	NACE MR0175/MR0103 — NOT available with carbon steel flange

7 | FLANGE OPTIONS

0	None
1	Offset (For use with AURORA) — Available only with 3rd digit G and J and 4th digit 6
2	Offset with 1/2" NPT Vent (For use with AURORA) — Available only with 3rd digit G and J and 4th digit 6
3	Offset with 3/4" NPT Vent (For use with AURORA) — Available only with 3rd digit G and J and 4th digit 6

8 | MATERIAL OF CONSTRUCTION - MFG/NUT/ROD/INSULATION

A	316 SS/316L SS
B	Hastelloy C
C	Monel
R	316 SS/316L SS with Carbon Steel Flange
S	Hastelloy C with Carbon Steel Flange
T	Monel with Carbon Steel Flange

9 | SPACER MATERIAL

2	PEEK HT (+345 °C/+650 °F)
3	Ceramic (High Temp.>+425 °C/+800 °F) — Available only with 3rd digit J
4	Duratron® CU60 PBI (+425 °C/+800 °F) — Available only with 3rd digit J

10 | O-RING MATERIALS/SEAL OPTIONS

0	Viton® GFLT — Not available with 3rd digit J or L
2	Kalrez 4079 — Not available with 3rd digit J or L
8	Aegis PF 128 (NACE) — Not available with 3rd digit J or L
A	Kalrez 6375 — Not available with 3rd digit J or L
B	HF Acid Probe — Available only with 3rd digit G and 8th digit C
D	None/Glass Ceramic Alloy (Dual Seal Design with annunciator fitting) — Not available with 3rd digit G
N	None/Glass Ceramic Alloy —Not available with 3rd digit G

11 | PROBE SIZE/ELEMENT TYPE/FLUSHING CONNECTION

0	None

12 | SPECIAL OPTIONS ①

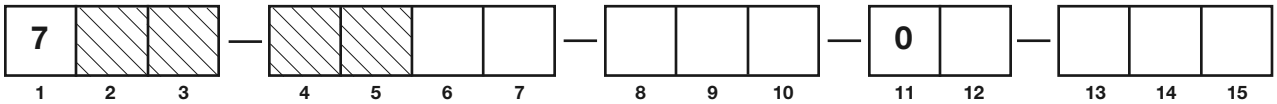
1	Single Length Removable Probe
2	2-piece Segmented Probe
3	3-piece Segmented Probe
4	4-piece Segmented Probe

① Refer to section 3.7.7.

13 14 15 | INSERTION LENGTH

X X X	cm (030 – 732) inches (012 – 288) ①

unit of measure determined by 2nd digit of model number



3.7.5 Single Rod Rigid Probe

1 | TECHNOLOGY

7	ECLIPSE GWR Probes - Model 706

2 | MEASUREMENT SYSTEM

A	English (inches)
C	Metric (centimeters)

3 | CONFIGURATION/STYLE (RIGID)

F	Single Rod, Standard (200 °C/+400 °F) for in-tank applications — NOT available with 10th digit N or D
M	Single Rod, High Pressure Probe with glass seal (+200 °C/+400 °F), for in-tank applications — Available only with 10 th Digit N or D
N	Single Rod, High Temp/High Pressure with glass seal (+450 °C/+850 °F), for in-tank applications — Available only with 10 th Digit N or D

4 5 | PROCESS CONNECTION – SIZE/TYPE (consult factory for other process connections) ①

Threaded

1 1	3/4" NPT Thread ②
2 1	1" NPT Thread ②
4 1	2" NPT Thread

2 2	1" BSP (G 1") Thread ②
4 2	2" BSP (G 2") Thread

ASME Flanges

3 3	1 1/2" 150# ASME RF①③
3 4	1 1/2" 300# ASME RF①③
3 5	1 1/2" 600# ASME RF①③
3 7	1 1/2" 900/1500# ASME RF④
3 K	1 1/2" 600# ASME RTJ ④
3 M	1 1/2" 900/1500# ASME RTJ④
4 3	2" 150# ASME RF ①
4 4	2" 300# ASME RF ①
4 5	2" 600# ASME RF ①
4 7	2" 900/1500# ASME RF④
4 8	2" 2500# ASME RF ④
4 K	2" 600# ASME RTJ ④
4 M	2" 900/1500# ASME RTJ ④

4 N	2" 2500# ASME RTJ ④
5 3	3" 150# ASME RF
5 4	3" 300# ASME RF
5 5	3" 600# ASME RF
5 6	3" 900# ASME RF ④
5 7	3" 1500# ASME RF ④
5 8	3" 2500# ASME RF ④
5 K	3" 600# ASME RTJ ④
5 L	3" 900# ASME RTJ ④
5 M	3" 1500# ASME RTJ ④

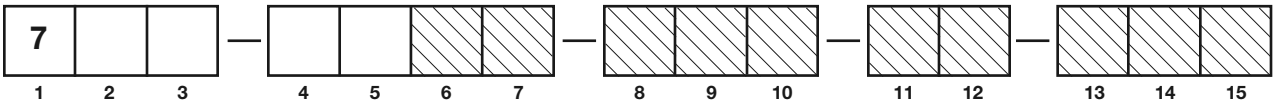
5 N	3" 2500# ASME RTJ ④
6 3	4" 150# ASME RF
6 4	4" 300# ASME RF
6 5	4" 600# ASME RF
6 6	4" 900# ASME RF ④
6 7	4" 1500# ASME RF ④
6 8	4" 2500# ASME RF ④
6 K	4" 600# ASME RTJ ④
6 L	4" 900# ASME RTJ ④
6 M	4" 1500# ASME RTJ ④
6 N	4" 2500# ASME RTJ ④

EN Flanges

C B	DN 40, PN 16/25/40	EN 1092-1 TYPE A ①③
C C	DN 40, PN 63/100	EN 1092-1 TYPE B2 ①③
C F	DN 40, PN 160	EN 1092-1 TYPE B2 ①③④
C G	DN 40, PN 250	EN 1092-1 TYPE B2 ①③④
D A	DN 50, PN 16	EN 1092-1 TYPE A ①
D B	DN 50, PN 25/40	EN 1092-1 TYPE A ①
D D	DN 50, PN 63	EN 1092-1 TYPE B2 ①
D E	DN 50, PN 100	EN 1092-1 TYPE B2 ①
D F	DN 50, PN 160	EN 1092-1 TYPE B2 ④
D G	DN 50, PN 250	EN 1092-1 TYPE B2 ④
D H	DN 50, PN 320	EN 1092-1 TYPE B2 ④
D J	DN 50, PN 400	EN 1092-1 TYPE B2 ④
E A	DN 80, PN 16	EN 1092-1 TYPE A ①
E B	DN 80, PN 25/40	EN 1092-1 TYPE A

E D	DN 80, PN 63	EN 1092-1 TYPE B2
E E	DN 80, PN 100	EN 1092-1 TYPE B2
E F	DN 80, PN 160	EN 1092-1 TYPE B2 ④
E G	DN 80, PN 250	EN 1092-1 TYPE B2 ④
E H	DN 80, PN 320	EN 1092-1 TYPE B2 ④
E J	DN 80, PN 400	EN 1092-1 TYPE B2 ④
F A	DN 100, PN 16	EN 1092-1 TYPE A
F B	DN 100, PN 25/40	EN 1092-1 TYPE A
F D	DN 100, PN 63	EN 1092-1 TYPE B2
F E	DN 100, PN 100	EN 1092-1 TYPE B2
F F	DN 100, PN 160	EN 1092-1 TYPE B2 ④
F G	DN 100, PN 250	EN 1092-1 TYPE B2 ④
F H	DN 100, PN 320	EN 1092-1 TYPE B2 ④
F J	DN 100, PN 400	EN 1092-1 TYPE B2 ④

① Confirm mounting conditions/nozzle diameter to ensure sufficient clearance.
② Not available with 3rd Digit N or 8th Digit P
③ Not available with 3rd digit 'M' or 'N'
④ Not available with 3rd digit 'F'



6 | CONSTRUCTION CODES

0	Industrial
K	ASME B31.1
L	ASME B31.3
M	ASME B31.3 & NACE MR0175/MR0103 — NOT available with carbon steel flange
N	NACE MR0175/MR0103 — NOT available with carbon steel flange

7 | FLANGE OPTIONS

0	None

8 | MATERIAL OF CONSTRUCTION - MFG/NUT/ROD/INSULATION

A	316 SS/316L SS
B	Hastelloy C
C	Monel
F	Faced Flange, PFA coated wetted surfaces — Available only with Digit 3rd digit F
P	PFA coated rod — Available only with Digit 3rd digit F
R	316 SS/316L SS with Carbon Steel Flange
S	Hastelloy C with Carbon Steel Flange
T	Monel with Carbon Steel Flange

9 | SPACER MATERIAL

0	None – Not available with 3rd Digit N
2	PEEK HT (+345 °C/+650 °F) — Available only with 3rd digit N
3	Ceramic (High Temp.>+425 °C/+800 °F) — Available only with 3rd digit N
4	Duratron® CU60 PBI (+425 °C/+800 °F) — Available only with 3rd digit N

10 | O-RING MATERIALS/SEAL OPTIONS

0	Viton® GFLT — Not available with 3rd digit M or N
2	Kalrez 4079 — Not available with 3rd digit M or N
8	Aegis PF 128 (NACE) — Not available with 3rd digit M or N
A	Kalrez 6375 — Not available with 3rd digit M or N
D	None/Glass Ceramic Alloy Dual Seal with annunciator fitting — Not available with 3rd digit F
N	None/Glass Ceramic Alloy Dual Seal — Not available with 3rd digit F

11 | PROBE SIZE/ELEMENT TYPE/FLUSHING CONNECTION

0	Standard Single Rod

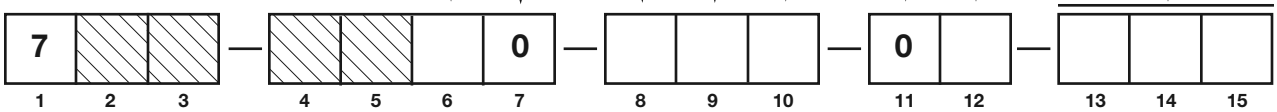
12 | SPECIAL OPTIONS

0	Non-Removable Rod — Available only with PFA Coated Probes(8th digit F or P)
1	Removable Rod — Not available with PFA Coated Probes(8th Digit F or P)
2	Two-piece segmented probe
3	Three-piece segmented probe
4	Four-piece segmented probe
5	Five-piece segmented probe
6	Six-piece segmented probe

13 14 15 | INSERTION LENGTH

X X X	cm (030 – 732) inches (012 – 288) maximum 610 cm (240 inches) when 8th digit = F or P

Unit of measure determined by 2nd digit of model number.



3.7.6 Single Rod Flexible Probe

1 | TECHNOLOGY

7	ECLIPSE GWR Probes - Model 706

2 | MEASUREMENT SYSTEM

A	English (inches)
C	Metric (centimeters)

3 | SPECIALTY FLEXIBLE PROBES

1	Single Cable Flexible standard for in-tank applications (+200 °C/+400 °F)
2	Single Cable Flexible Light Duty Bulk Solids
3	Single Cable Flexible HP for in-tank applications (+200 °C/+400 °F)
6	Single Cable Flexible HTHP for chamber applications (+450 °C/+850 °F)

4 5 | PROCESS CONNECTION – SIZE/TYPE (consult factory for other process connections)

Threaded

4 1	2" NPT Thread (not available with the 7y6)

4 2	2" BSP (G 2") Thread (not available with the 7y6)

ASME Flanges

4 3	2" 150# ASME RF ①
4 4	2" 300# ASME RF ①
4 5	2" 600# ASME RF ①
4 7	2" 900/1500# ASME RF
4 8	2" 2500# ASME RF
4 K	2" 600# ASME RTJ
4 M	2" 900/1500# ASME RTJ
4 N	2" 2500# ASME RTJ

5 3	3" 150# ASME RF
5 4	3" 300# ASME RF
5 5	3" 600# ASME RF
5 6	3" 900# ASME RF
5 7	3" 1500# ASME RF
5 8	3" 2500# ASME RF
5 K	3" 600# ASME RTJ
5 L	3" 900# ASME RTJ
5 M	3" 1500# ASME RTJ
5 N	3" 2500# ASME RTJ

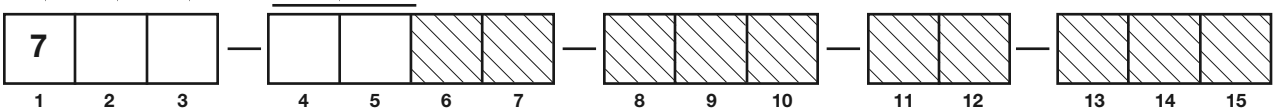
6 3	4" 150# ASME RF
6 4	4" 300# ASME RF
6 5	4" 600# ASME RF
6 6	4" 900# ASME RF ②
6 7	4" 1500# ASME RF ②
6 8	4" 2500# ASME RF ②
6 K	4" 600# ASME RTJ ②
6 L	4" 900# ASME RTJ ②
6 M	4" 1500# ASME RTJ ②
6 N	4" 2500# ASME RTJ ②

EN Flanges

D A	DN 50, PN 16	EN 1092-1 TYPE A ①
D B	DN 50, PN 25/40	EN 1092-1 TYPE A ①
D D	DN 50, PN 63	EN 1092-1 TYPE B2 ①
D E	DN 50, PN 100	EN 1092-1 TYPE B2 ①
D F	DN 50, PN 160	EN 1092-1 TYPE B2 ②
D G	DN 50, PN 250	EN 1092-1 TYPE B2 ②
D H	DN 50, PN 320	EN 1092-1 TYPE B2 ②
D J	DN 50, PN 400	EN 1092-1 TYPE B2 ②
E A	DN 80, PN 16	EN 1092-1 TYPE A ①
E B	DN 80, PN 25/40	EN 1092-1 TYPE A
E D	DN 80, PN 63	EN 1092-1 TYPE B2
E E	DN 80, PN 100	EN 1092-1 TYPE B2

E F	DN 80, PN 160	EN 1092-1 TYPE B2 ②
E G	DN 80, PN 250	EN 1092-1 TYPE B2 ②
E H	DN 80, PN 320	EN 1092-1 TYPE B2 ②
E J	DN 80, PN 400	EN 1092-1 TYPE B2 ②
F A	DN 100, PN 16	EN 1092-1 TYPE A
F B	DN 100, PN 25/40	EN 1092-1 TYPE A
F D	DN 100, PN 63	EN 1092-1 TYPE B2
F E	DN 100, PN 100	EN 1092-1 TYPE B2
F F	DN 100, PN 160	EN 1092-1 TYPE B2 ②
F G	DN 100, PN 250	EN 1092-1 TYPE B2 ②
F H	DN 100, PN 320	EN 1092-1 TYPE B2 ②
F J	DN 100, PN 400	EN 1092-1 TYPE B2 ②

① Confirm mounting conditions/nozzle diameter to ensure sufficient clearance.
② Available only with 3rd Digit 3 or 6



6 | CONSTRUCTION CODES

0	Industrial

7 | FLANGE OPTIONS

0	None

8 | MATERIAL OF CONSTRUCTION - MFG/NUT/ROD/INSULATION

A	316 SS/316L SS
F	Faced Flange, PFA Coated Wetted Surfaces — Available only with 3rd digit 1
P	PFA Coated 316/316L SS Cable — Available only with 3rd digit 1
R	316 SS/316L SS with Carbon Steel Flange

9 | SPACER/WEIGHT OPTIONS

0	No Spacer — Not available with 3rd digit 3
1	PTFE Spacer — Available only with 3rd digit 3
4	Duratron® CU60 PBI Spacer — Available only with 3rd digit 6
5	Metal Weight — Available only with 3rd digit 3

10 | O-RING MATERIALS/SEAL OPTIONS

0	Viton® GFLT
2	Kalrez 4079
8	Aegis PF 128 (NACE)
A	Kalrez 6375
D	Glass Ceramic Alloy Dual Seal with annunciator fitting — Available only with 3rd digit 3 or 6
N	None/Glass Ceramic Alloy Dual Seal — Available only with 3rd digit 3 or 6

11 | PROBE SIZE/ELEMENT TYPE/FLUSHING CONNECTION

3	Flexible Cable Probe

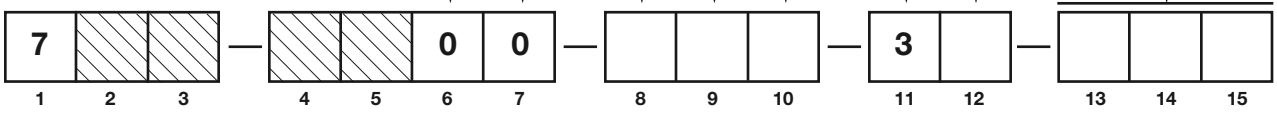
12 | SPECIAL OPTIONS

0	Non-removable Probe Cable — Available only with 3rd digit 2 or 8th digit F
1	Removable Single-piece Probe Cable — Available only with 3rd digit 1, 3, 6 and 8th digit NOT F

13 14 15 | INSERTION LENGTH

X X X	meters (001 – 030) feet (003 – 100)

unit of measure determined by 2nd digit of model number



3.7.7 Segmented Probe Options

12th Digit of Model Number

Probe Model	Single length	One Segment	Two Segments	Three Segments	Four Segments	Five Segments	Six Segments
Coaxial Models 7yD, 7yP and 7yT (Enlarged versions only) (3", DN 80 Process Connections and larger)	30 – 610 cm (12 – 240")	60 – 182 cm (24 – 72")	120 – 365 cm (48 – 144")	180 – 548 cm (72 – 216")	240 – 731 cm (96 – 288")	305 – 914 cm (120 – 360")	365 – 999 cm (144 – 396")
Caged Models 7yG, 7yL and 7yJ	Not Available	30 – 305 cm (12 – 120")	60 – 610 cm (24 – 240")	90 – 732 cm (36 – 288")	120 – 732 cm (48 – 288")	Not Available	Not Available

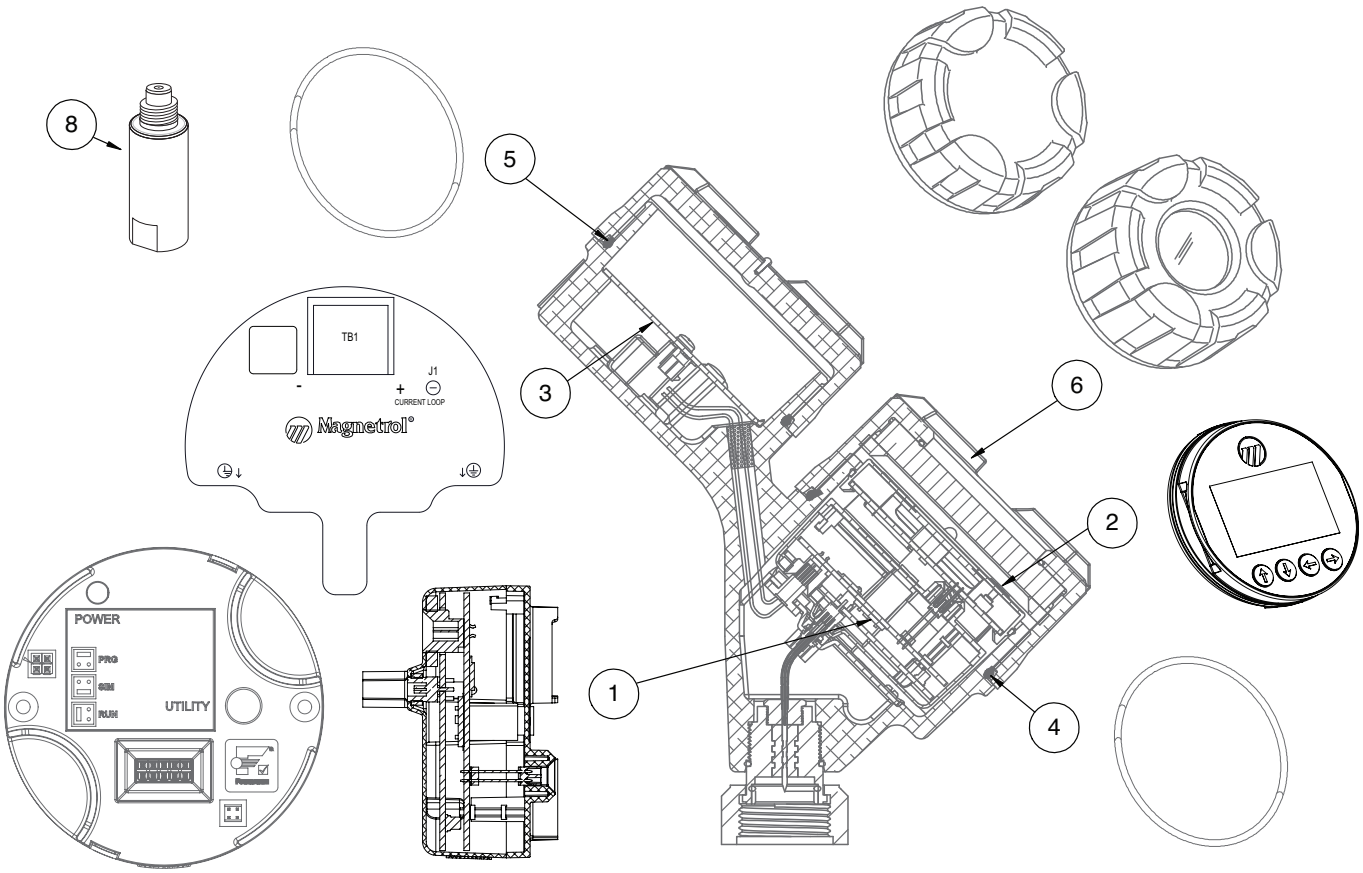
NOTE: Segments will be evenly divided over the length of the probe.

3.8 Parts

3.8.1 Replacement Parts

EXPEDITE SHIP PLAN (ESP)

Several parts are available for quick shipment, within max. 1 week after factory receipt of purchase order, through the Expedite Ship Plan (ESP).
Parts covered by ESP service are conveniently grey coded in the selection tables.



Electronics:

Partn°: 7 0 6 — 5 _ _ _ — _ _ _

Digit in partn°: X 1 2 3 — 4 5 6 7 — 8 9 10

X = product with a specific customer requirement

Serial n°: _ _ _ _ _ _ — _ _ — _ _ _

See nameplate, always provide complete partn° and serial n° when ordering spares.

(1) Electronic module		
Digit 5	**Digit 6**	**Replacement part**
1	1, 2	Z31-2849-001
2	0	Z31-2849-002
3	0	Z31-2858-001
4	0	Z31-2849-001

(3) Wiring PC board		
Digit 5	**Digit 6**	**Replacement part**
1	1, 2	Z30-9165-001
2, 3	0	Z30-9166-002
4	0	Z31-2859-001

(6) Housing cover			
Digit 7	**Digit 8**	**Digit 9**	**Replacement part**
0, 1, 2	all	1, A	004-9225-002
		2, B	004-9225-003
A, B, C	0, 1, A	1, A	036-4413-005
	3, B, C, D		036-4413-001
	all	2, B	036-4413-002

(2) Display module	
Digit 7	**Replacement part**
0, 1, 2	not applicable
A, B, C	Z31-2850-001

	Replacement part
(4) "O"-ring	012-2201-237
(5) "O"-ring	012-2201-237

(7) Housing cover	
Digit 9	**Replacement part**
1, A	004-9225-002
2, B	004-9225-003

(8) 705/706 Adapter	
Digit 9	**Replacement part**
1, 2	not applicable
A, B	032-6923-001

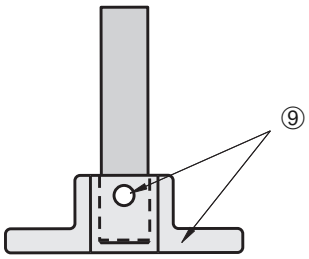
Probe:

Partn°:

Digit in partn°: X 1 2 3 – 4 5 6 7 – 8 9 10 – 11 12 – 13 14 15

X = product with a specific customer requirement

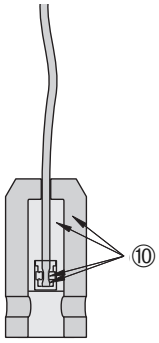
Bottom spacer for single rod GWR probe



7yF, 7yM or 7yN single rod

(9) Bottom spacer + pin kit			
Digit 3	**Digit 8**	**Digit 9**	**Replacement part**
F, M	A, R, U	0	089-9114-008
	B, S		089-9114-009
	C, T		089-9114-010
N	A, R, U	2	089-9114-005
	B, S		089-9114-006
	C, T		089-9114-007

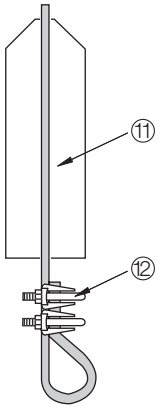
Cable weight for flexible GWR probe



7y1, 7y3 single cable

(10) Cable weight assembly				
Digit 3	**Digit 4**	**Digit 8**	**Digit 9**	**Replacement part**
1	2, 3	A, J	0	consult factory
	4, 5, 6, D, E, F	A, R, U		089-9120-001
	4, 5, 6, D, E, F	F, J		consult factory
3	all	all	1	consult factory

(11) Cable weight			
Digit 3	**Digit 8**	**Digit 9**	**Replacement part**
2	A, R	0	004-8778-001
3	all	5	consult factory



7y2, 7y3 single cable

(12) Cable clamp			
Digit 3	**Digit 8**	**Digit 9**	**Replacement part**
2	A, R	0	010-1731-001 (ordering quantity: 2)
3	A, R, U	5	
3	J	5	consult factory

4.0 Advanced Configuration/ Troubleshooting Techniques

This section contains information regarding some of the advanced configuration and troubleshooting capability contained within the Model 706 transmitter. These diagnostic options are best suited for use with PACTware and the Model 706 DTM, and should be implemented only after contacting Magnetrol Technical Support.

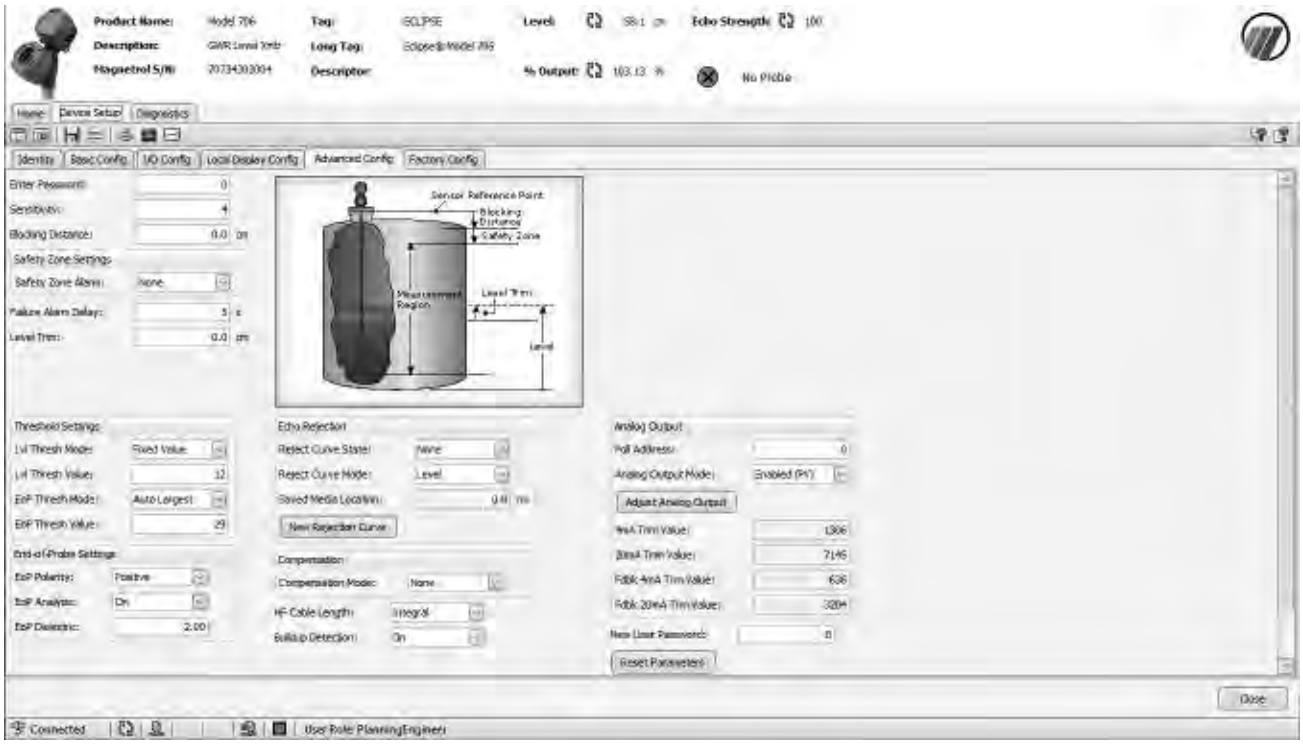
4.1 End-of-Probe Analysis (EOPA)

Please note that due to the operation of this method, End of Probe Analysis cannot be applied with interface measurement, applications with a "water" bottoms, or with stratifying liquids. Therefore, EOPA will not be available when Measurement Type = Interface & Level.

When EOPA is enabled and the calculated (inferred level) is being used, a diagnostic warning shown as "Inferred Level" will be present.

4.1.1 Enable EOPA using PACT*ware*

Click on the Device Setup tab, and then select Advanced Config. In the lower left corner select the correct Polarity for the End of Probe pulse, then turn on the EoP Analysis. The Eop Dielectric box will then appear. Fill in the correct Dielectric of the process medium being measured.



4.1.2 Enable EOPA using keypad/LCD

From the MAIN MENU, select DEVICE SETUP and press Enter.

Scroll down to Advanced Config, and then press Enter.

Scroll down to END of PROBE ANALYSIS, and then press Enter.

Enter the correct polarity for EoP Polarity, turn on EoP Analysis, and then enter the correct value for EoP Dielectric. EoP Dielectric is the dielectric constant of the process medium being measured.

4.2 Sloped Threshold

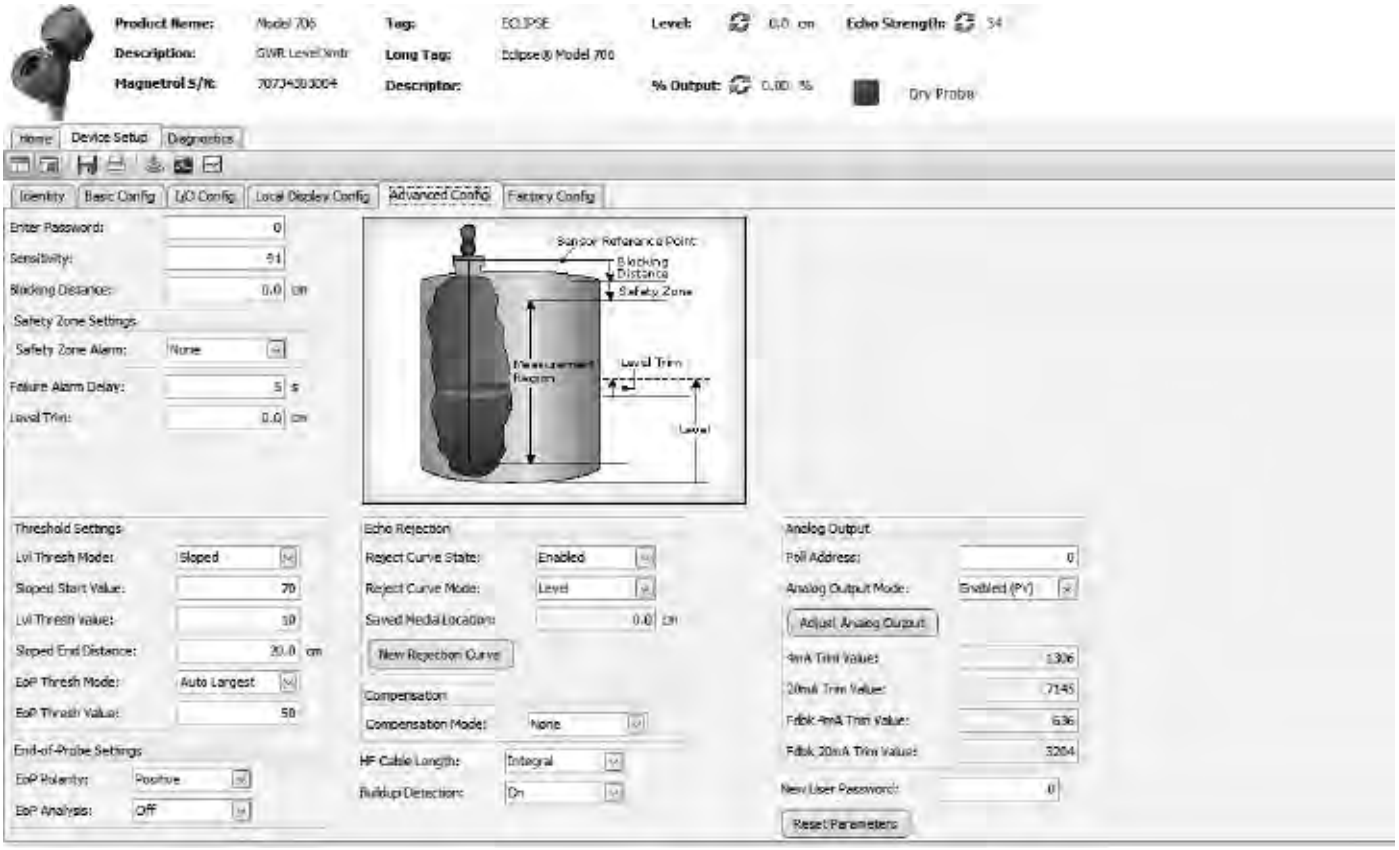
The Sloped Threshold option contained in the Model 706 allows the user additional level detection capability by allowing the threshold to be sloped (bent) around an unwanted signal. The result is a convenient way to ignore undesired signals.

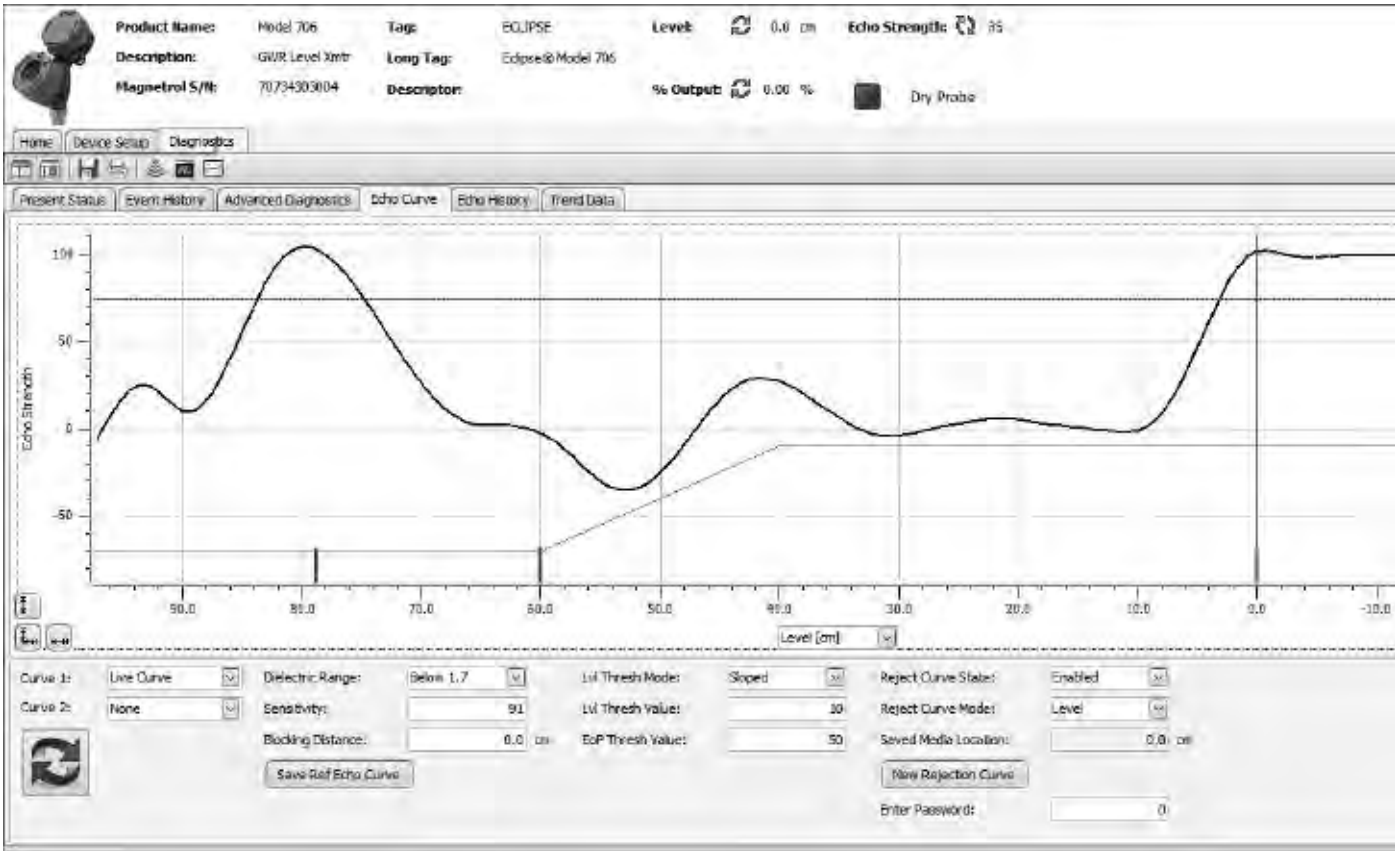
The use of PACTware and the Model 706 DTM is recommended for this option.

Using PACTWare, click on the Device Setup tab, and then select Advanced Config.

In the Threshold Settings section, select “Sloped” within in the Lvl Tresh Mode dropdown box.

Then set the Sloped Start Value, Lvl Tresh Value, and Sloped End Distance.


Product Name: Model 706
Description: GWR Level Xmtr
Magnetrol S/N: 70734303004
Tag: ECLIPSE
Long Tag: Eclipse® Model 706
Descriptor:
Level: 0.0 cm
% Output: 0.00 %
Echo Strength: 34
Dry Probe
Home
Device Setup
Diagnostics
Identity
Basic Config
I/O Config
Local Display Config
Advanced Config
Factory Config
Enter Password:
Sensitivity:
Blocking Distance:
Safety Zone Settings
Safety Zone Alarm:
Failure Alarm Delay:
Level Trim:
Sensor Reference Point
Blocking Distance
Safety Zone
Measurement Region
Level Trim
Level
Threshold Settings
Lvl Thresh Mode:
Sloped Start Value:
Lvl Thresh Value:
Sloped End Distance:
EoP Thresh Mode:
EoP Thresh Value:
End-of-Probe Settings
EoP Polarity:
EoP Analysis:
Echo Rejection
Reject Curve State:
Reject Curve Mode:
Saved Media Location:
New Rejection Curve
Compensation
Compensation Mode:
HF Cable Length:
Buildup Detection:
Analog Output
Poll Address:
Analog Output Mode:
Adjust Analog Output
4mA Trim Value:
20mA Trim Value:
Fdbk 4mA Trim Value:
Fdbk 20mA Trim Value:
New User Password:
Reset Parameters

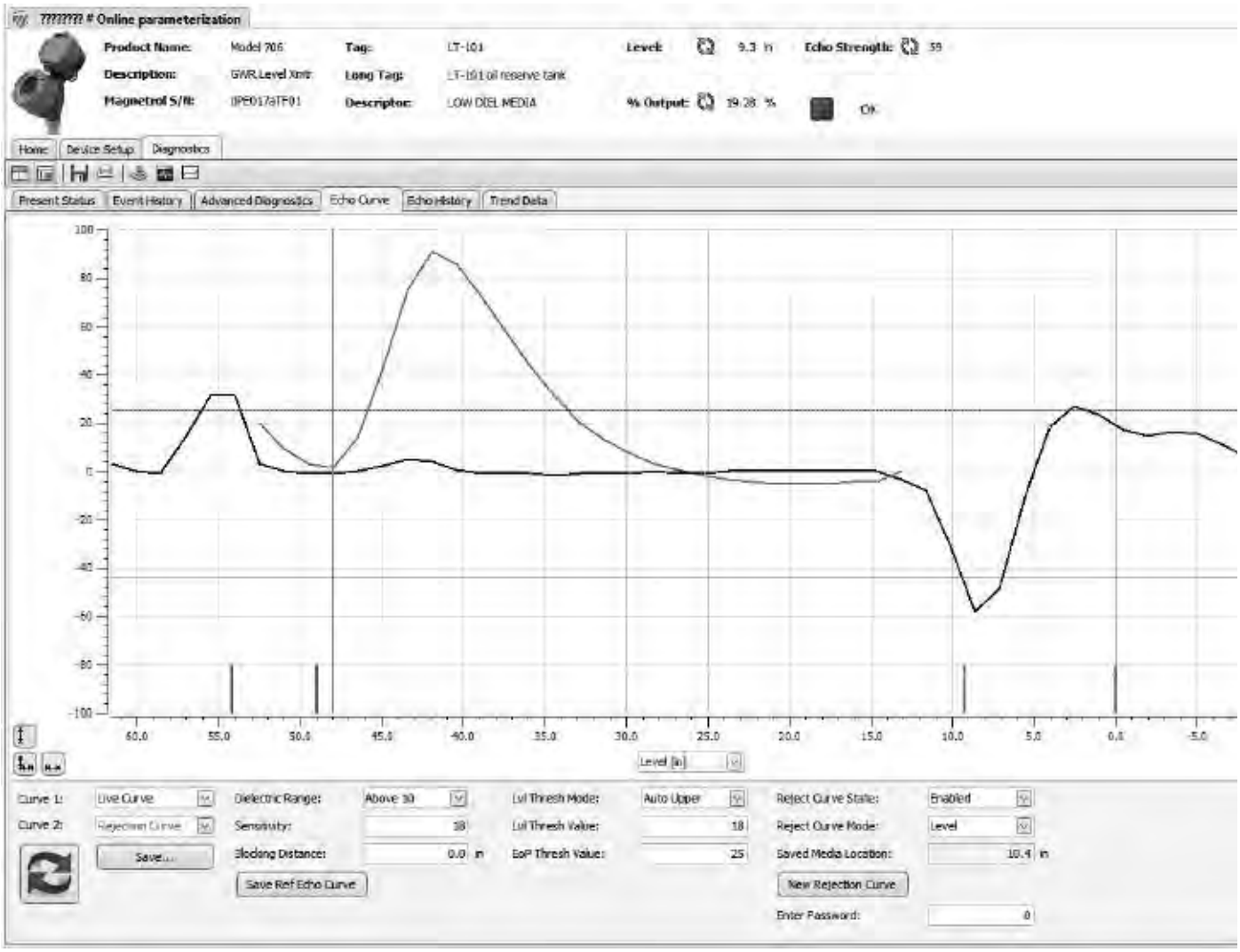

Product Name: Model 706
Description: GWR Level Xmtr
Magnetrol S/N: 70734303004
Tag: ECLIPSE
Long Tag: Eclipse® Model 706
Descriptor:
Level: 0.0 cm
% Output: 0.00 %
Echo Strength: 35
Dry Probe
Home
Device Setup
Diagnostics
Present Status
Event History
Advanced Diagnostics
Echo Curve
Echo History
Trend Data
Echo Strength
Level [cm]
Curve 1:
Curve 2:
Dielectric Range:
Sensitivity:
Blocking Distance:
Save Ref Echo Curve
Lvl Thresh Mode:
Lvl Thresh Value:
EoP Thresh Value:
Reject Curve State:
Reject Curve Mode:
Saved Media Location:
New Rejection Curve
Enter Password:

4.3 Echo Rejection

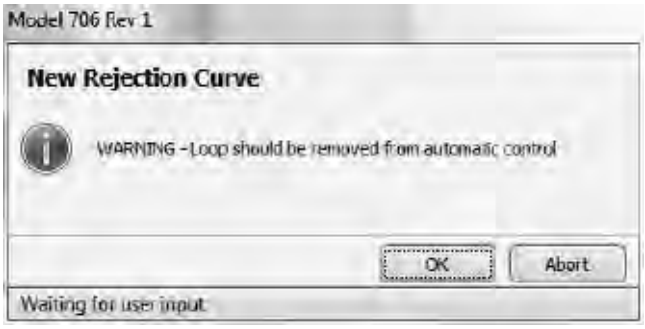
Another way to ignore unwanted signals along the length of the probe is by utilizing the Echo Rejection feature.

Setup using Pactware

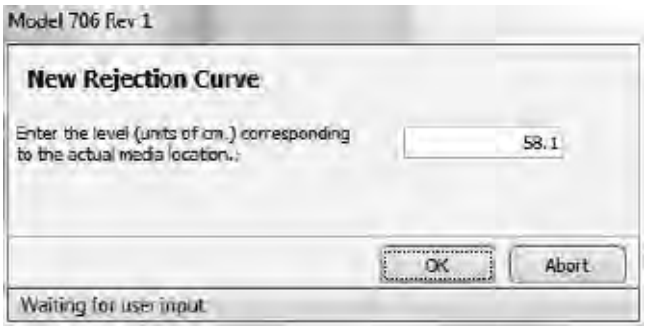
Select the Diagnostics tab and then the Echo Curve tab. Then click on New Rejection Curve



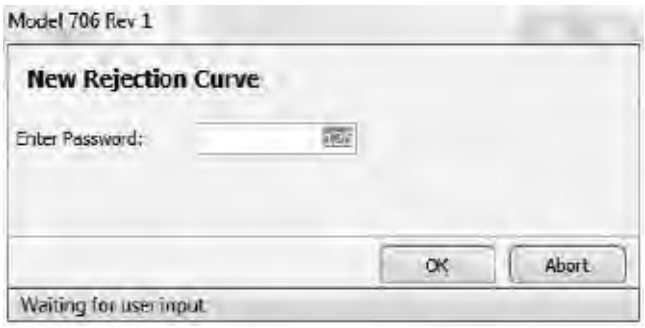
Click on OK at the loop warning message.

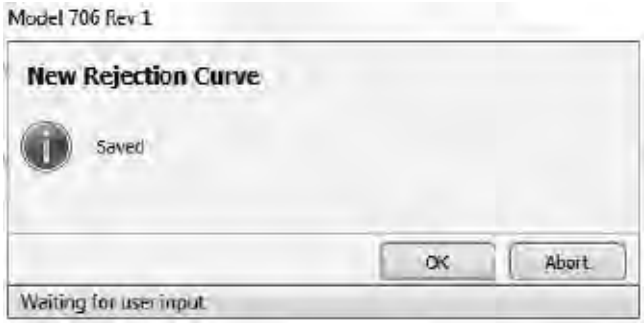


On the next screen, please enter the actual process media location and then hit OK.

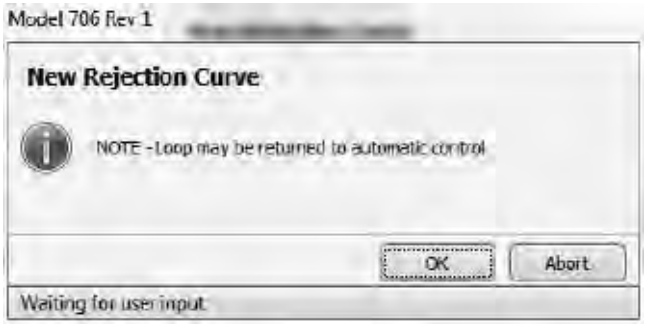


A password window will then appear (unless the password was previously entered). Enter the password and hit OK. Then the system calculates the curve, and then saves it. Hit OK to confirm.





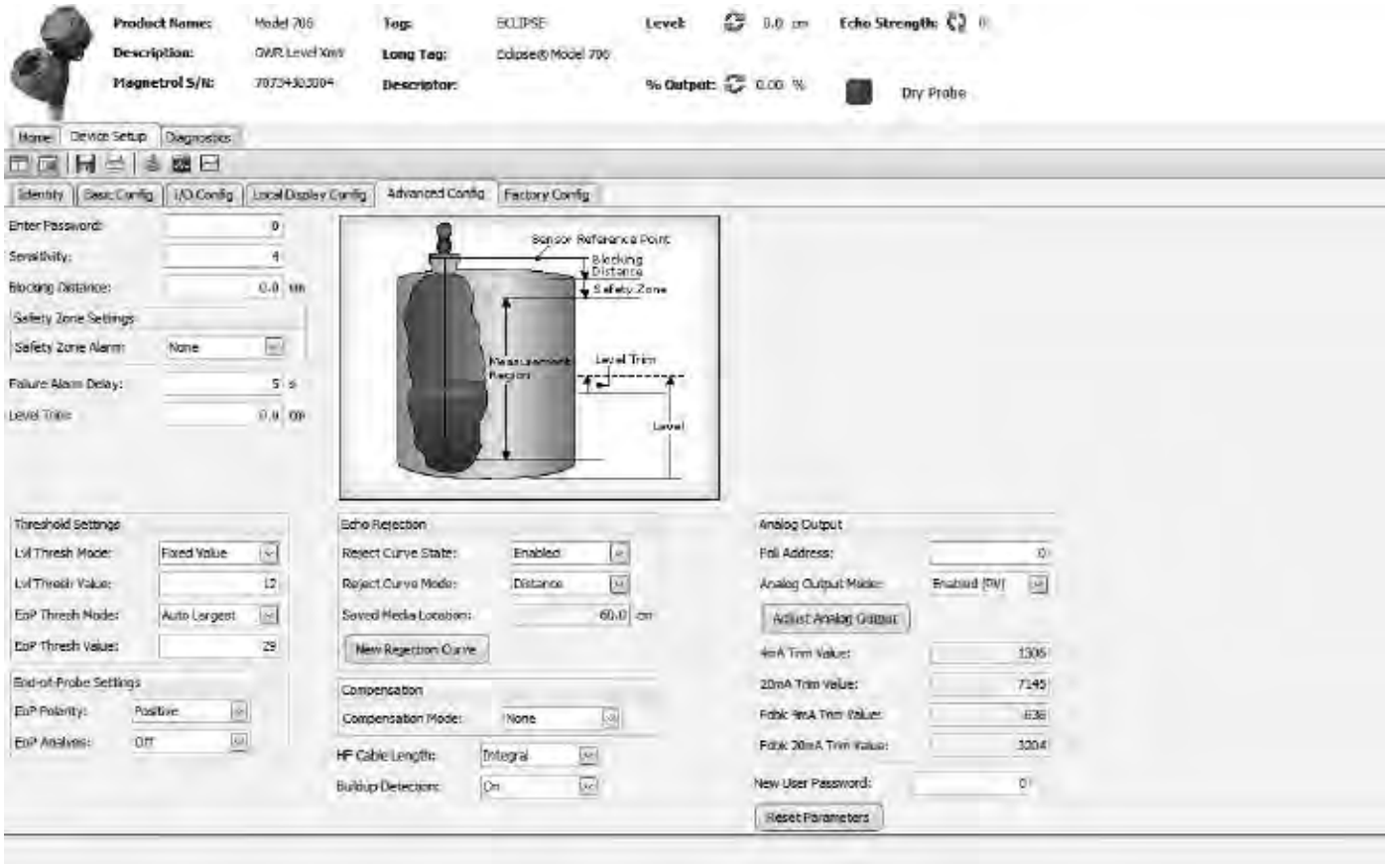
A warning screen is then shown so that the loop can be returned to automatic control.



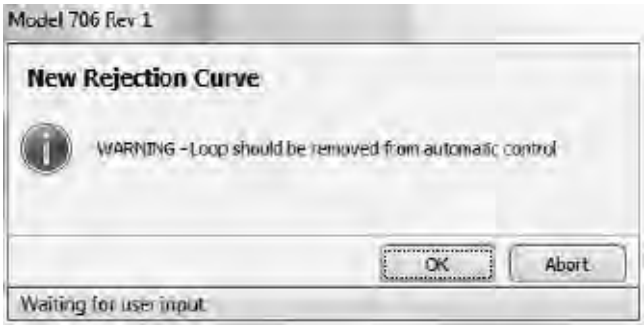
At this point the echo rejection curve can be viewed by selecting Rejection Curve as Curve 2 in the lower left corner of the screen. The Rejection curve will then be displayed in red as shown in the screenshot above.

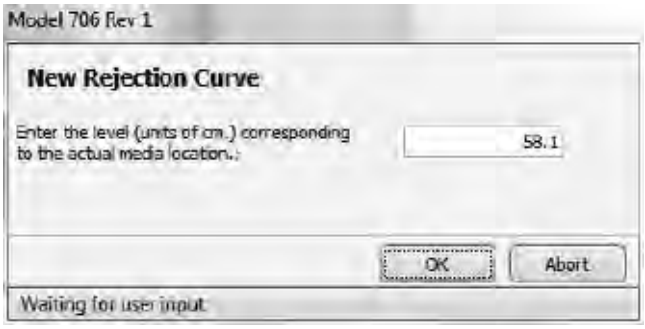
Alternatively, you can follow the procedure below:

Select the Device Setup tab, and then select the Advanced Config tab. Then click on New Rejection Curve.

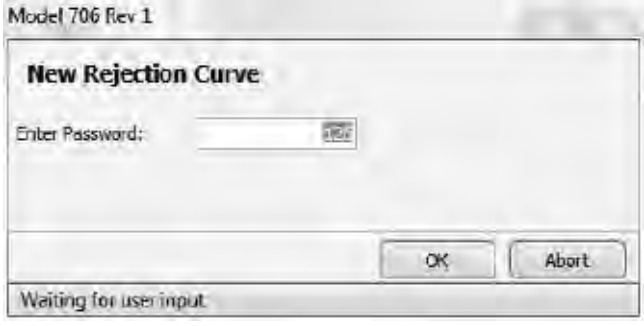


You will get a warning regarding the loop, hit OK. On the next screen you need to enter the actual media location and then hit OK.

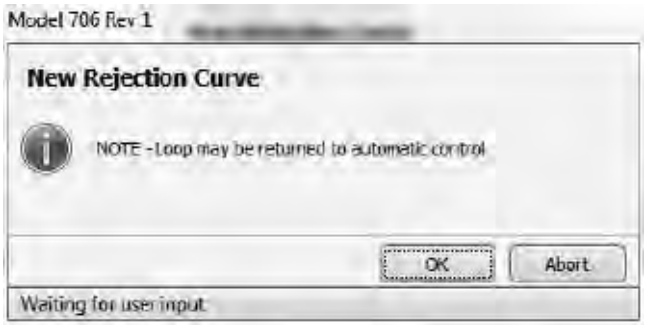




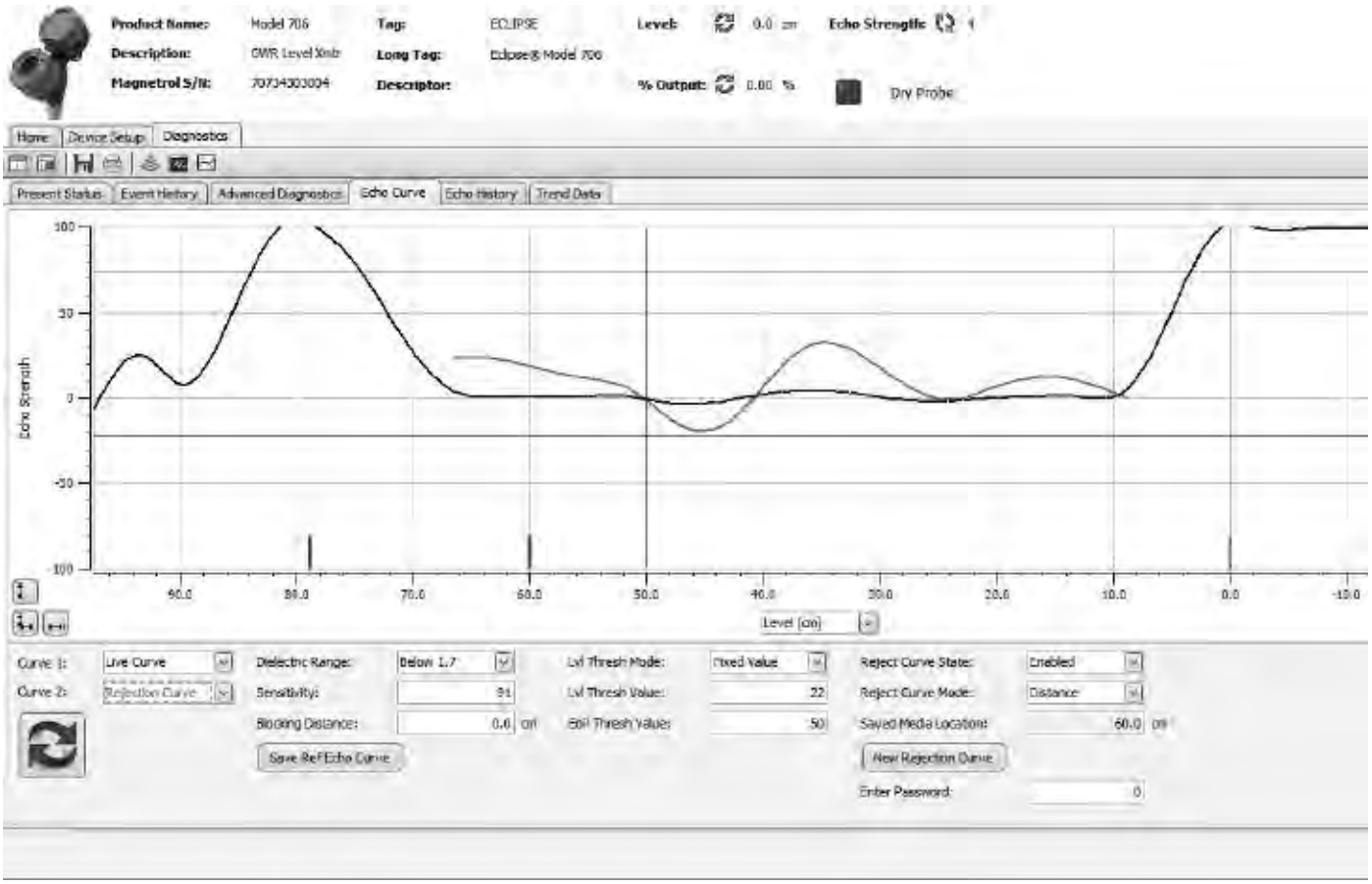
Next a password window might appear if not already entered. Then the system calculates the curve, and then saves it. Hit OK to confirm.



A warning screen is shown that the loop can be returned to automatic control.



At this point the echo rejection curve can be viewed by selecting Rejection Curve as Curve 2 in the lower left corner of the Echo Curve screen. The Rejection curve will then be displayed in red as shown in the screenshot below.

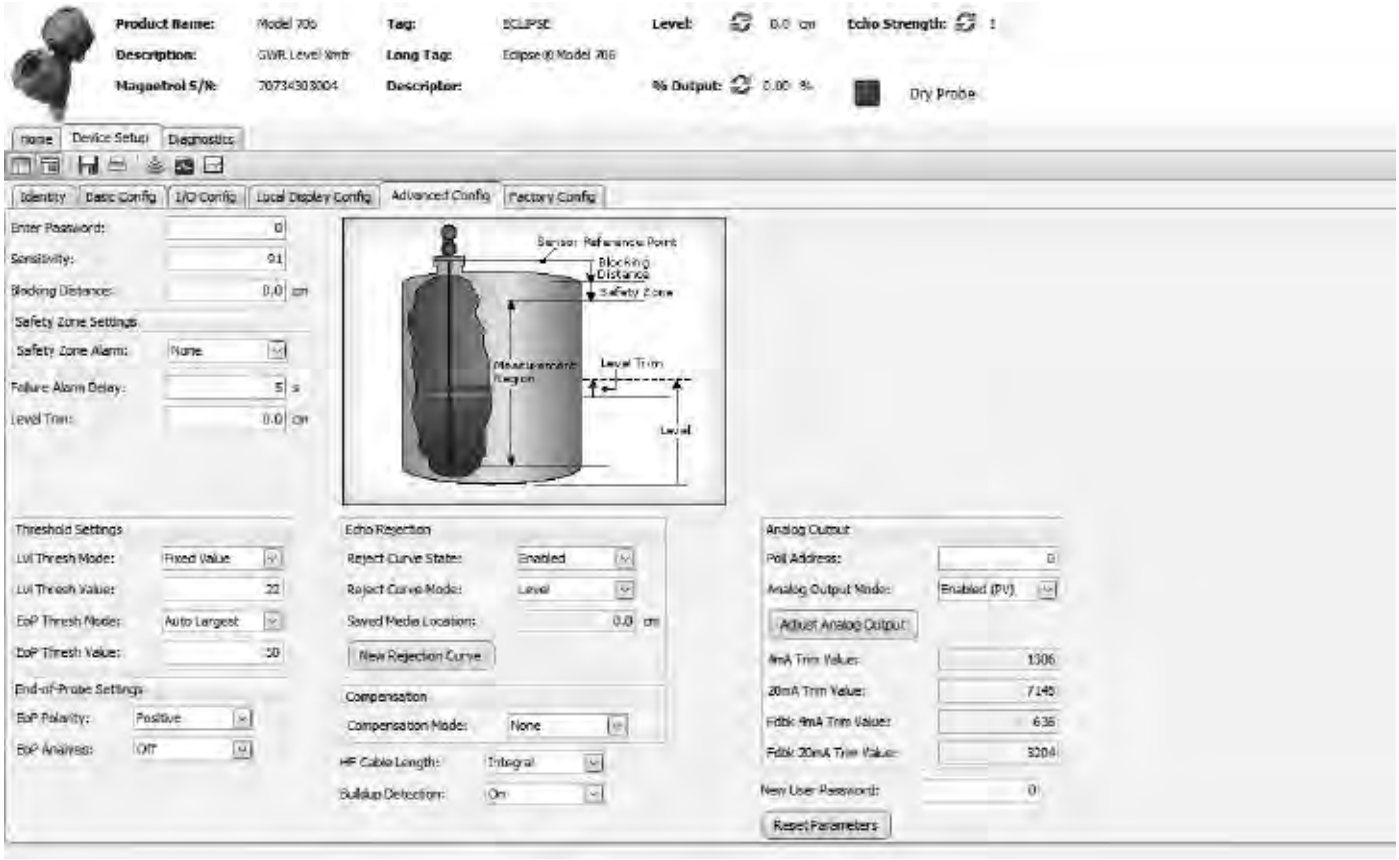


4.4 Buildup Detection

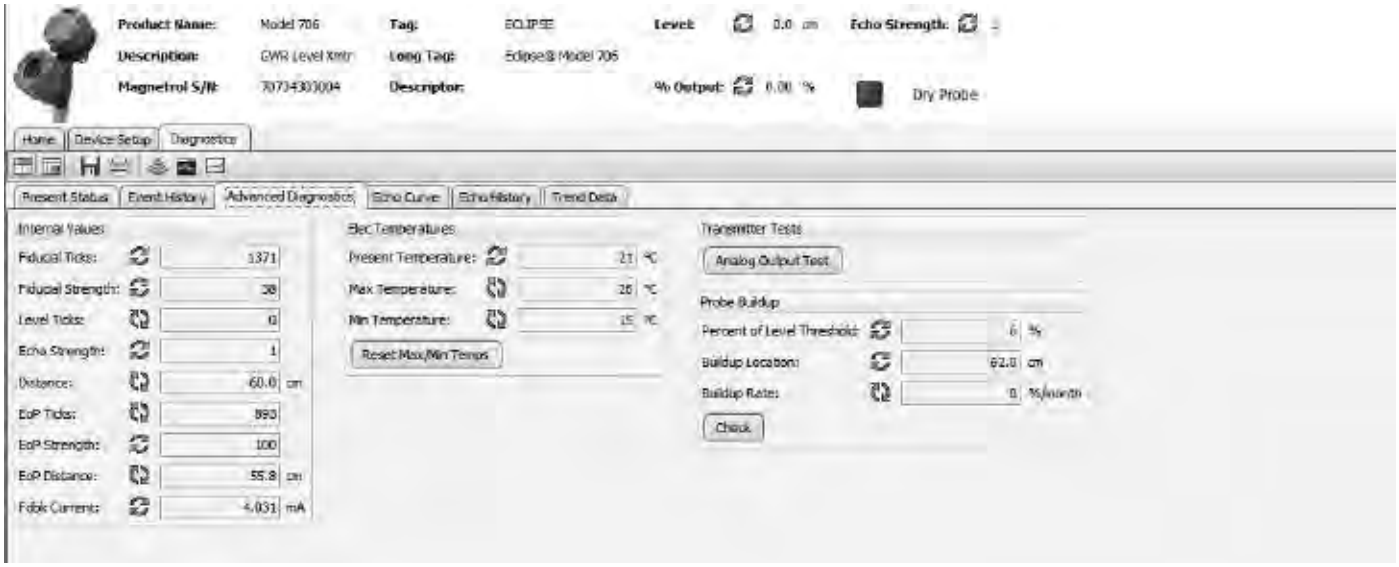
A unique feature contained within the Model 706 can be used to obtain an indication of build-up along the length of the probe. This can be set as the HART SV or TV which can be monitored in the control room. An algorithm compares the buildup echo strength as compared to the Lvl Thrsh Value, and outputs value in percent.

4.4.1 Buildup Detection Setup using PACT*ware*

Buildup detection is a feature that needs to be turned on in Advanced Config, see below.



Once turned on progress can be checked in the Advanced Diagnostics screen, see below.



4.4.2 Buildup Detection Setup using the Keypad

From the menu select DEVICE SETUP and hit Enter.

Scroll down to ADVANCED CONFIG and hit Enter

Select On and hit Enter

Checking buildup can be done from the main display screen. First the unit must be set up to display the Buildup percentage. Go to the main menu and select DEVICE SETUP then hit Enter.

Scroll down to DISPLAY CONFIG and hit Enter.

Scroll down to Probe Buildup and hit Enter, then select View. From the main screen the Buildup percentage is now shown.

IMPORTANT

SERVICE POLICY

Owners of Magnetrol products may request the return of a control; or, any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Magnetrol International will repair or replace the control, at no cost to the purchaser, (or owner) ***other than transportation cost*** if:

a. Returned within the warranty period; and,
b. The factory inspection finds the cause of the malfunction to be defective material or workmanship.

If the trouble is the result of conditions beyond our control; or, is **NOT** covered by the warranty, there will be charges for labour and the parts required to rebuild or replace the equipment.
In some cases, it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned, will be determined on the basis of the applicability of our warranty.
No claims for misapplication, labour, direct or consequential damage will be allowed.

RETURNED MATERIAL PROCEDURE

So that we may efficiently process any materials that are returned, it is essential that a “Return Material Authorisation” (RMA) form will be obtained from the factory. It is mandatory that this form will be attached to each material returned. This form is available through Magnetrol’s local representative or by contacting the factory. Please supply the following information:

1. Purchaser Name
2. Description of Material
3. Serial Number and Ref Number
4. Desired Action
5. Reason for Return
6. Process details

Any unit that was used in a process must be properly cleaned in accordance with the proper health and safety standards applicable by the owner, before it is returned to the factory.
A material Safety Data Sheet (MSDS) must be attached at the outside of the transport crate or box.
All shipments returned to the factory must be by prepaid transportation. Magnetrol ***will not accept*** collect shipments.
All replacements will be shipped Ex Works.

UNDER RESERVE OF MODIFICATIONS

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MAGNETROL®

AMETEK®

Installation & Maintenance Instructions

MAGNETROL AMETEK HART® TO MODBUS® ADAPTOR

Eclipse® Model 706, Jupiter® Model JM4, Pulsar® Model R96

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Operating Manual

Firmware Version 1.7

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Eclipse® Model 706
Guided Wave Radar Level Transmitter

Jupiter® Model JM4
Magnetostrictive Level Transmitter

Pulsar® Model R96
Pulse Burst Radar Level Transmitter

TABLE OF CONTENTS

INTRODUCTION

This document is intended to provide a guide for utilizing the various features of the Magnetrol HART to Modbus Adaptor (HMA). For each feature, a step-by-step procedure is provided to demonstrate how to set up the HMA and attached HART devices for a particular configuration. Other configurations are possible with various combinations of the number of HART to Modbus Adapters on a single RS-485 line and the number and type of Magnetrol HART devices attached to those HMAs. The operations in those configurations can be accomplished by extending the procedures provided in this document. Additionally, it is not required to use the Modbus RTUs or host applications shown in this document. Any RTU or host application that allows for reading and writing Modbus registers to a slave device can be used.

The HART to Modbus Adaptor (HMA) is designed to allow Magnetrol HART transmitters to be utilized in a Modbus®[1] system. The following Modbus protocols are supported:

- Modbus RTU – Function codes 3, 4, 6, and 16
- Modbus ASCII – Function codes 3, 4, 6, and 16
- Levelmaster – Commands Uxx?, UxxF?, UxxOL?, and UxxOLxxxx?

A unique feature of the HMA is that it will support up to five attached HART devices; one in the same housing as the HMA, and up to four external devices attached through a 4-20 mA loop.

- The attached devices do not have to all the same type transmitter.
- The HMA provides power for all attached HART units.
- The attached units should be set to a fixed 4 mA loop current.

Communication

Within the above protocols, it is possible to configure communications parameters such as baud rate, parity, stop bits, etc. to match the settings for a particular Modbus Remote Terminal Unit (RTU) or host.

To ensure a standard method to communicate with the HMA, setting DIP switch positions 1 – 3 to OFF, and 4 to ON, (see Appendix A) will configure the HMA to communicate via Modbus RTU with the default communications settings shown in Appendix F.

[1] Modbus® is a registered trademark of Schneider Electric, licensed to the Modbus Organization, Inc.

Operating Modes

Modbus RTU and Modbus ASCII

When using the Modbus RTU and ASCII protocols, the HMA can be used in several ways:

1. HMA with a single transmitter (HMA mode) – The Modbus host addresses the HMA directly, using the address of the HMA. The registers in the HMA for the attached device follow the numbers listed for Slave 1 in the device register appendices L through S. In this mode, the allowable Modbus addresses are in the range of 1 through 247. **This is the default configuration for the HMA.**
2. HMA with multiple transmitters and one Modbus address (HMA mode) – The Modbus host addresses the HMA directly, using only the address of the HMA. The registers in the HMA for each attached device depend on the slave number of the attached devices as listed in Appendices L through S. The HMA will appear to be a Modbus device capable of providing multiple level measurements. In this mode, the allowable Modbus addresses are in the range of 1 through 247.
3. Single Modbus Device – The HMA is connected to only the HART device present in the same transmitter housing. The HART poll address of the HART device and the Modbus poll address of the HMA are the same. Changing the HART poll address of the attached transmitter will automatically change the Modbus poll address of the HMA to match. Essentially, they appear to a Modbus master as a single native Modbus device. The registers in the HMA for the attached device follow the numbers listed for Slave 1 in the device register appendices L through S. In this mode, the allowable Modbus/HART addresses are limited to the range of 1 through 62.

LevelMaster

When using the LevelMaster protocol, the HMA will appear to be invisible to the LevelMaster host. This is due to the limited command set available with LevelMaster. Instead, the attached HART devices will appear to be native LevelMaster devices. They will respond to the Modbus poll address equivalent to their HART poll address. In this mode, the allowable Modbus/HART addresses are limited to the range of 1 through 62.

Supported Device Parameters

Not all of the parameters for a particular Magnetrol HART transmitter are supported by the HMA using Modbus communication. For each device type, the parameters that are available have been chosen to represent the most commonly for optimization and troubleshooting. The available parameters are listed in Appendices L through S.

Full Device Configuration

Using a HART DD or DTM, the full range of HART transmitter parameters can be accessed to configure an attached HART device. There are two ways to connect a HART host to the transmitter enclosed with the HMA. In each case, the HART Poll Address of the attached device must be used for communication rather than the Modbus poll address of the connected HMA.

1. A HART modem can be connected directly to the HART terminal block on the HMA. The HMA will always act as a primary master on the HART loop. Therefore, if connecting another HART host to the terminal HART block, that additional host must either be capable of automatically setting itself to be a secondary master, or be manually configured as a secondary master. Note that the HART terminal block has a built-in 250-ohm resistor to facilitate HART communication. See the section on using a DTM with the HMA.
2. The HMA is capable of passing HART commands using the RS-485 connection to the attached devices.

QUICK START PROCEDURE

The following procedure demonstrates basic steps for configuring a Magnetrol transmitter containing a HART to Modbus Adaptor (HMA) for use with a Modbus system. The example given is for an installation where a single HART transmitter is attached to the HMA.

More complete instructions are provided in the SETUP PROCEDURES section as well as other configurations and communication protocols.

1. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA:
   1.1. Receive/Transmit Data lead (+, A) connected to the positive terminal
   1.2. Receive/Transmit Data lead (–, B) connected to the negative terminal.
   1.3. Connect a 120Ω resistor between the two RS-485 terminal block positions.
   1.4. Connect the other end of the cable to a PC which has a Modbus host application installed.
2. Ensure that the DIP switches on the HMA are set as follows:
   2.1. 1 == OFF (Default Config Mode)
   2.2. 2 == OFF
   2.3. 3 == OFF
   2.4. 4 == ON.

   See Appendix A for the location of the DIP switch, and Appendix B for a legend of the four switch positions.
3. Connect the device containing the HMA to a power supply via the power terminal block.
4. Apply power to the HMA.
5. Set the Modbus host application to communicate via the default Modbus RTU communication settings shown in Appendix F.
6. Set registers 3000 through 3006 to the desired communication settings for use with the host system. **Register 3001 (Slave address) should be set to the Modbus address desired for communicating with the HMA.**
7. Ensure that register 3007 (HMA Mode) is set to 0.
8. Change register 3012 to a value of 0. This will cause the HMA to scan the attached HART device at initial start-up, and record the poll address and other information for the device.
9. If RS-232 communication is to be used, set DIP switch 3 to ON, and DIP switch 4 to OFF.
10. Change DIP switch 1 to ON. The HMA will automatically reboot, scan for the attached device, and configure itself for the communication protocol and Modbus address selected in step 6.
11. By viewing the appropriate registers, verify that the desired transmitter measured values are being actively read by the Modbus host.
12. The device is ready to use.

SETUP PROCEDURES

1. Configuring communications settings in the HMA

1.1. Purpose

This procedure instructs how to configure HART to Modbus Adaptor (HMA) communications using a basic Modbus master simulator application. The procedure can also be performed using any Modbus master that permits reading and writing of the appropriate registers in the HMA.

To ensure that there is a known communication configuration for the HMA, position 1 of the DIP switch is used to select between a fixed communication setting and a user-configurable setting. When the switch is set to OFF, the HMA communicates using Modbus RTU with a poll address of 247 at 9600 baud, 8 data bits, no parity, and 1 stop bit. When in the default configuration, the user-selectable communication settings can be adjusted. When the user communication settings are desired to be used, position 1 of the DIP switch should be set to ON, and then input power cycled. Changing back to the fixed default settings also requires a power cycle.

1.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
USB Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A

1.3. Setup

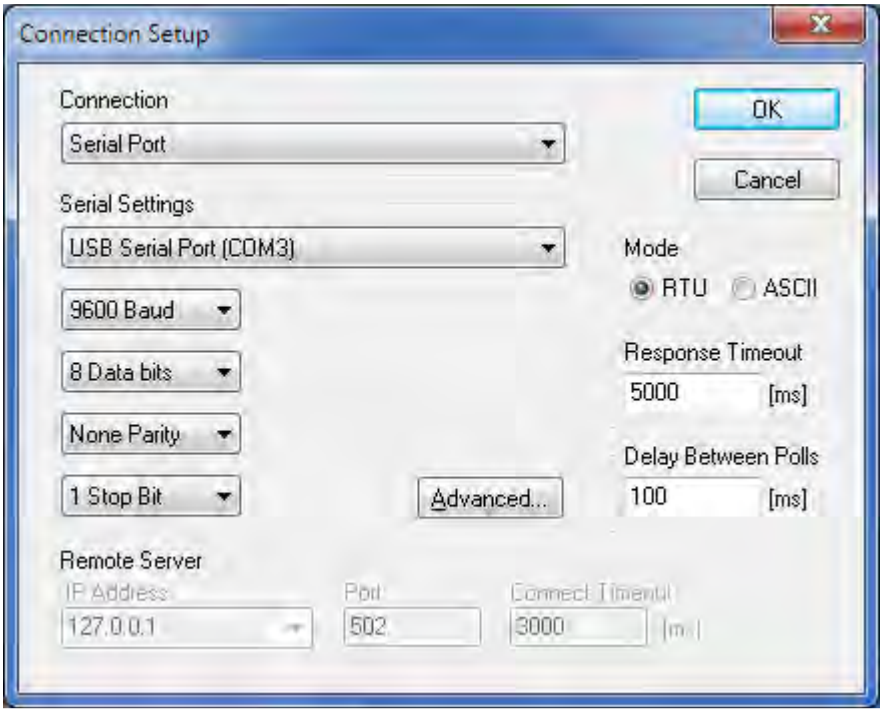
Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

1.4. Procedure

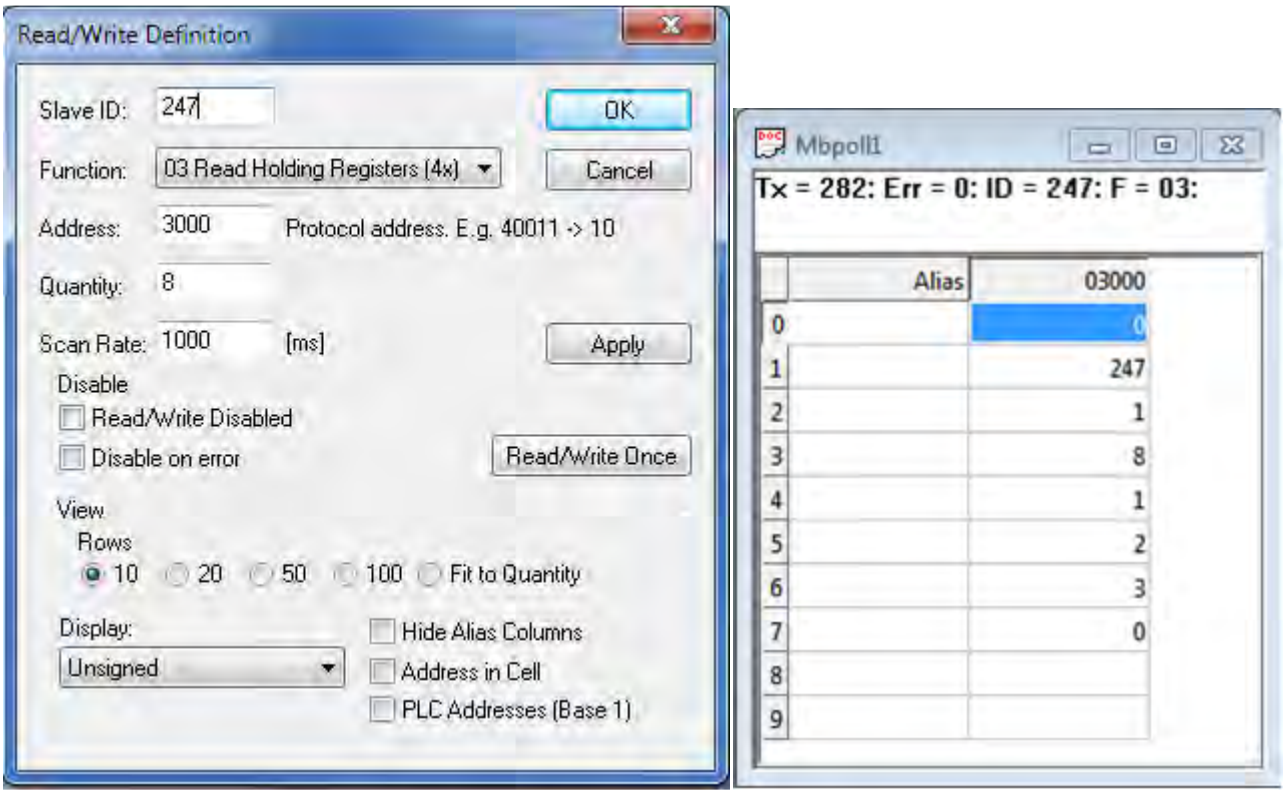
1.4.1 Ensure that the DIP switches on the HMA are set to 1 == OFF (Default Config Mode), 2 == OFF, 3 == OFF, 4 == ON. See Appendix A for the location of the DIP switch, and Appendix B for a legend of the four switch positions.

1.4.2 Open the Modbus Poll application.

1.4.3 Select Connection\Connect from the menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.



1.4.4 Open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:



1.4.5 Verify that the values in the registers listed in the Mbpoll window match the values for the desired Modbus protocol settings. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

1.4.6 Change DIP switch 1 to ON. This sets the device to run in the selected communications mode.

1.4.7 If communication at the new settings is not achieved, change DIP switch 1 to OFF. This sets the device to run in the default Modbus RTU communications mode. Check the communication setting registers to ensure that the desired values are present.

2. Reading and writing registers in the HMA

2.1. Purpose

This procedure instructs how to read and write HART to Modbus Adaptor (HMA) registers using a basic Modbus master simulator application. The procedure can also be performed using any Modbus master that permits reading and writing of the appropriate registers in the HMA.

2.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
USB Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A

2.3. Setup

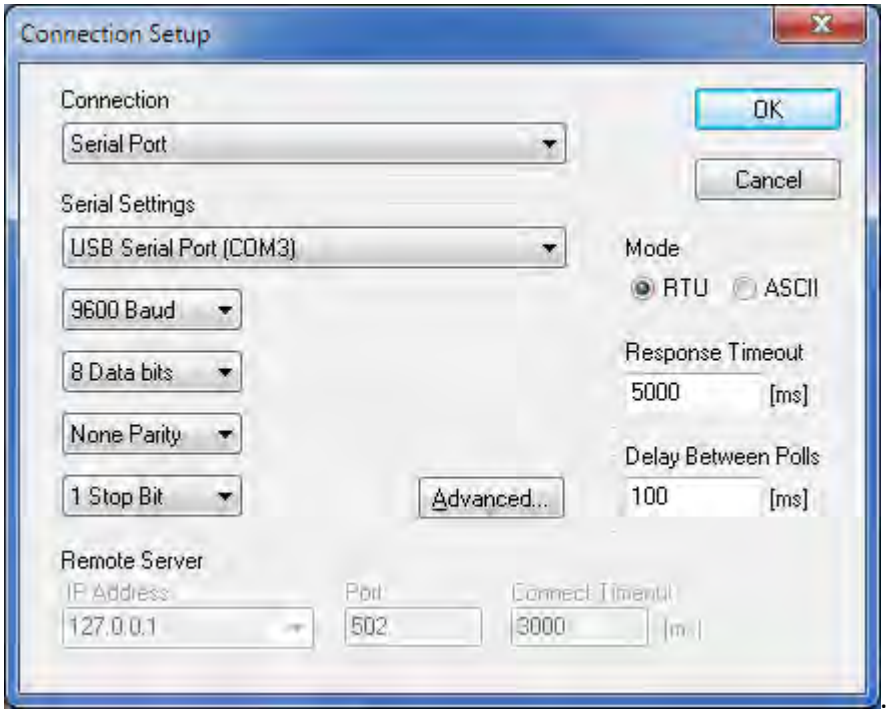
Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

2.4. Procedure

2.4.1 Ensure that the DIP switches on the HMA are set to 1 == OFF (Default Config Mode), 2 == OFF, 3 == OFF, 4 == ON. See Appendix A for the location of the DIP switch, and Appendix B for a legend of the four switch positions.

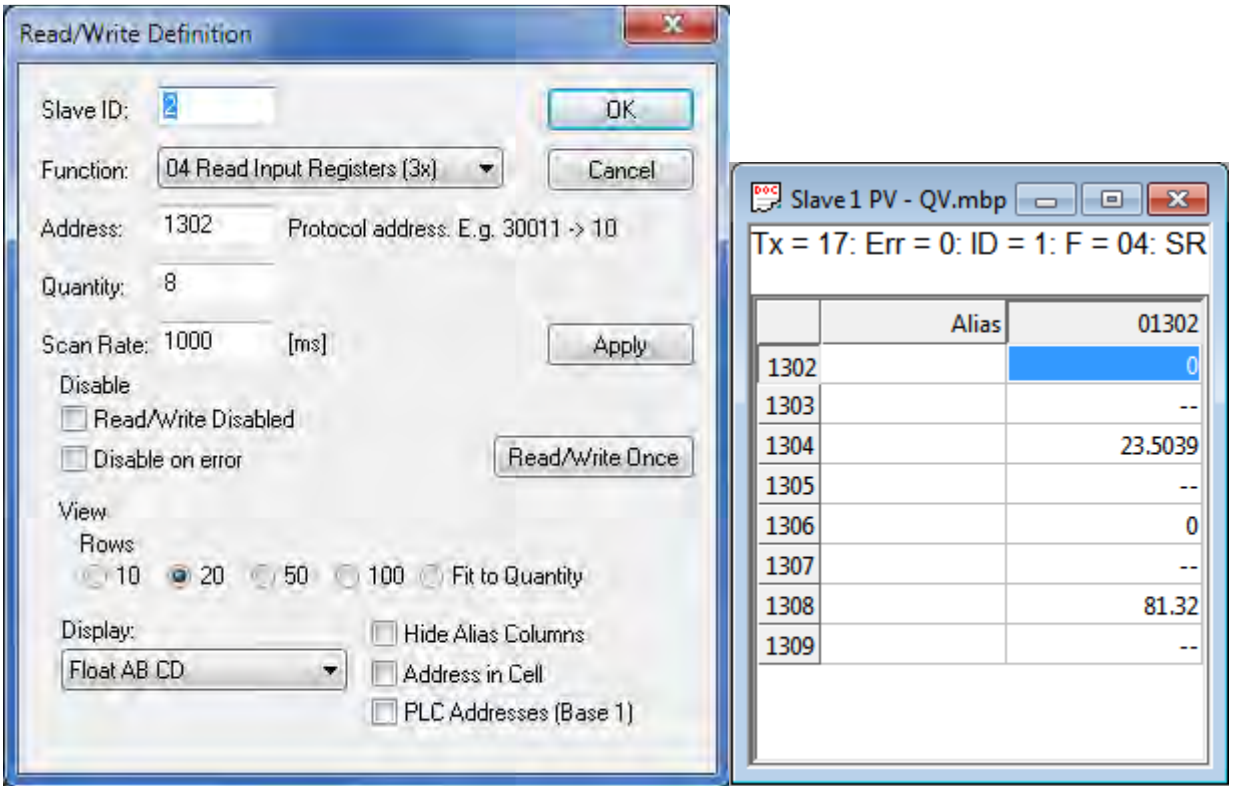
2.4.2 Open the Modbus Poll application.

2.4.3 Select Connection\Connect from the menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.

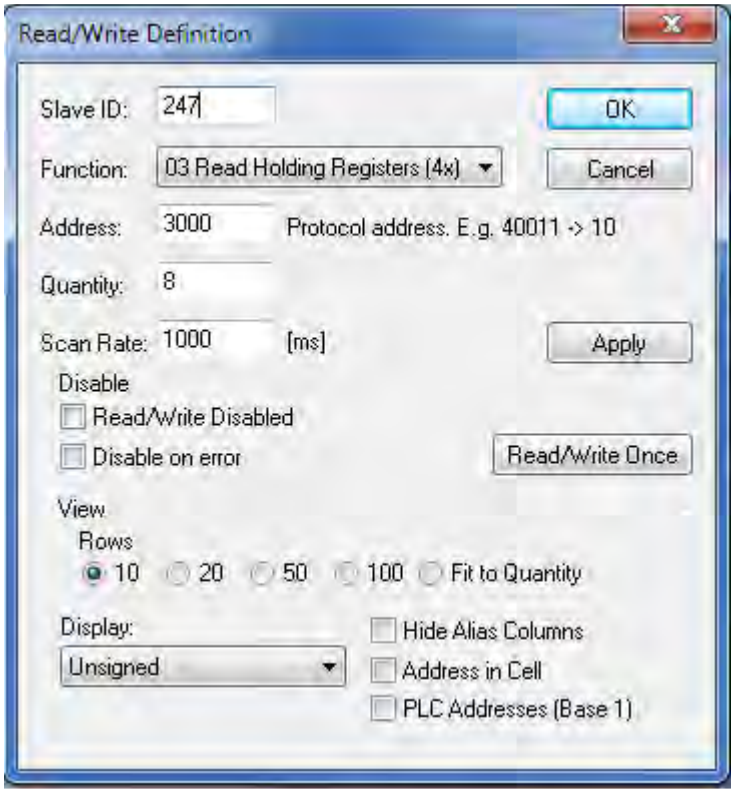


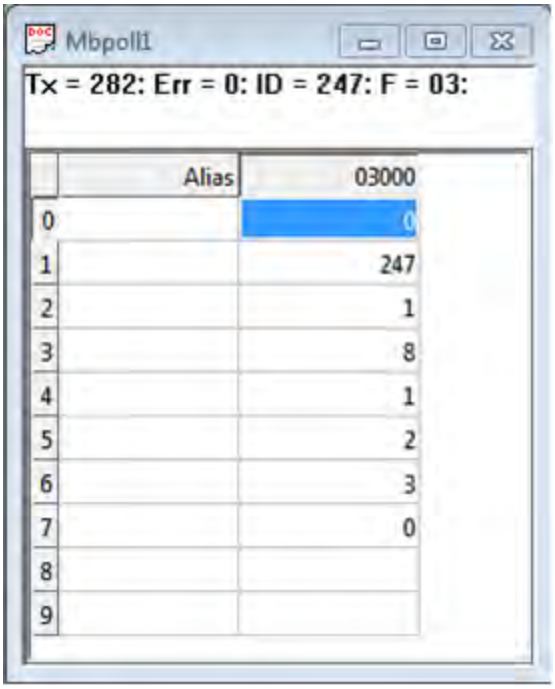
2.4.4 To read an input register, open or click on an Mbpoll window, and select Setup\Read\Write Definition from the menu bar. Set the Slave ID to match the Modbus Poll Address of the HMA. Set the Function to '04 Read Input Registers (3x)'. Using Appendices L through S, set the Address, Quantity and Display type in the pop-up dialog as required. Then click OK. The register value should appear in the Mbpoll window.

In general, the Address should be set to the number of the first register to be accessed. (Address numbers are listed in the Modbus Register Number columns in the appendices.) The Quantity should be set to the sum of the individual sizes of sequential registers to be accessed. In the below example, four registers are to be read and since each have a size of 2 (listed in the Number column in the appendices).



2.4.5 To read a holding register, open or click on an Mbpoll window, and select Setup\Read\Write Definition from the menu bar. Set the Slave ID to match the Modbus Poll Address of the HMA. Set the Function to '03 Read Holding Registers (4x)'. Using Appendices L through S, set the Address, Quantity and Display type in the pop-up dialog as required. Then click OK. The register value should appear in the Mbpoll window.





2.4.6 To write a holding register, double-click on the register value displayed in step 2.4.6. Enter the new value and click on 'Send. Confirm that the new value appears in the Mbpoll window.

3. Using a DTM with the HMA

3.1. Purpose

This procedure instructs how to connect a HART DTM to the HMA to configure or troubleshoot an attached HART transmitter.

3.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
HART Modem	MacTek	Viator
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

3.3. Setup

Connect the HMA, with an attached HART transmitter, to a power supply via the power terminal block. Connect the HART Modem to the HART terminal block on the HMA. Note that the HMA provides 24 VDC on the terminal block and contains an internal 250-ohm resistor, so the modem can be directly connected to the terminal block.

3.4. Procedure

3.4.1 Start PACTware.

3.4.2 Add a HART Comm DTM to the Project.

3.4.3 Right click on the Comm DTM in the Project tree and select 'Add device' to add a DTM to the Project for the connected transmitter.

3.4.4 Right-click on the Comm DTM item and select Parameter. Select the correct COM port for the HART modem, set the Start address and End address to match the HART Poll Address for the attached transmitter. (The Poll Address can be read from the Device Setup\Advanced Config\Analog Output menu on the transmitter's local display.) Set the Comm DTM to be a secondary master, then click OK.

3.4.5 Right-click on the Comm DTM item and select Additional functions\Change DTM address. Click on the Change address button. Select the address number corresponding to the attached Model 706 device, then click Close.

3.4.6 Right-click on the device DTM item and select Connect.

3.4.7 Double click on the transmitter entry in the Project tree to open the Online parameterization window.

3.4.8 All features of the DTM will be available. Note that since the DTM is acting as a secondary master and the HMA is periodically sending commands as the primary master, the response of the DTM will be slower than when it is connected directly to a transmitter.

4. Using a Handheld Field Communicator with the HMA

4.1. Purpose

This procedure instructs how to connect a handheld communicator, such as the Emerson 475, to the HMA to configure or troubleshoot an attached HART transmitter.

4.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
Field Communicator	Emerson	475
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

4.3. Setup

Connect the HMA, with an attached HART transmitter, to a power supply via the power terminal block. Connect the field communicator to the HART terminal block on the HMA. Note that the HMA provides 24 VDC on the terminal block and contains an internal 250-ohm resistor, so the field communicator can be directly connected to the terminal block.

4.4. Procedure

4.4.1 Start the field communicator.

4.4.2 Ensure that the field communicator is configured to scan for the HART Poll Address of the transmitter. (The Poll Address can be read from the Device Setup\Advanced Config\Analog Output menu on the transmitter's local display.)

4.4.3 When the field communicator finds the device, select it from the communicator's menu.

4.4.4 All features of the HART DD for the transmitter will be available. Note that since the field communicator is acting as a secondary master and the HMA is periodically sending commands as the primary master, the response of the field communicator will be slower than when it is connected directly to a transmitter.

5. Basic Modbus RTU Communication over RS-485

5.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the Modbus RTU protocol over RS-485.

5.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

5.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

5.4. Procedure

5.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values for the Modbus RTU protocol settings used by the intended Modbus master. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

5.4.2 Change DIP switch 1 to ON.

5.4.3 Connect the HMA to a Modbus master.

5.4.4 Apply power to the HMA.

5.4.5 Verify that the Modbus master is receiving responses from the HMA (Tx is increasing) and that there are no communication errors being reported.

7. Basic Modbus ASCII Communication over RS-485

7.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the Modbus ASCII protocol.

7.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A

7.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

7.4. Procedure

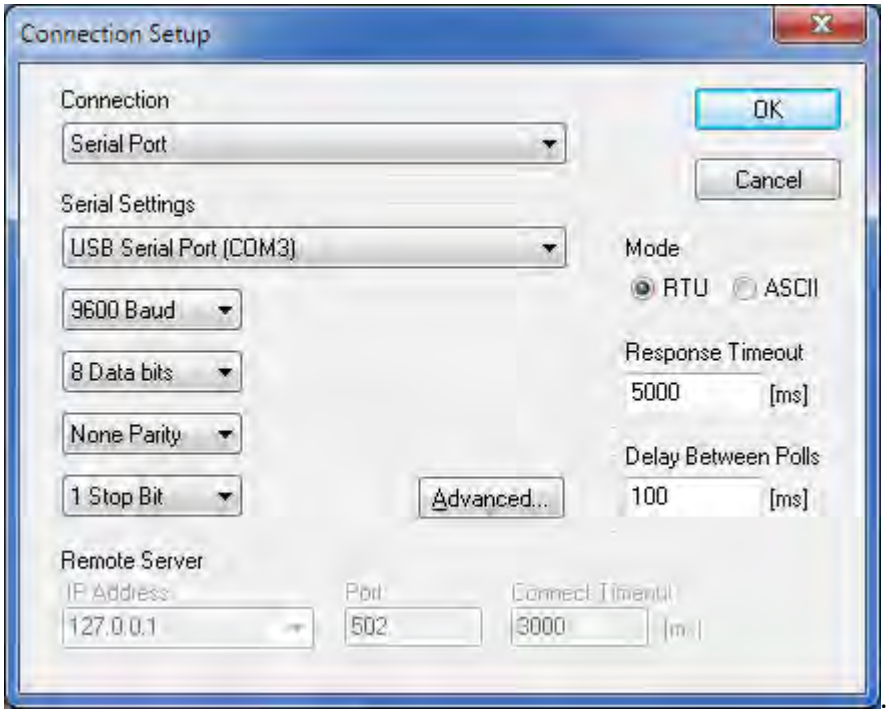
7.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values for the Modbus ASCII protocol settings used by the intended Modbus master. Refer to Appendix G for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

7.4.2 Change DIP switch 1 to ON. This sets the device to run in the selected communications mode.

7.4.3 Verify that the device is not communicating with the Modbus Poll application.

7.4.4 Select Connection\Disconnect from the Modbus Poll menu bar.

7.4.5 Select Connection\Connect from the menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.



7.4.6 Verify that the Modbus Poll application is receiving responses from the HMA (Tx is increasing) and that there are no communication errors being reported.

8. Modbus RTU Communication in HMA Mode

8.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA), when in the HMA mode, to support the various registers defined for one or multiple devices attached to a single HMA.

In the HMA mode (register 3007 set to 0), the HMA will be the only device directly visible to the Modbus RTU/master. This mode can be useful when more devices are attached to the same RS-485 line then there are available Modbus addresses. With each HMA supporting up to 5 HART devices, far fewer Modbus addresses are required for a given number of HART devices. All commands to read or write to a device are accomplished by using only HMA registers. In effect, the HART devices will invisible to the Modbus master, and the HMAs will appear to be able to provide multiple level readings. For the attached devices, the HMA register number to access various parameters in the attached HART devices will be different from HART device to HART device and will depend on the slave number of the device on the HMA.

The following procedure is an example of connecting two HART devices to a single HMA.

8.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible
Level transmitter	MII	Model 705 3x
Probe	MII	Model 705 3x compatible
Level transmitter	MII	Model 355
Level transmitter	MII	Model R82 R2
Level transmitter	MII	Model RX5
Level transmitter	MII	Enhanced Jupiter
Level transmitter	MII	E3 Modulevel

8.3. Setup

8.3.1 Single HMA

Connect an HMAs to a power supply via the power terminal block. Connect an RS-485 communications cable to a PC which has a Modbus host application. Connect the other end of the cable to the RS-485 terminal block of the HMA1. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect additional supported Magnetrol HART devices to the HART loop terminal block of the HMA. There can be any combination of devices including the Model 706, Model 705 3x, Model 355, Model R82 R2, Model RX5, Enhanced Jupiter and E3 Modulevel. Note that each device's Poll Address can be set to any value between 1 and 62 as long as it has a unique address from others connected to the same HMA, and there can be a maximum of 5 devices connected to an HMA including the device in the housing containing the HMA. It is suggested that the devices' poll addresses

be set to the range of 1 to 5 so that they correspond to the slave numbers shown in the registers tables of Sections L through S.

8.3.2 Multiple HMAs

Install jumper wires connecting the positive terminal of the RS-485 terminal block of HMA1 and the positive terminal of the RS-485 terminal block of HMA2 as well as the negative terminal of the two terminal blocks. Continue for the number of HMAs to be used on the line. Connect a 120Ω resistor between the two RS-485 terminal block positions of the last device on the RS485 line.

8.4. **Procedure**

8.4.1 Connect the HMA to a power supply, Modbus host and MII HART transmitters as specified in section 8.3.1.

8.4.2 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values for the Modbus RTU protocol settings used by the intended Modbus master. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

8.4.3 Using Procedure 2, change register 3001 to a value of 15. This changes the address of the HMA to 15 to be unique from other HMAs and from the attached devices. Note that the choice of address for the HMA is not critical as long as it is different from other HMAs to be used in the same system.

8.4.4 Change register 3007 to a value of 0. This sets the HMA to run in the HMA mode in which only the HMAs are directly addressed by the Modbus master.

8.4.5 Change register 3013 to a value of 2. This will cause the HMA to scan poll addresses 0 to 15 for attached devices at start-up, and record the poll address and other information for each device.

8.4.6 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each device.

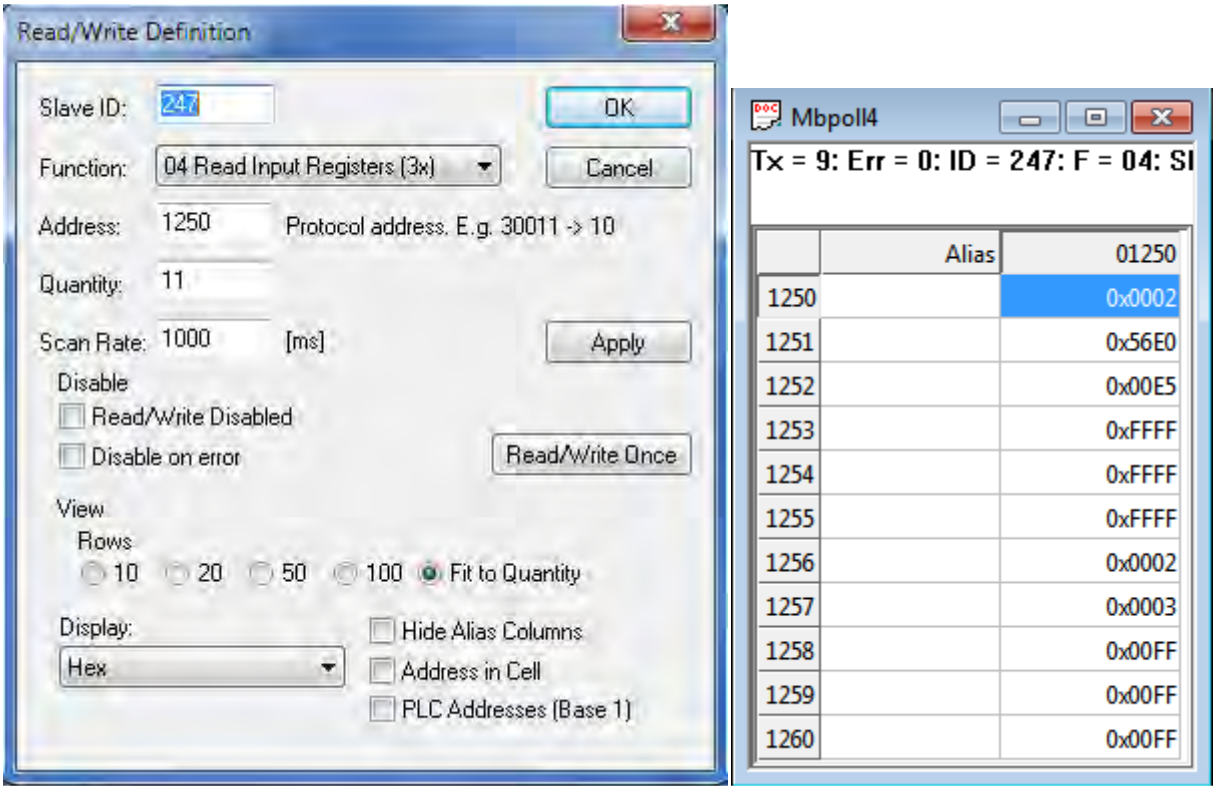
8.4.7 Change DIP switch 1 to ON.

8.4.8 Change the slave ID for the Read/Write Definition from 247 to 15 (or the Modbus address selected for the HMA).

8.4.9 Verify that register 3012 on each HMA has automatically changed to a value of 1 indicating that the HMA has found devices and stored their information in memory.

8.4.10 Verify that register 1250 on each HMA displays the correct number of attached devices.

8.4.11 Check that the Device Type (1251 – 1255) and Polling Address (1256 – 1260) registers display the correct values for the attached devices. All eight registers along with register 1250 can be displayed in one Mbpoll window if the Display parameter is set to 'Hex' in the Read/Write Definition dialog. Refer to Appendix K for the register numbers. For example, with two devices attached:



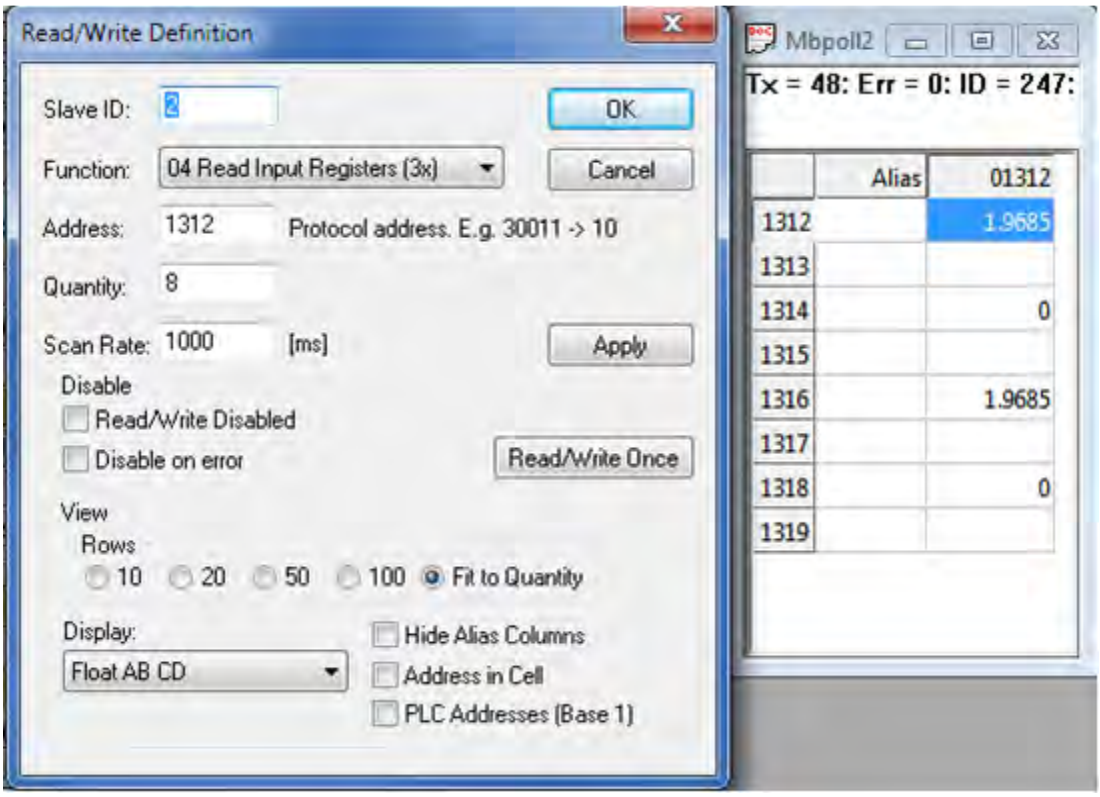
8.4.12 Note that Poll Address and Device Type registers corresponding to Slave IDs with no attached device will show 0xFFFF and 0x00FF respectively.

8.4.13 If using more than one HMA, repeat steps 8.4.1 through 8.4.12 except disconnecting HMA1 and connecting another HMA. Set the Poll Address of the new HMA to something other than to be used for the other HMAs. Repeat for any additional HMAs.

8.4.14 Reconnect all HMAs to be used, following the setup in section 8.3.2.

8.4.15 Open a new Mbpoll window.

8.4.16 The supported parameters for the HART devices are listed in Appendices L through S. For each device, use the appropriate table and the Modbus Register number column labeled with the Slave ID number of the device. Read the registers for each parameter. Note that the Slave ID number for the Mbpoll window must match the Slave ID of the HMA, not the attached HART device(s). For example, to read the PV through QV values for Slave ID 2, set the Read/Write Definition to:



8.4.17 Ensure that the values displayed match the values shown on the selected transmitter's local user interface.

9. Modbus RTU Communication in Single Modbus Device Mode

9.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA), when in the Single Modbus Device mode, to support the various parameter registers defined for the attached device.

In the Single Modbus Device mode (register 3012 set to 2), the HMA and attached HART device will appear to be a single native Modbus device to the Modbus RTU/master. This mode is for instances where an HMA is used with a single HART device and is designed to simplify the commissioning process. When the HART poll address of the device is changed, the HMA will automatically change its Modbus address to match the HART address when it starts up. Note that the range of Modbus/HART addresses is limited to 1 through 62.

9.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

9.3. Setup

Connect the HMA (mounted in a housing with a HART device) to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

9.4. Procedure

9.4.1 Using Procedure 1 (with position 1 of the DIP switch set to OFF), configure the communication settings HMA to match the settings for the Modbus host.

9.4.2 Using Procedure 2 (with position 1 of the DIP switch set to OFF), verify that register 3012 on the HMA is set to a value of 2 – Single Device.

9.4.3 Using the device's local display, change the HART Poll Address to the desired Modbus address (within the range of 1 to 62). On 4-button, multi-line displays, the Poll Address parameter can be found by navigating to the Device Setup\Advanced Config\Analog Output menu. On 3-button, 2-line displays, the Poll Address parameter can be found by repeatedly pressing the Up or Down arrow button.

9.4.4 Set position 1 of the DIP switch to ON.

9.4.5 The HMA will search through the 1 to 62 poll range for the attached HART device. Once the device is found, the HMA will automatically change its Modbus address to match, and then restart itself to use the new Modbus address.

9.4.6 The HMA / HART device can be communicated with using the Modbus address and the registers for Slave 1 as shown in Appendices L through S.

10. Basic LevelMaster Communication

10.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the Modbus LevelMaster protocol.

In the LevelMaster configuration, the HMA will appear to be invisible to the LevelMaster host. This is due to the limited command set available with LevelMaster. Instead, the attached HART devices will appear to be native LevelMaster devices. They will respond to the Modbus poll address equivalent to their HART poll address. The devices will return the HART PV and SV as the two D (float) values in the Uxx? command response. The F value corresponds to the Echo Signal strength. The E and W values correspond to the highest active Error and Warning diagnostic in each category.

10.2. Equipment

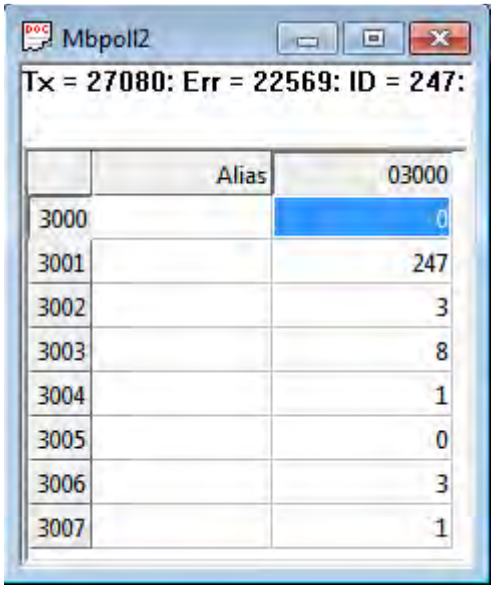
Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Terminal v1.9b application	hw-server.com	Version 1.9b - 20040204
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

10.3. Setup

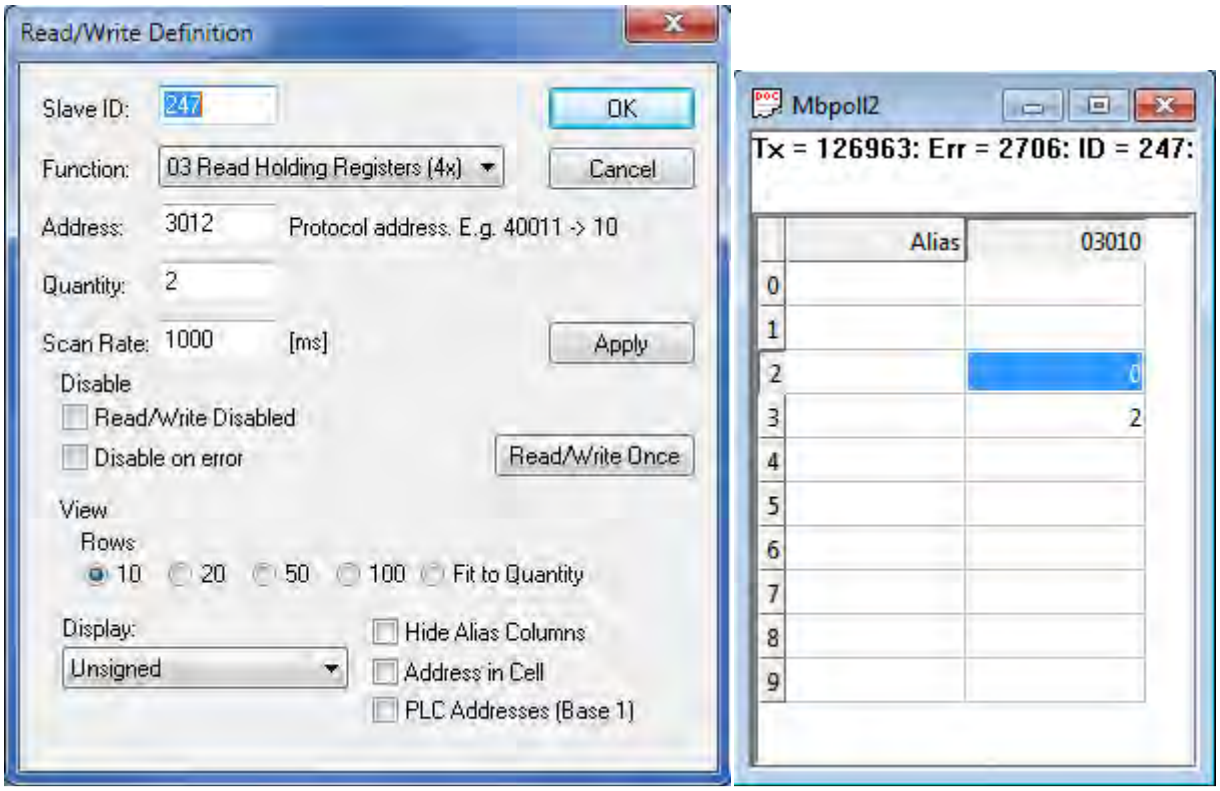
Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Besides the Model 706 in the housing, connect any additional HART devices to the HART loop terminal block of the HMA. Set the HART Poll Address of the internal Model 706 device to 2. Set the HART Poll Address of the other attached devices to different, unique values. Note that other Magnetrol HART transmitters and HART poll addresses can be used.

10.4. **Procedure**

10.4.1 Using Procedure 1, ensure that registers 3002 through 3007 of the HMA match the values shown for the Modbus LevelMaster protocol default settings. Refer to Appendix H for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send. Register 3001 can be left at 247.

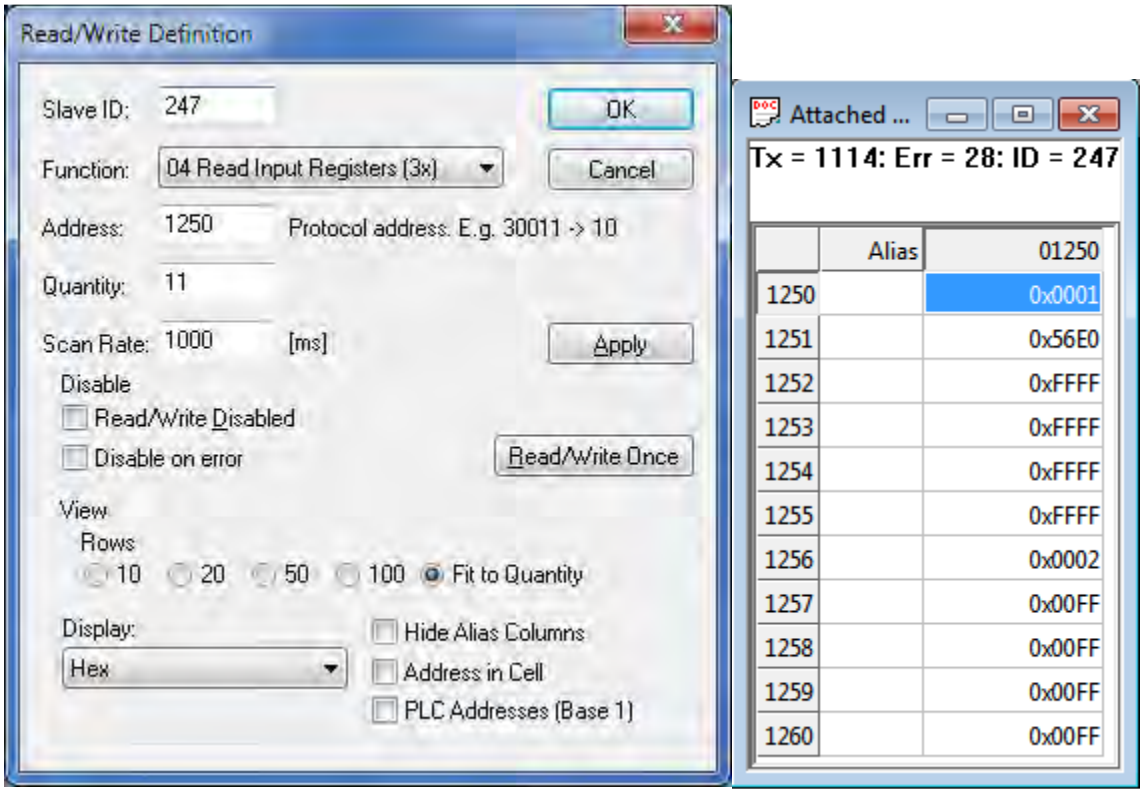


10.4.2 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each attached HART device.



10.4.3 Change DIP switch 1 to ON and then back to OFF.

10.4.4 Set up a window to read 11 registers starting at address 1250.



10.4.5 Verify that register 1251 shows the correct device type and register 1256 shows the HART Poll Address of the attached transmitter.

10.4.6 Change DIP switch 1 to ON.

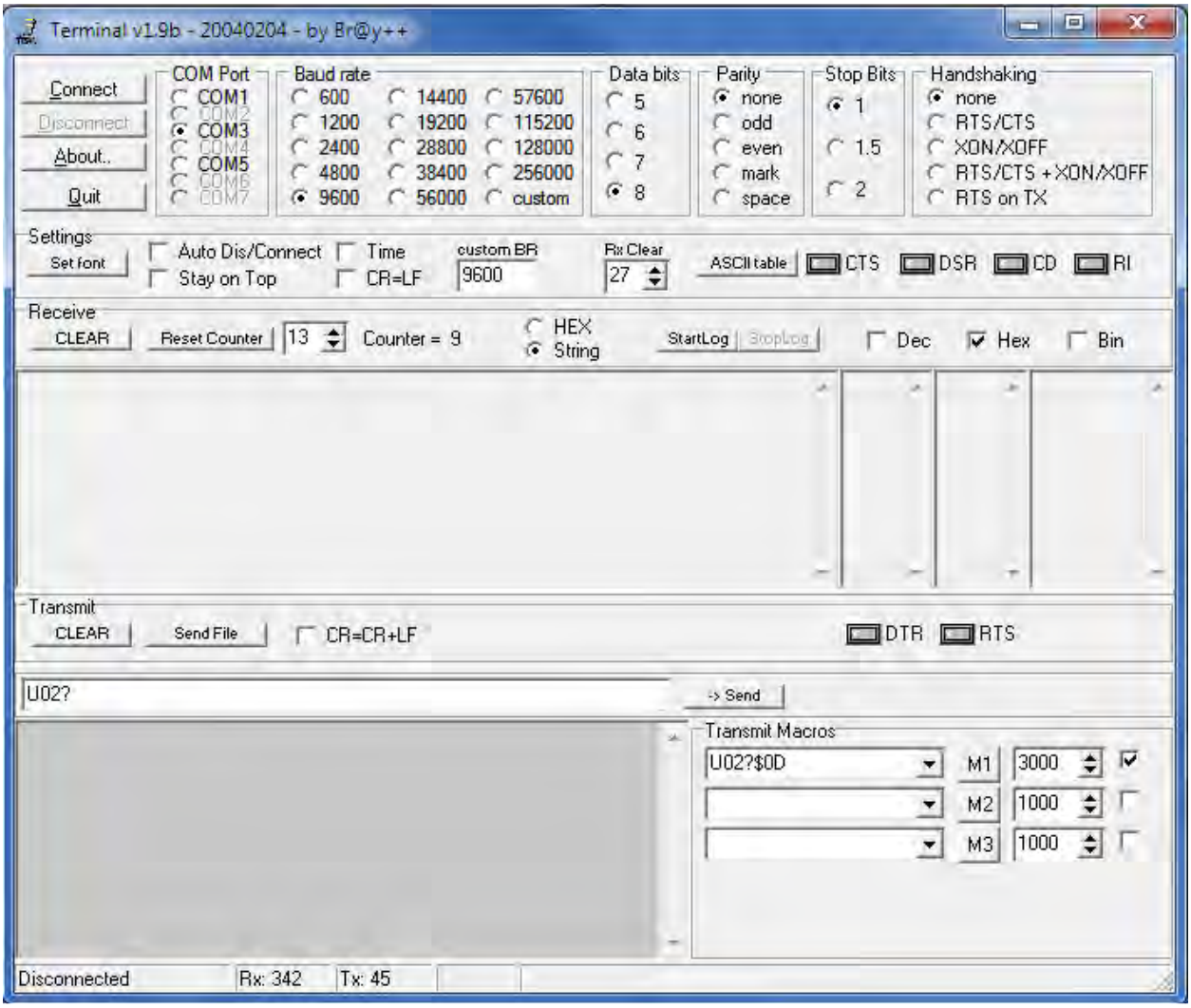
10.4.7 Select Connection\Disconnect from the menu bar.

10.4.8 Start the Terminal v1.9b application. Note that any similar application that supports transmission/reception of ASCII characters over the RS-485 connection may be used.

10.4.9 Set the COM Port to match the COM port used for the communication cable (the same number as with the Modbus Poll application).

10.4.10 Set the Baud rate, Data bits, Parity, Stop Bits and Handshaking parameters to match the settings made in the HMA for LevelMaster communication.

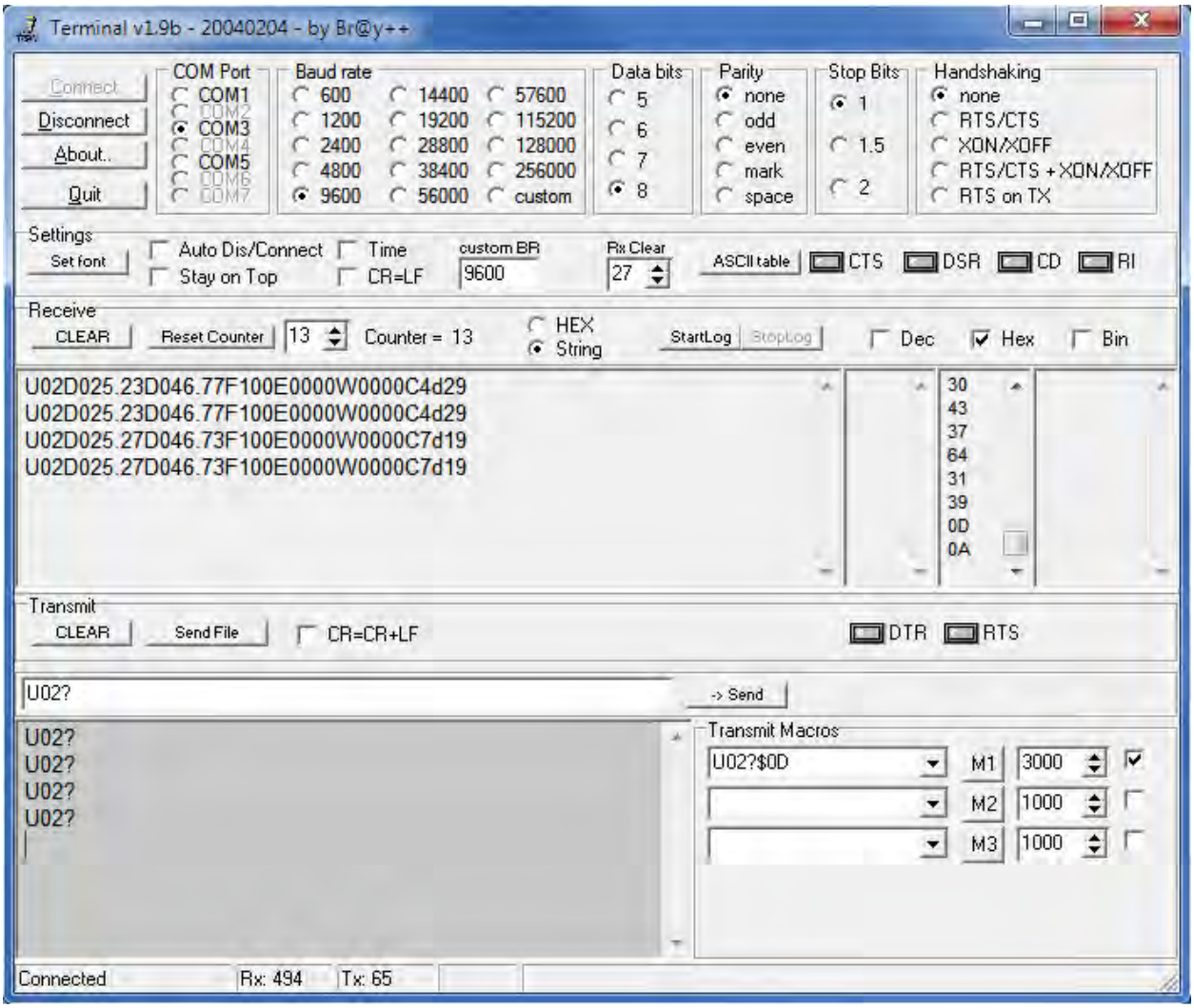
10.4.11 The Terminal application settings should be as below.



10.4.12 Click Connect.

10.4.13 Create a Transmit Macro that will send U02?$0D and check the checkbox to the right of the macro definition. Note that the 02 in the macro represents the Poll Address of the Model 706 device.

10.4.14 Verify that the Terminal application is receiving responses from the HMA and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



10.4.15 Verify that the value after the U in the response matches the Poll Address of the Model 706 device.

10.4.16 Verify that the value after the first D in the response matches the PV value shown on the local display of the Model 706 device.

10.4.17 Verify that the value after the second D in the response matches the SV value shown on the local display of the Model 706 device.

10.4.18 Verify that the value after the F in the response matches the Echo Strength value shown on the local display of the Model 706 device.

10.4.19 Verify that the values after the E and W in the response match the highest priority of any active diagnostics in the attached device. See Appendix T for a listing of codes. Typically, the code should match the active diagnostic displayed on the device's LCD home screen.

11. Additional LevelMaster Commands

11.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the additional Modbus LevelMaster protocol commands implemented in the HMA.

Using this procedure, the Number of Floats (UxxF?) can be read from the attached HART device and the Level Offset parameter can be read (UxxOL?) and changed (UxxOLxxxx?).

Note that the returned value for Level Offset, as well as the value for writing to the device, is multiplied by a factor of 10. For instance, a value of 0015 in the UxxOL? command represents a value of 1.5 in the HART device. This is to allow a more precise adjustment capability within the context of the command being limited to whole numbers.

11.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Terminal v1.9b application	hw-server.com	Version 1.9b - 20040204
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

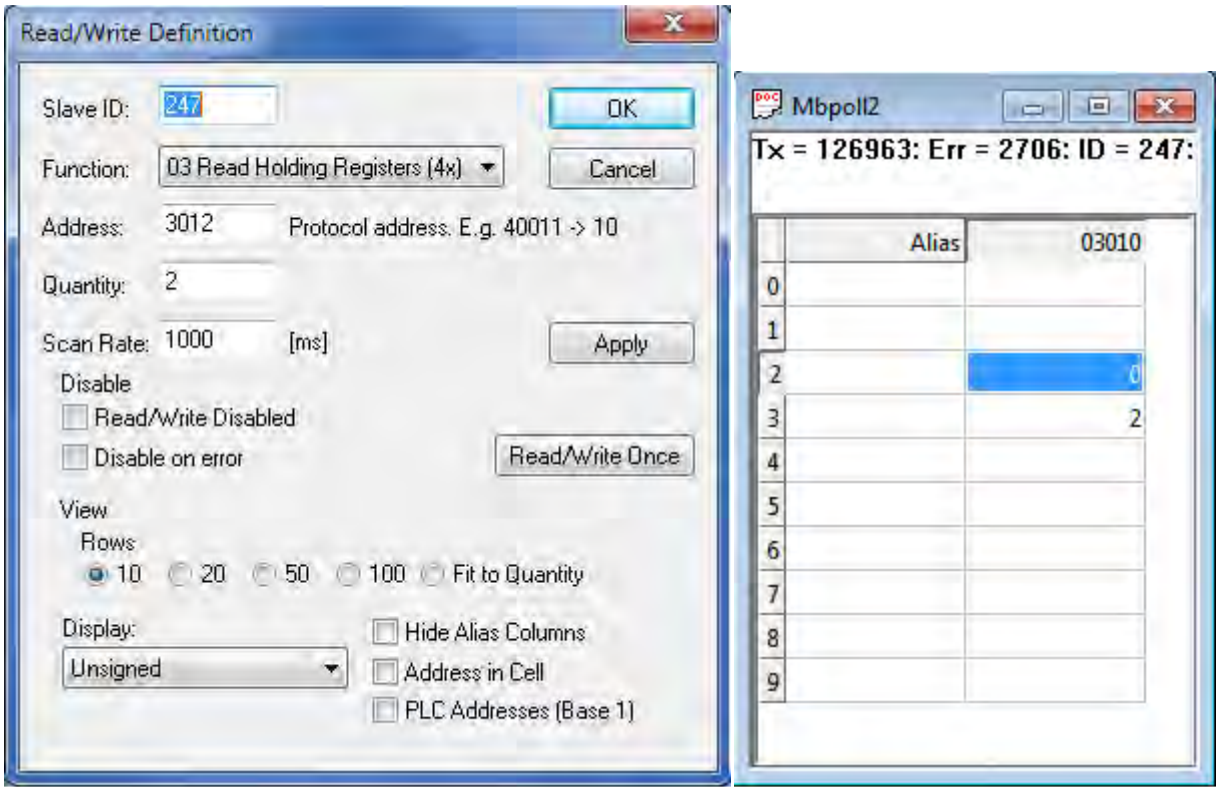
11.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect a Model 706 level transmitter to the HART loop terminal block of the HMA. Set the HART Poll Address of the Model 706 device to 3. Note that other Magnetrol HART transmitters and HART poll addresses can be used.

11.4. Procedure

11.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus LevelMaster protocol default settings. Refer to Appendix H for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

11.4.2 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each device.



11.4.3 Change DIP switch 1 to ON.

11.4.4 Select Connection\Disconnect from the Modbus Poll menu bar.

11.4.5 Start the Terminal v1.9b application.

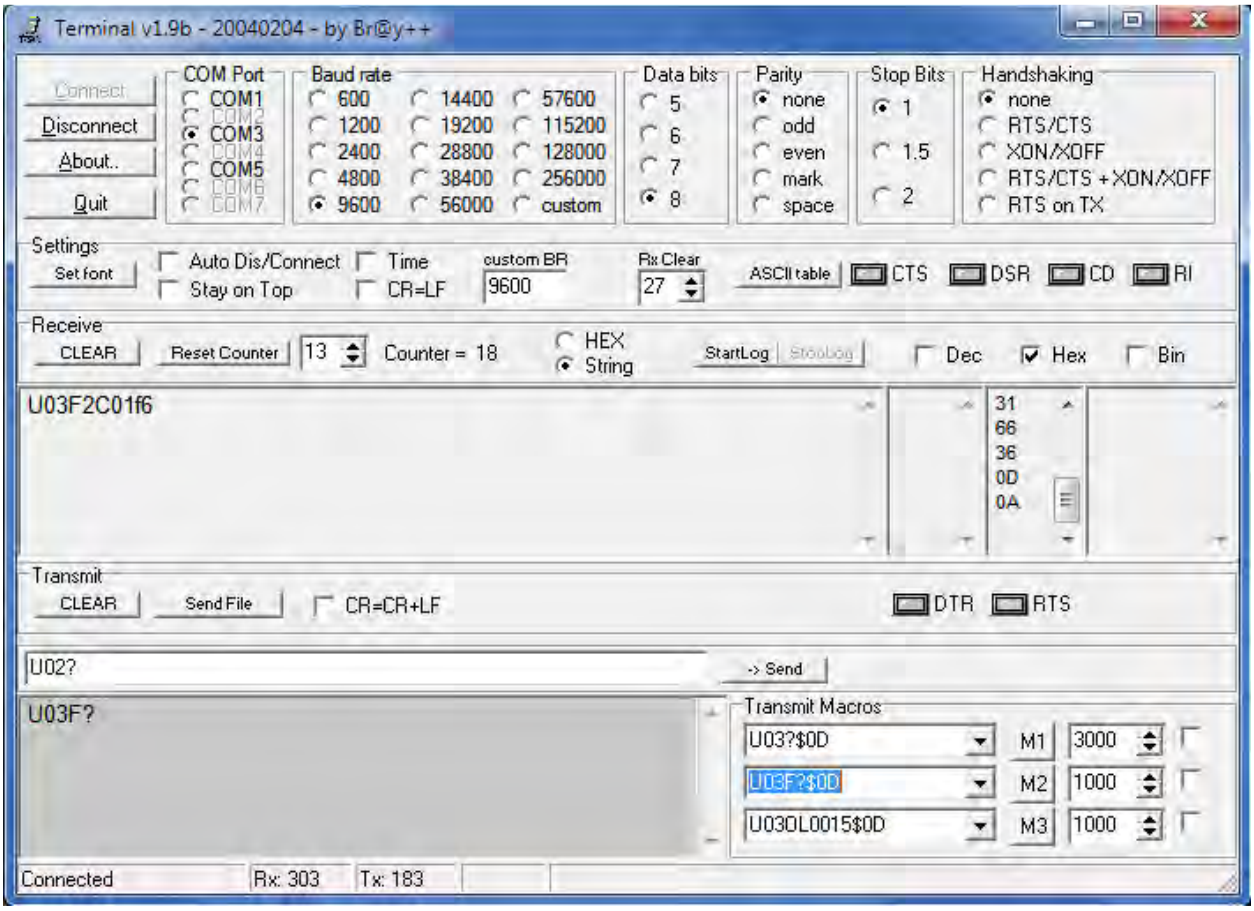
11.4.6 Set the COM Port to match the COM port used for the communication cable (the same number as with the Modbus Poll application).

11.4.7 Set the Baud rate, Data bits, Parity, Stop Bits and Handshaking parameters to match the settings made in the HMA for LevelMaster communication.

11.4.8 Click Connect.

11.4.9 Create a Transmit Macro that will send U03F?$0D and click on the Mx button to the right of the macro definition. This command requests the number of floating point numbers that the attached device will return when responding to the Uxx? command. For the HMA implementation, there will always be two floating point numbers returned so '2' should always be returned by the UxxF? Command. Note that the 03 in the macro represents the Poll Address of the Model 706 device.

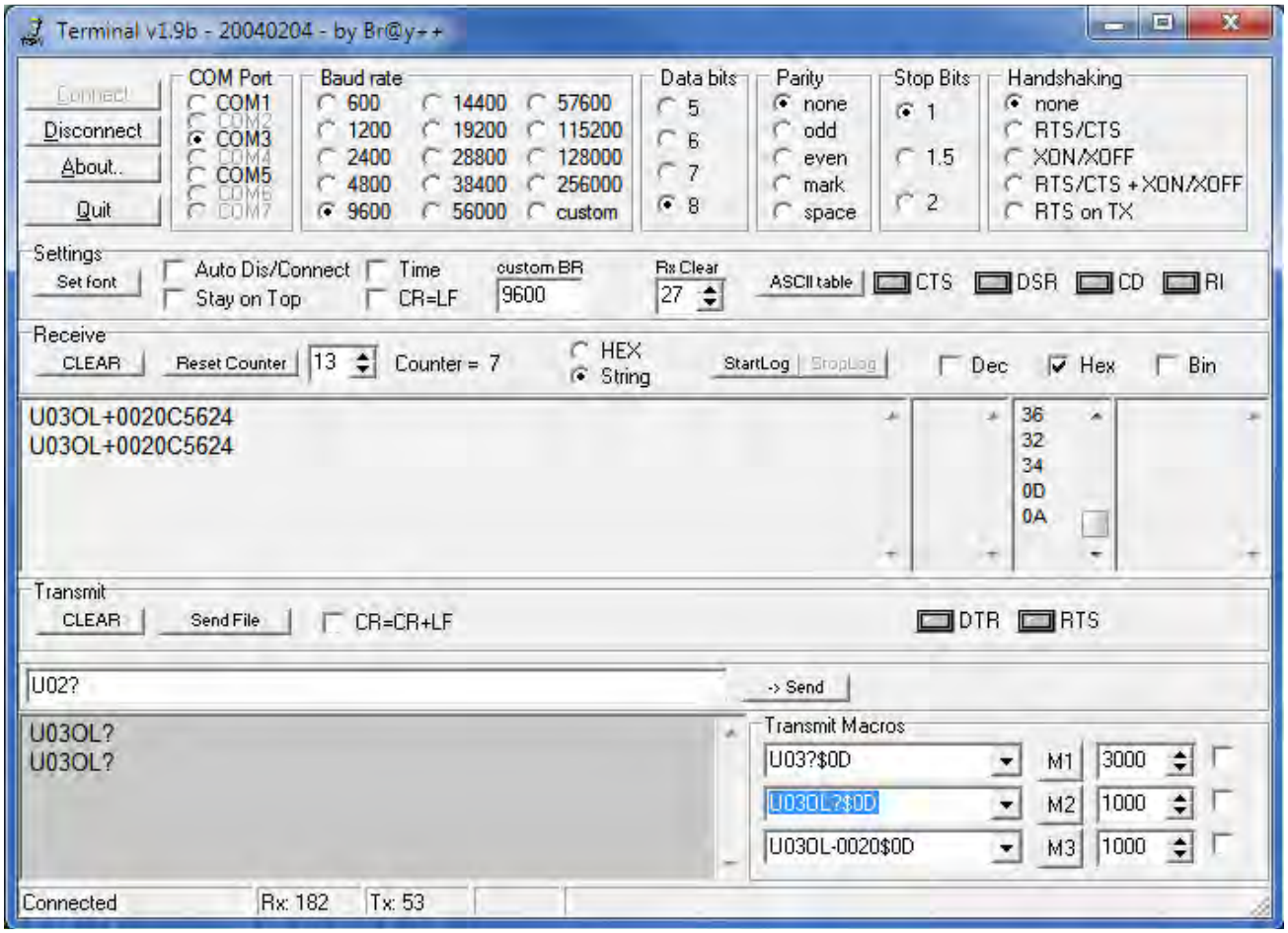
11.4.10 Verify that the Terminal application receives a response from the HMA each time the Mx button is clicked, and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



11.4.11 Verify that the value after the F in the response (indicating the number of floating point values that will be returned) equals '2' (from the above, U03F201f6).

11.4.12 Create a Transmit Macro that will send U03OL?$0D and click on the Mx button to the right of the macro definition. This command requests the value for Level Offset in the attached device. Note that the 03 in the macro represents the Poll Address of the Model 706 device.

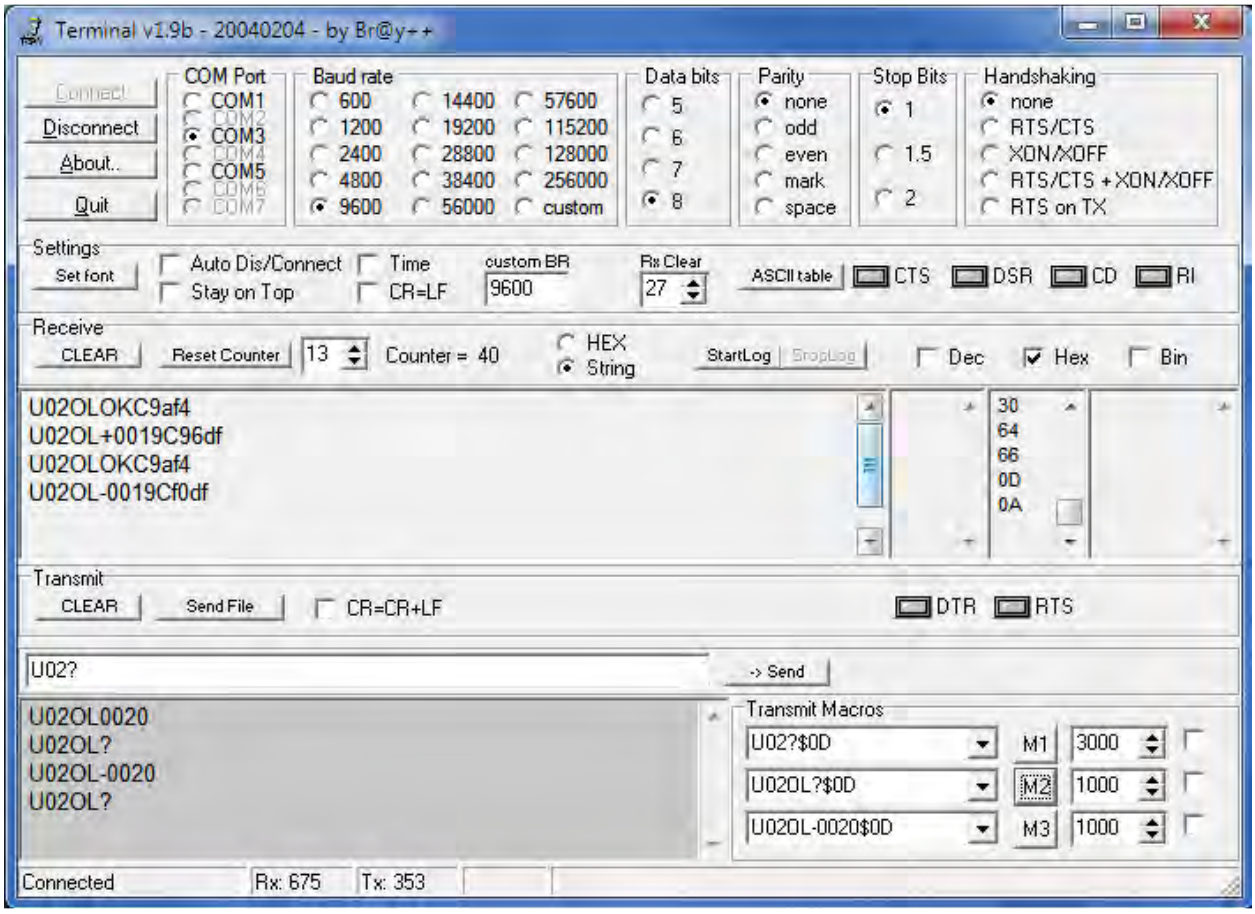
11.4.13 Verify that the Terminal application receives a response from the HMA each time the Mx button is clicked, and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



11.4.14 Verify that the value after the OL in the response matches the Level Offset value shown on the local display of the Model 706 device. The value displayed is shown as an integer number to conform to the command requirements, but actually represents the Level Offset multiplied by 10. For example, a Level Offset of 1.5 inches will be displayed in the command response as 0015. The value returned by the command may vary from the value shown on the local display by a value of 1 due to rounding. The value returned will be in terms of Level Units.

11.4.15 Create a Transmit Macro that will send U03OL0020$0D and click on the Mx button to the right of the macro definition. This command requests that the sent value be saved for Level Offset in the attached device. The value is in terms of Level Units.

11.4.16 Verify that the Terminal application receives a response from the HMA each time the Mx button is clicked, and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



11.4.17 Verify that the value after the OL in the response to command U03OL?$0D matches the Level Offset value sent by the U03OL0020$0D command and shown on the local display of the Model 706 device. The value returned by command U03OL?$0D may vary from the value shown on the local display by a value of 1 due to the effects of rounding.

11.4.18 Repeat steps 12.4.15 through 12.4.17 while sending U03OL-0020$0D to cause the writing of -2.0 as the Level Offset.

12. Auto Switching Between Modbus RTU/ASCII and HART over RS-485 Communication

12.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to automatically switch between Modbus RTU and HART over RS-485 communication when it receives the appropriate commands. This procedure uses a Model 706 as the attached device as an example; other Magnetrol HART devices can also be used with this procedure.

This provides a convenient method for configuring or troubleshooting an attached HART device using PACTware. The process is to set a register to a value of 1 while the HMA is in a Modbus communication mode. The HMA will automatically switch to the HART over RS-485 mode. No cycling of power is required. PACTware can then be connected to a device through the RS-485 terminal block on the HMA. Once the PACTware session is completed, by sending a HART command 0 with a poll address of 63, a user can cause the HMA to automatically revert to the previous Modbus configuration protocol settings. Again, no cycling of power is required.

This procedure demonstrates the auto-switching feature using the Modbus RTU protocol. The process can be used for the Modbus ASCII protocol by setting the HMA for that protocol in step 13.4.2.

12.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

12.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect a Model 706 transmitter and probe, or other supported Magnetrol HART transmitter, to the HART loop terminal block of the HMA. The device's Poll Address can be set to any value between 0 and 14.

12.4. Procedure

12.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus RTU protocol default settings. The address shown in register 3001 can be between 0 and 14. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

12.4.2 Note that when the HMA is in the Single Device Mode (register 3012 set to 2), the HMA address shown in register 3001 will match the HART Poll Address of the attached HART device.

12.4.3 Change DIP switch 1 to ON.

12.4.4 Click on the Mbpoll window, select Setup\Read\Write Definition from the menu bar, change the Slave ID to match the address shown in step 13.4.2 for register 3001, and then click OK.

12.4.5 Verify that the Modbus Poll application is communicating with the HMA.

12.4.6 Change to value of register 3008 to 1. This causes the HMA to automatically reboot into the HART over RS-485 mode.

12.4.7 Verify that the HMA is not communicating with the Modbus Poll application.

12.4.8 Select Connection\Disconnect from the Modbus Poll menu bar.

12.4.9 Start PACTware.

12.4.10 Add a HART Comm DTM to the Project.

12.4.11 Left click on the Comm DTM in the Project tree and add a DTM to the Project for one of the listed devices.

12.4.12 Right-click on the Comm DTM Project item and select Parameter. Select the correct COM port for the RS-485 communications cable, set the Start address and End address to cover the range of addresses for the attached devices. Set the Comm DTM to be a secondary master, then click OK.

12.4.13 Right-click on the Comm DTM Project item and select Additional functions\Change dtm address. Click on the Change address button. Select the poll address number corresponding to the attached Model 706 device, then click Close.

12.4.14 Right-click on the Comm DTM Project item and select Connect.

12.4.15 Right-click on the Comm DTM Project item and select Additional functions\Change device address. The DTM will scan for attached devices and display them in a list. If necessary, click on the Refresh button.

12.4.16 Verify that the attached Model 706 is listed and is shown with the correct Poll Address.

12.4.17 Right-click on the Comm DTM Project item and select Connect.

12.4.18 Double click on the device entry in the Project tree to open the Online parameterization window.

12.4.19 Verify that the DTM communicates with the device and features such are changing parameters and viewing Echo Curves, Echo History (as appropriate) and Trend Data are operational.

12.4.20 Close the Online parameterization window.

12.4.21 Right-click on the Comm DTM Project item and select Disconnect.

12.4.22 Right-click on the Comm DTM Project item and select Parameter. Set both the Start address and End address to 63, then click OK.

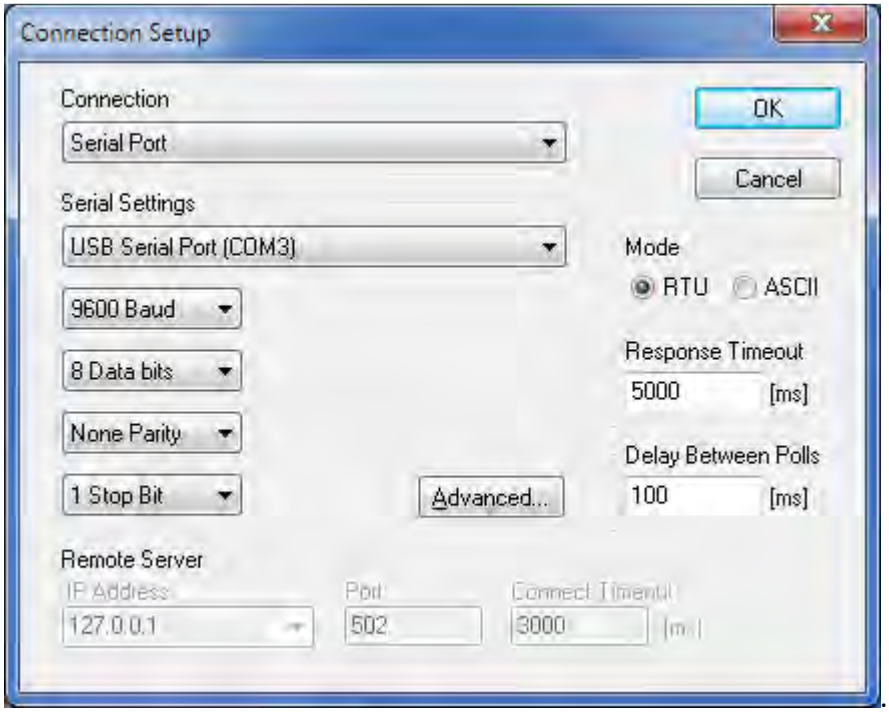
12.4.23 Right-click on the Comm DTM Project item and select Connect.

12.4.24 Right-click on the Comm DTM Project item and select Additional functions\Scan list. The DTM will scan for attached device, sending a HART Command 0 with an address of 63. Receipt of that command by the HMA will cause it to reboot into the Normal operating mode.

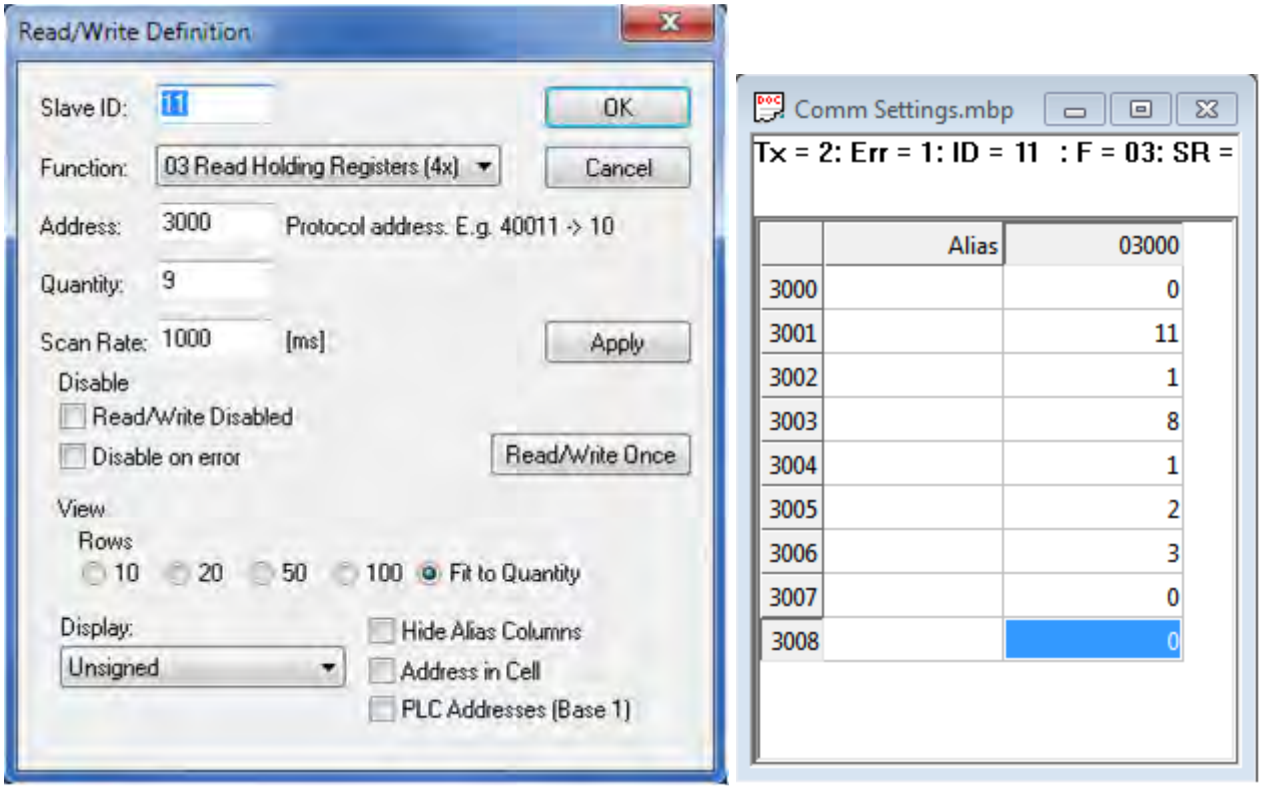
12.4.25 Shut down PACTware.

12.4.26 Open the Modbus Poll application.

12.4.27 Select Connection\Connect from the Modbus Poll menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.



12.4.28 Open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows (the Slave ID should match the address entered into register 3001 in step 13.4.1), and then click OK:



12.4.29 Verify that the Tx count in the Mbpoll window is increasing, the Err count is not increasing and there are no reported communication errors.

12.4.30 Verify that register 3008 is set to 0.

12.4.31 If unable to establish communication in the HART over RS-485 mode, the HMA can be reset to normal Modbus operating mode by switching DIP switch 1 to OFF. The HMA will switch into the default communication mode. Using Procedure 1, set register 3008 to 0. The HMA can be used either in that mode, or by setting DIP switch 1 to ON it can be used in its normal Modbus configuration mode.

13. Auto Switching Between LevelMaster and HART over RS-485 Communication

13.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to automatically switch between Modbus and HART over RS-485 communication when it receives the appropriate commands. This procedure uses a Model 706 as the attached device as an example; other Magnetrol HART devices can also be used with this procedure.

13.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Terminal v1.9b application	hw-server.com	Version 1.9b - 20040204
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
HART Modem	MacTek	Viator
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

13.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect a Model 706 transmitter and probe, or other supported Magnetrol HART transmitter, to the HART loop terminal block of the HMA. The device's Poll Address can be set to any value between 1 and 62.

13.4. Procedure

13.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus LevelMaster protocol default settings. The address shown in register 3001 can be between 1 and 62. Refer to Appendix H for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

13.4.2 Change DIP switch 1 to ON.

13.4.3 Ensure that the Modbus Poll application is not communicating with the HMA.

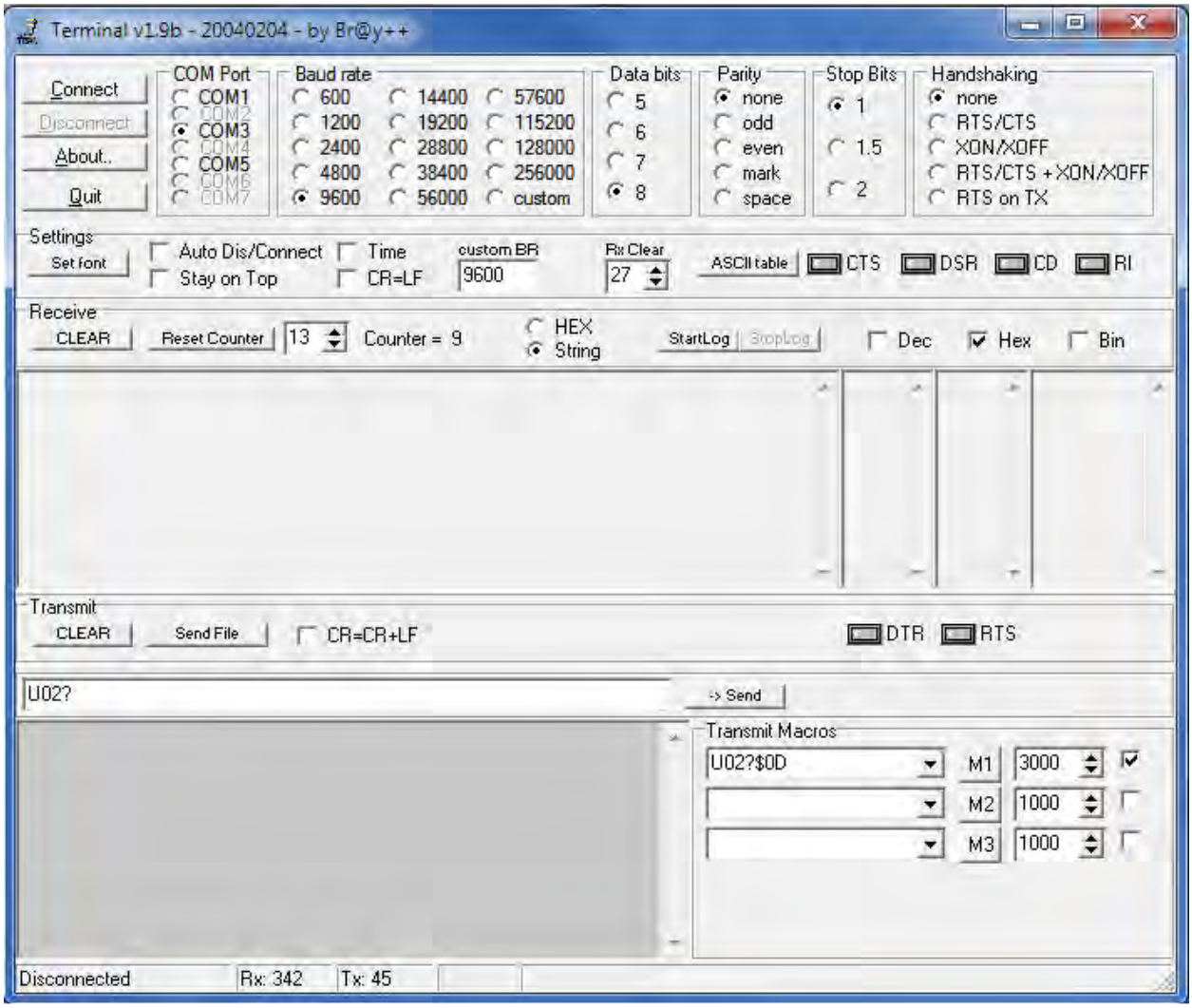
13.4.4 Select Connection\Disconnect from the Modbus Poll menu bar.

13.4.5 Start the Terminal v1.9b application.

13.4.6 Set the COM Port to match the COM port used for the communication cable (the same number as with the Modbus Poll application).

13.4.7 Set the Baud rate, Data bits, Parity, Stop Bits and Handshaking parameters to match the settings made in the HMA for LevelMaster communication.

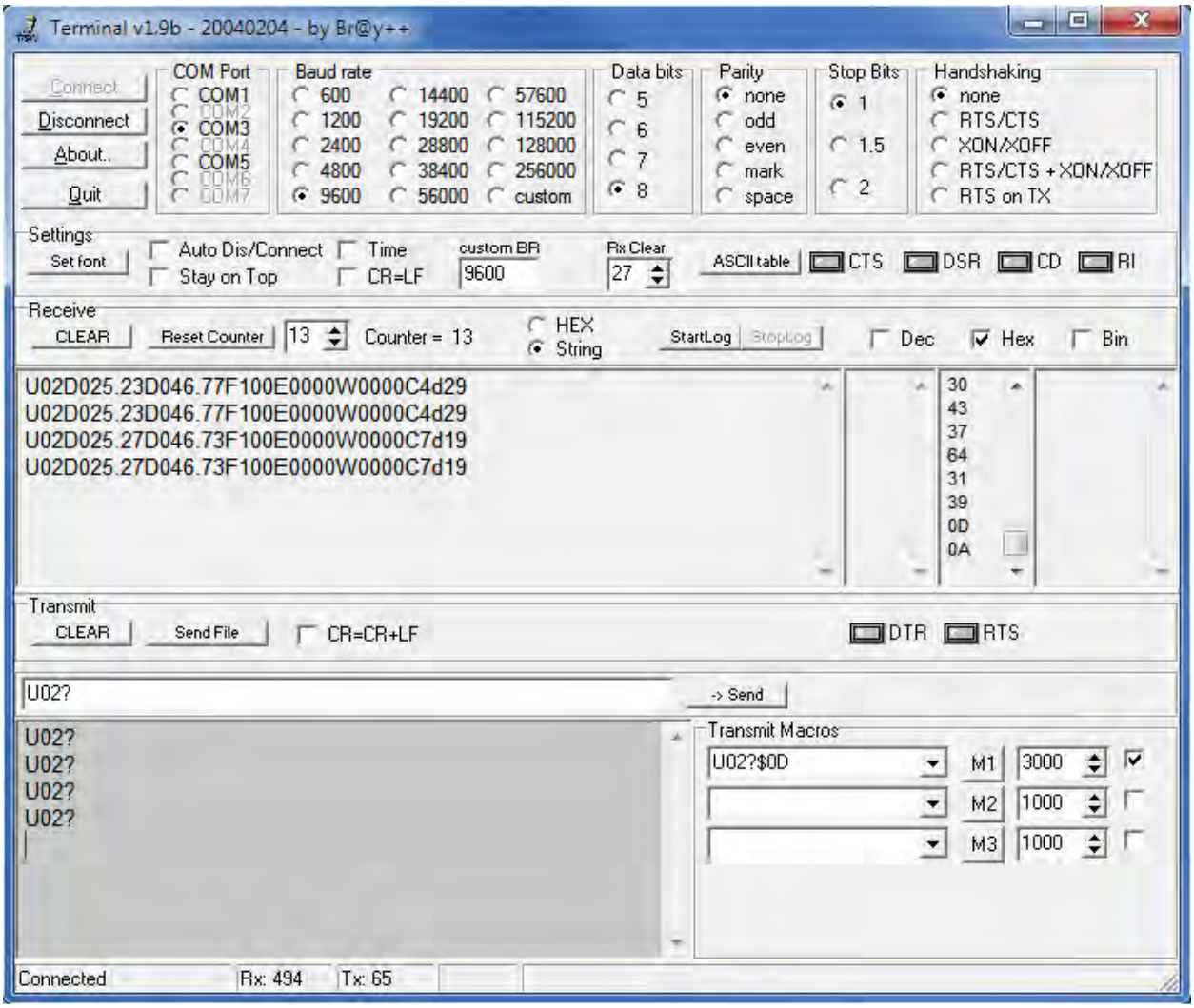
13.4.8 The Terminal application settings should be as below.



13.4.9 Click Connect.

13.4.10 Create a Transmit Macro that will send U02?$0D and check the checkbox to the right of the macro definition. Note that the 02 in the macro represents the Poll Address of the Model 706 device, so the number used should match the actual Poll Address of the attached device.

13.4.11 Verify that the Terminal application is receiving responses from the HMA and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



13.4.12 Uncheck the checkbox to stop the macro from repeating.

13.4.13 Create another Transmit Macro that will send U63?$0D and click on the Mx button to the right of the macro definition. This causes the HMA to automatically reboot into the HART over RS-485 mode. There shall be no response from the HMA.

13.4.14 Check the checkbox to the right of the U02?$0D macro definition.

13.4.15 Ensure that there is no response from the HMA.

13.4.16 Click on the Disconnect button.

13.4.17 Start PACTware.

13.4.18 Add a HART Comm DTM to the Project.

13.4.19 Left click on the Comm DTM in the Project tree and add a DTM to the Project for one of the listed devices.

13.4.20 Right-click on the Comm DTM Project item and select Parameter. Select the correct COM port for the RS-485 communications cable, set the Start address and End address to cover the range of addresses for the attached devices. Set the Comm DTM to be a secondary master, then click OK.

13.4.21 Right-click on the Comm DTM Project item and select Additional functions\Change dtm address. Click on the Change address button. Select the address number corresponding to the attached Model 706 device, then click Close.

13.4.22 Right-click on the Comm DTM Project item and select Connect.

13.4.23 Right-click on the Comm DTM Project item and select Additional functions\Change device address. The DTM will scan for attached devices and display them in a list. If necessary, click on the Refresh button.

13.4.24 Ensure that the attached Model 706 is listed and is shown with the correct Poll Address.

13.4.25 Right-click on the Comm DTM Project item and select Connect.

13.4.26 Double click on the device entry in the Project tree to open the Online parameterization window.

13.4.27 Ensure that the DTM communicates with the device and features such are changing parameters and viewing Echo Curves, Echo History (as appropriate) and Trend Data are operational.

13.4.28 Close the Online parameterization window.

13.4.29 Right-click on the Comm DTM Project item and select Disconnect.

13.4.30 Right-click on the Comm DTM Project item and select Parameter. Set both the Start address and End address to 63, then click OK.

13.4.31 Right-click on the Comm DTM Project item and select Connect.

13.4.32 Right-click on the Comm DTM Project item and select Additional functions\Scan list. The DTM will scan for attached device, sending a HART Command 0 with an address of 63. Receipt of that command by the HMA will cause it to reboot into the Normal operating mode.

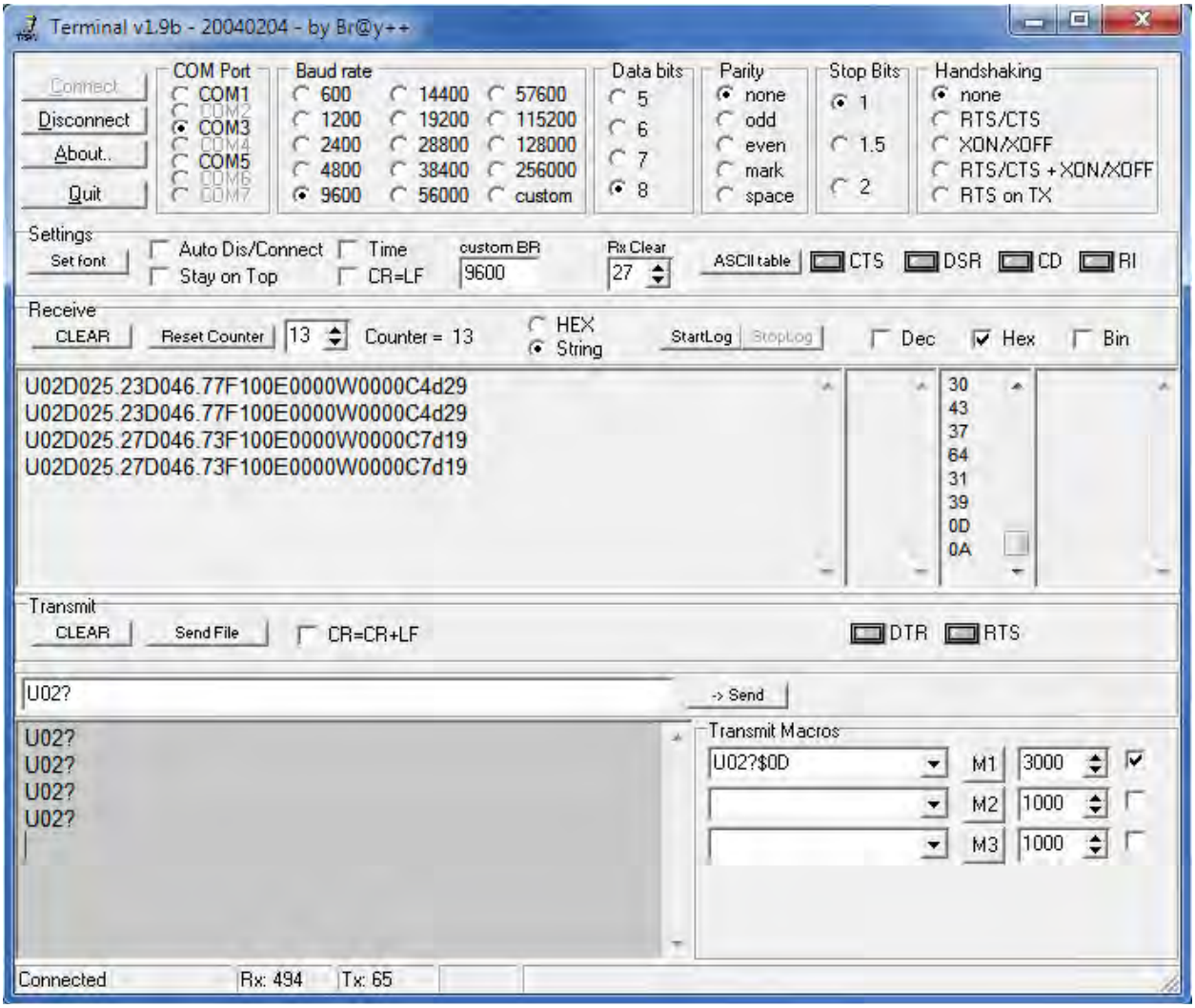
13.4.33 Shut down PACTware.

13.4.34 Open the Terminal application.

13.4.35 Click on the Connect button.

13.4.36 Create a Transmit Macro that will send Uxx?$0D to an attached device and check the checkbox to the right of the macro definition. Note that the xx in the macro represents the Poll Address of the target device.

13.4.37 Ensure that the Terminal application is receiving responses from the HMA and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



13.4.38 If unable to establish communication in the HART over RS-485 mode, the HMA can be reset to the default Modbus RTU operating mode by switching DIP switch 1 to OFF. The HMA will switch to the default communication mode. Using Procedure 1, set register 3008 to 0. The HMA can be used either in that mode, or by setting DIP switch 1 to ON it can be used in its normal Modbus configuration mode.

14. HMA Diagnostics

14.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to display diagnostic information. While the default Modbus RTU protocol is used to communicate with the HMA in this procedure, any supported Modbus RTU or ASCII communication configuration can be used.

14.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

14.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect up to five Magnetrol HART level transmitters (including the transmitter in the housing containing the HMA) to the HART loop terminal block of the HMA.

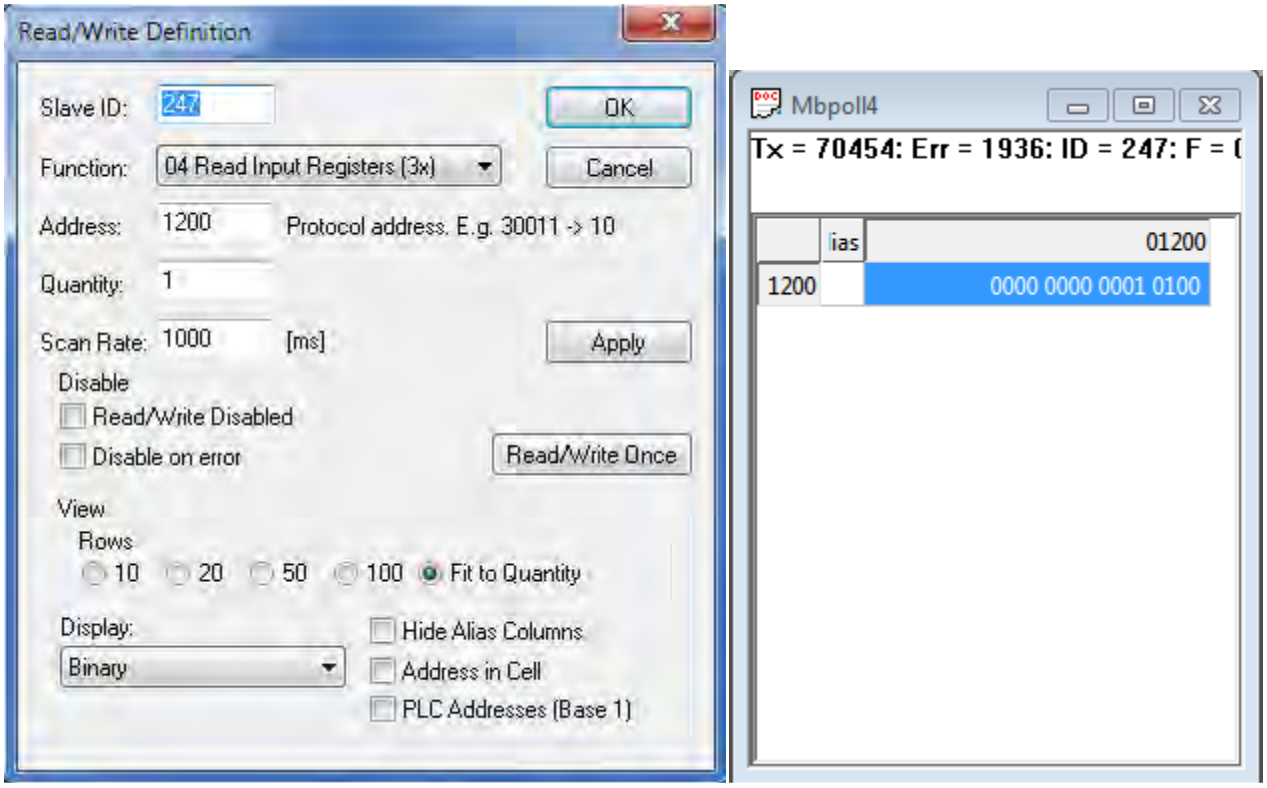
14.4. Procedure

14.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus RTU protocol default settings. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

14.4.2 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each device.

14.4.3 Power cycle the HMA, or move DIP switch 1 to ON and then back to OFF.

14.4.4 **To check the slave malfunction diagnostics**, open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:



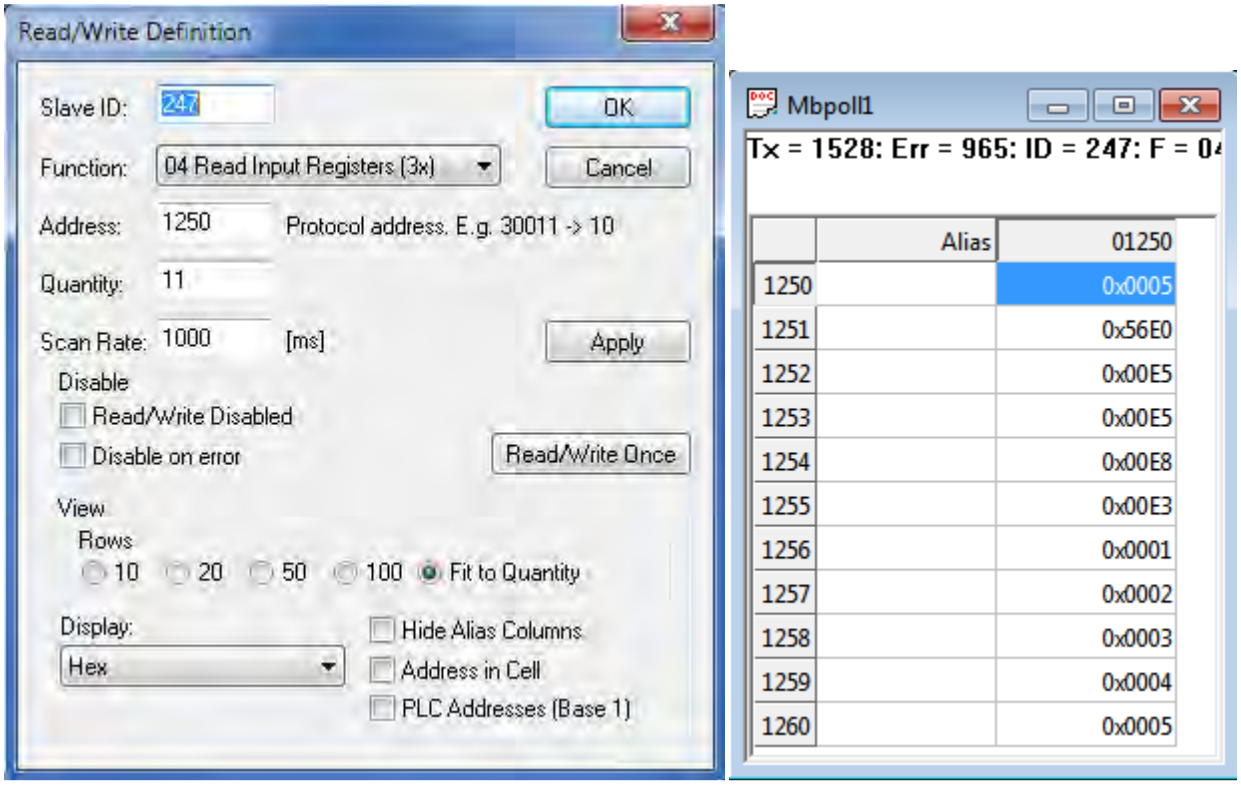
14.4.5 Remove one of the attached HART devices.

14.4.6 Verify that the corresponding slave malfunction bit (see Appendix J) changes to 1.

14.4.7 Reconnect the disconnected device.

14.4.8 Verify that the corresponding slave malfunction bit changes to 0.

14.4.9 **To check the types and poll addresses of the attached HART devices**, open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:

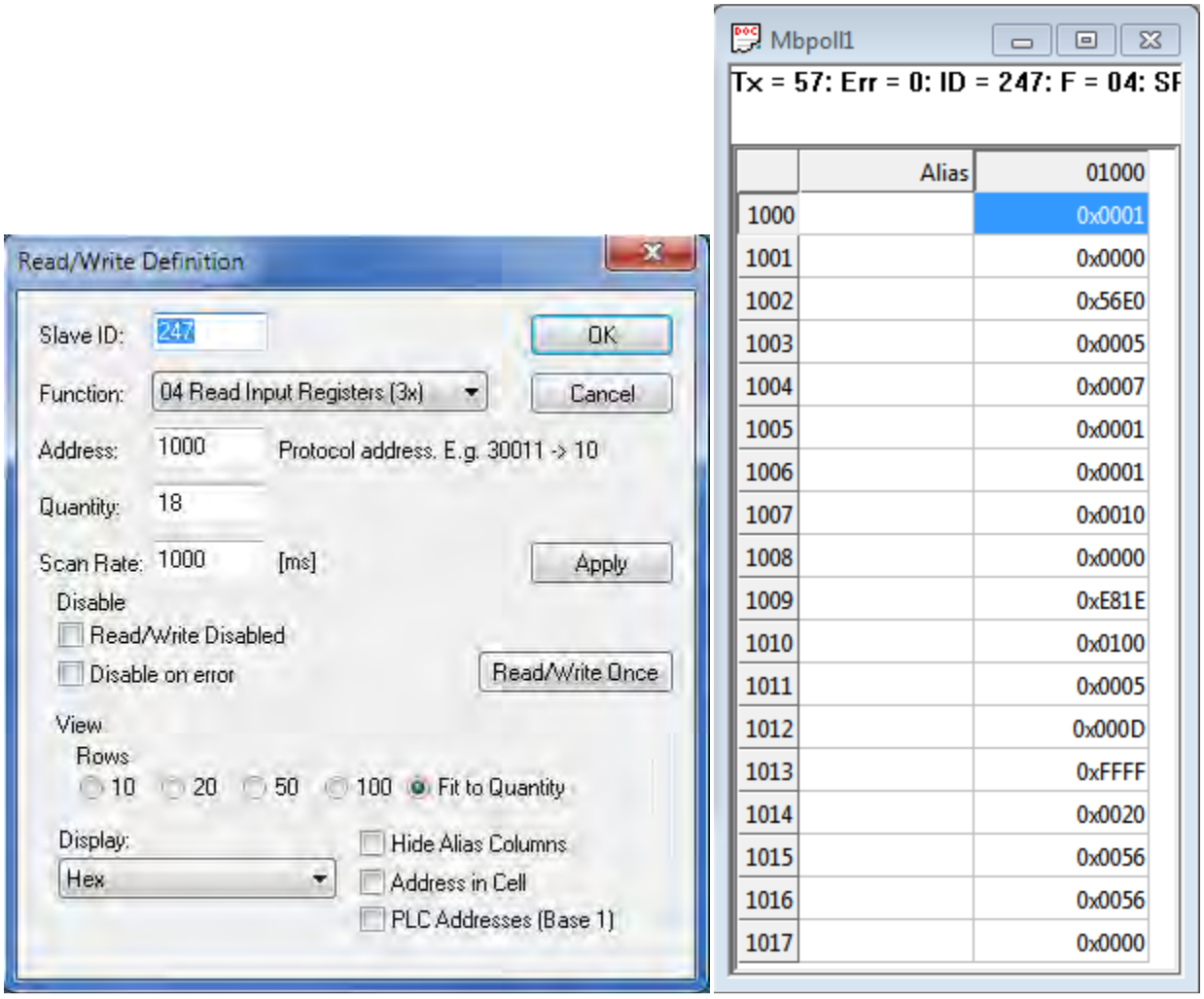


14.4.10 Verify that register 1250 indicates the correct number of attached devices.

14.4.11 Verify that registers 1251 through 1255 show the correct Device Types of the attached devices for each corresponding Poll Address.

14.4.12 Verify that registers 1256 through 1260 show the correct Poll Addresses of the attached devices.

14.4.13 **To check the device information for the attached HART devices**, open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:



14.4.14 Verify that registers 1000 through 1017 show the correct information for the attached device as listed in Appendix K.

14.4.15 Repeat steps 15.4.14 and 15.4.15 for the remaining four devices, changing the register addresses as appropriate.

15. Emerson ROC 800

15.1. Initial HMA Configuration

15.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values desired for communication with the ROC 800. Refer to Appendix F for the HMA RTU Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

15.2. Physical Connections

15.2.1 Connect the ROC 800 to a computer using an LOI RS-232 cable.

15.2.2 Connect an appropriate power supply to the power supply module of the ROC 800.

15.2.3 Connect the HMA to a 9 – 30 VDC power supply via terminal block TB1.

15.2.4 Connect an RS-485 communications cable between terminals A and B of the ROC 800 RS-485 module and the RS-485 terminal block (TB2) of the HMA.

15.2.5 Connect a 120Ω resistor between the two RS-485 terminal block positions of the last HMA on the bus

15.3. Initial ROC 800 Configuration

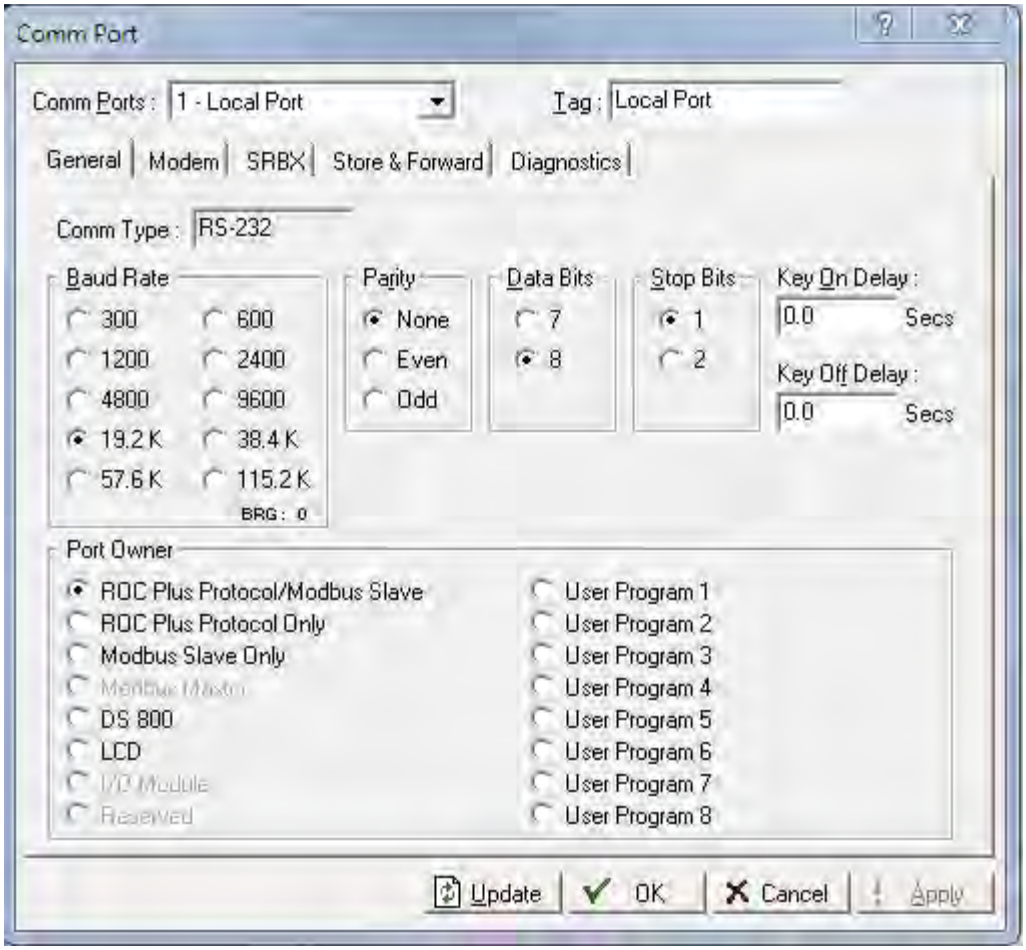
15.3.1 Start the ROCLINK 800 application.

15.3.2 Select ROC \ Direct Connect in the ROCLINK 800 Menu bar. An image of the front of the ROC 800 will appear.

15.3.3 Mouse over the image of the RS-485 module. A flyover text box will appear that identified the Comm Port used for RS-485 communication with the HMA.

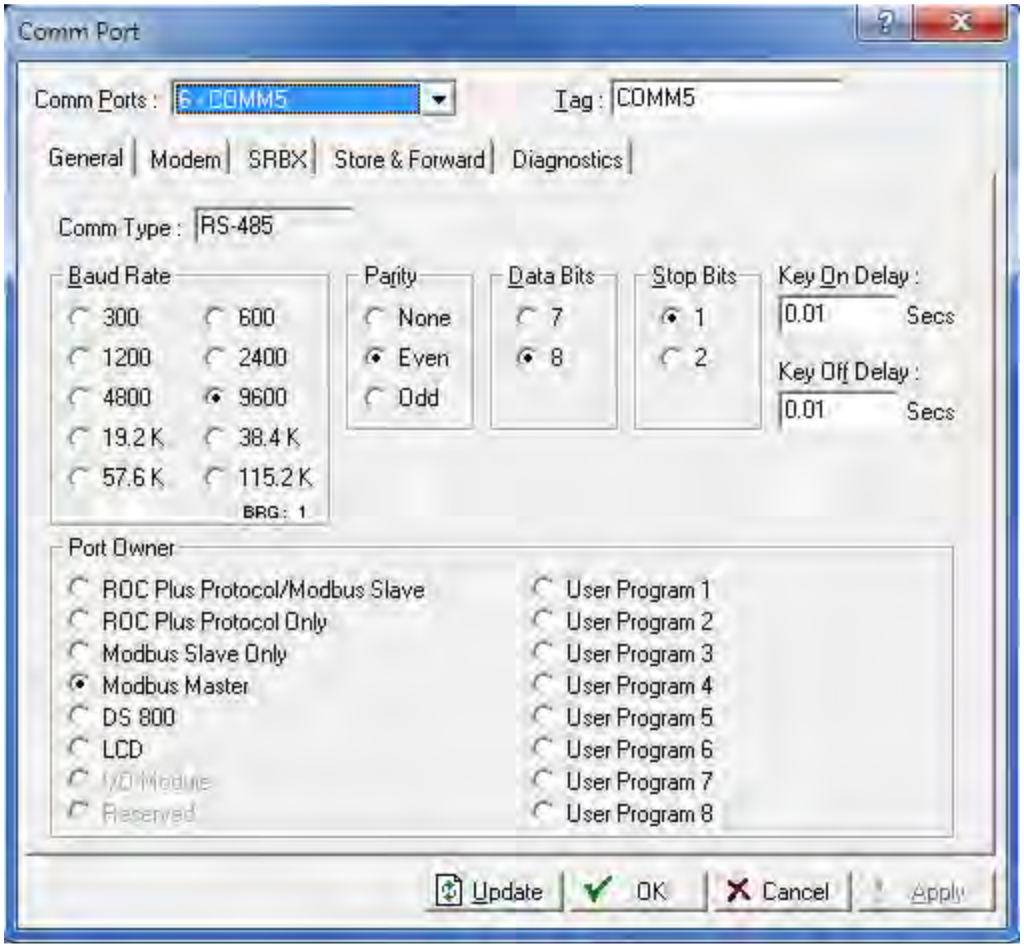
15.3.4 Click on ROC \ Comm Ports in the ROCLINK 800 Menu bar.

15.3.5 Ensure that the communication settings for 1 – Local Port are as follows.



15.3.6 For Comm Ports, select the port number displayed in step 16.3.3.

15.3.7 Ensure that the communications settings match the settings of the HMA performed in step 16.1.1, then click OK. Ensure that the Port Owner is set to Modbus Master. For example,



15.4. **Reading registers from the HMA**

15.4.1 Select Configure \ MODBUS from the ROCLINK 800 Menu bar.

15.4.2 Change the Comm Port to match the port to which the HMA is connected.

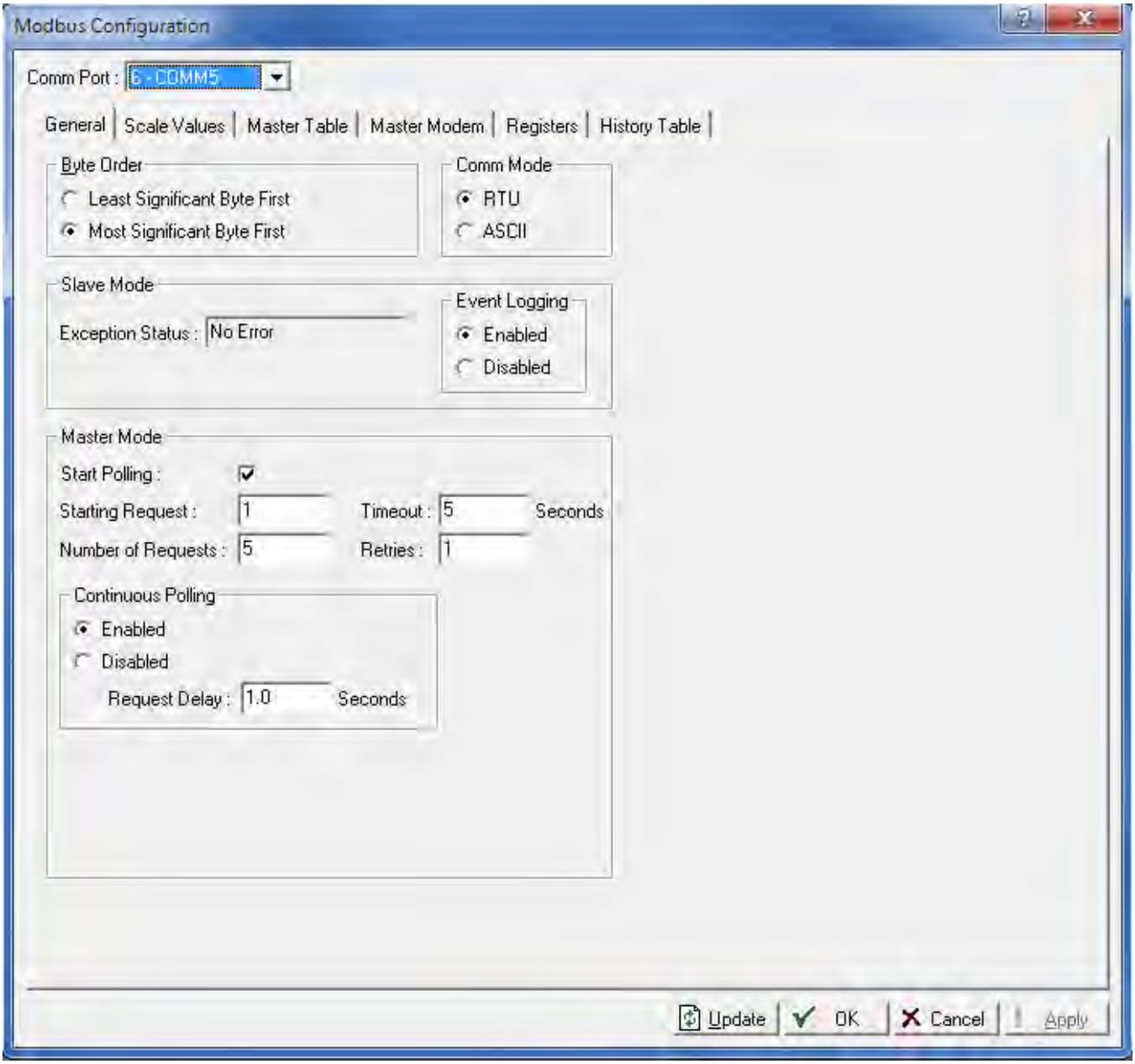
15.4.3 The followings steps demonstrate how to read the PV, SV, TV and QV as well as the Blocking Distance from a HART device attached to the HMA.

15.4.4 For the General tab,

15.4.5 Ensure that the Byte Order and Comm Mode match the selections made in step 16.1.1.

15.4.6 Check ‘Start Polling’. Set the Starting Request to 1 and the Number of Requests to match the total number of separate rows defined in the Master Table tab below.

15.4.7 Select the Enabled radio button in the Continuous Polling group box.

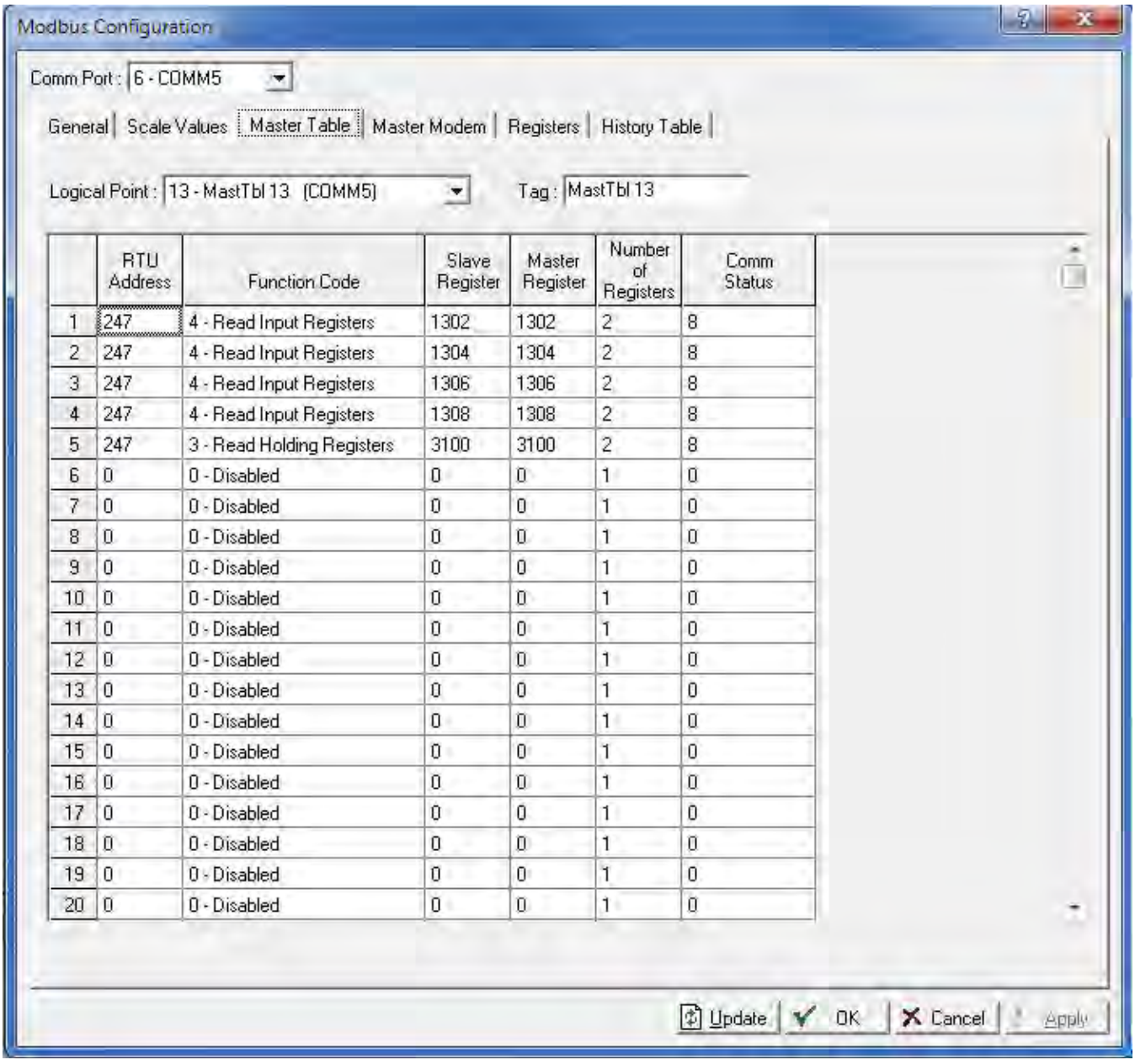


15.4.8 For the Master Table tab,

15.4.9 Set the Logical Point to 13 – MastTbl 13 (COMM5).

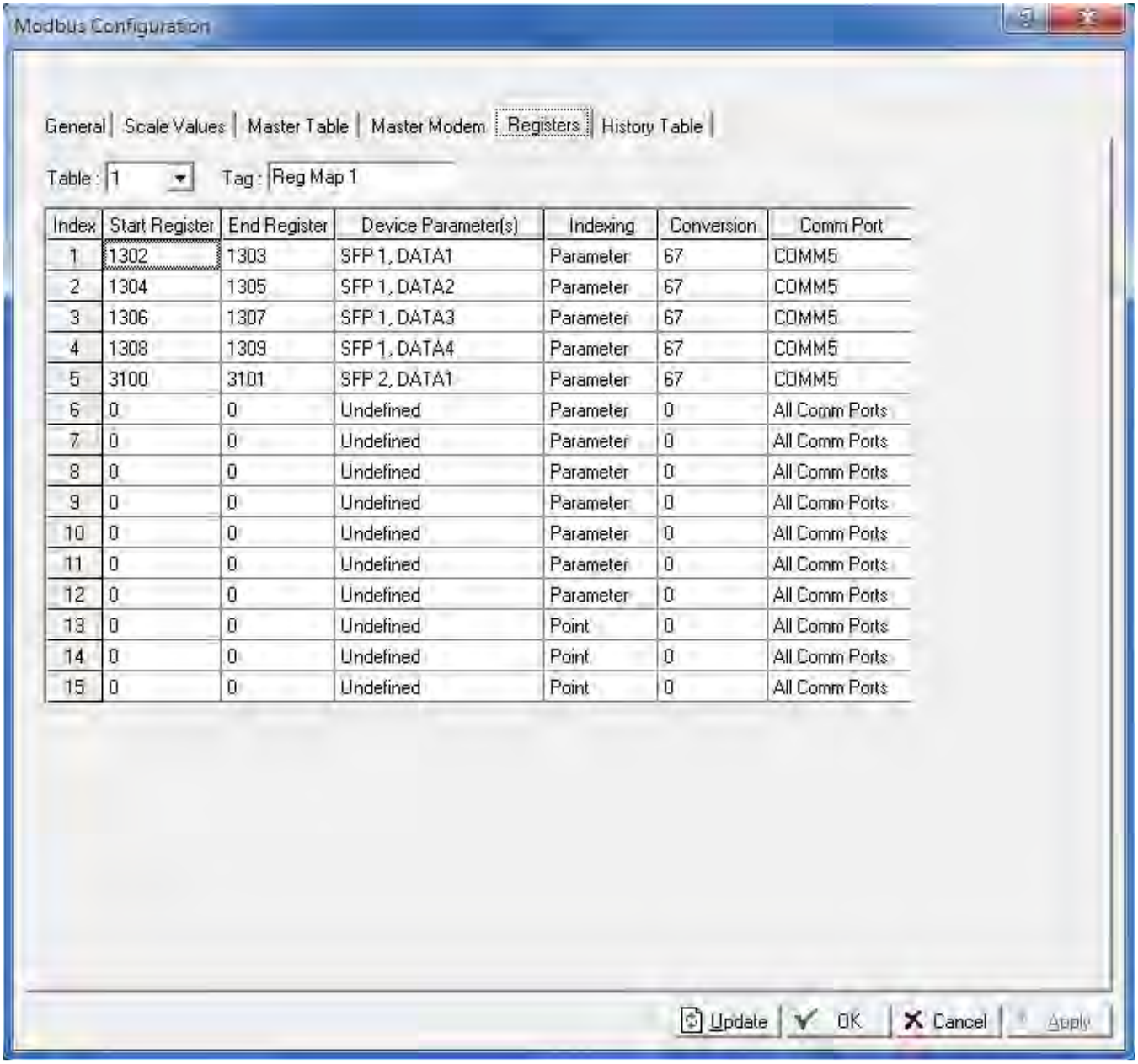
15.4.10 Enter into the table the sets of registers to be read from the device. Set the RTU Address to that of the HMA when it is in the 'HMA' mode. Set the RTU Address to that of the individual attached HART device to be queried when the HMA is in the 'Device' mode.

15.4.11 In the example below, the HMA is in 'HMA' mode and has an address of 247.



	RTU Address	Function Code	Slave Register	Master Register	Number of Registers	Comm Status
1	247	4 - Read Input Registers	1302	1302	2	8
2	247	4 - Read Input Registers	1304	1304	2	8
3	247	4 - Read Input Registers	1306	1306	2	8
4	247	4 - Read Input Registers	1308	1308	2	8
5	247	3 - Read Holding Registers	3100	3100	2	8
6	0	0 - Disabled	0	0	1	0
7	0	0 - Disabled	0	0	1	0
8	0	0 - Disabled	0	0	1	0
9	0	0 - Disabled	0	0	1	0
10	0	0 - Disabled	0	0	1	0
11	0	0 - Disabled	0	0	1	0
12	0	0 - Disabled	0	0	1	0
13	0	0 - Disabled	0	0	1	0
14	0	0 - Disabled	0	0	1	0
15	0	0 - Disabled	0	0	1	0
16	0	0 - Disabled	0	0	1	0
17	0	0 - Disabled	0	0	1	0
18	0	0 - Disabled	0	0	1	0
19	0	0 - Disabled	0	0	1	0
20	0	0 - Disabled	0	0	1	0

15.4.12 For the Registers tab,

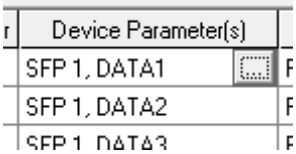


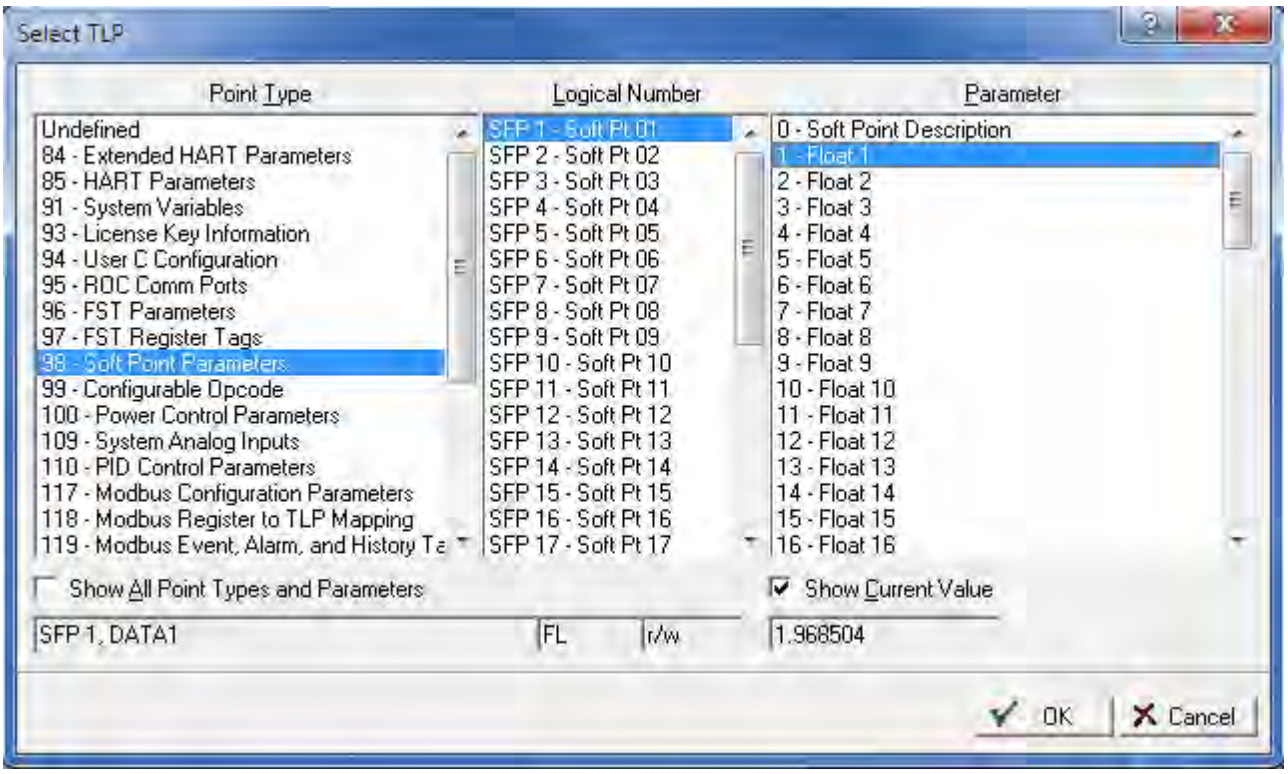
Index	Start Register	End Register	Device Parameter(s)	Indexing	Conversion	Comm Port
1	1302	1303	SFP 1, DATA1	Parameter	67	COMM5
2	1304	1305	SFP 1, DATA2	Parameter	67	COMM5
3	1306	1307	SFP 1, DATA3	Parameter	67	COMM5
4	1308	1309	SFP 1, DATA4	Parameter	67	COMM5
5	3100	3101	SFP 2, DATA1	Parameter	67	COMM5
6	0	0	Undefined	Parameter	0	All Comm Ports
7	0	0	Undefined	Parameter	0	All Comm Ports
8	0	0	Undefined	Parameter	0	All Comm Ports
9	0	0	Undefined	Parameter	0	All Comm Ports
10	0	0	Undefined	Parameter	0	All Comm Ports
11	0	0	Undefined	Parameter	0	All Comm Ports
12	0	0	Undefined	Parameter	0	All Comm Ports
13	0	0	Undefined	Point	0	All Comm Ports
14	0	0	Undefined	Point	0	All Comm Ports
15	0	0	Undefined	Point	0	All Comm Ports

15.4.13 Set the Table to 1, and for each variable to be read,

15.4.14 Enter the Start and End Register numbers. Refer to Appendices F through S for register numbers of the HMA and attached HART devices.

15.4.15 Create a Soft Point and Data number in the Device Parameter(s) column. Click on the ellipsis button that appears at the right side of the cell to open the 'Select TLP' dialog.





15.4.16 Select 98 – Soft Point Parameters for the Point Type, SFP 1 – Soft Point 01 for the Logical Number, and 1 – Float 1 for the Parameter. Note the name for the point, for example, SPF 1, DATA 1. By checking 'Show Current Value', one can confirm that the desired parameter is being read correctly. Then click 'OK' to close the Select TLP dialog.[2]

15.4.17 Set a Convert Code (see ROCLINK 800 Help) in the Conversion column () to properly interpret the data bytes into the correct numerical format.

15.4.18 Assign the correct Comm Port number.

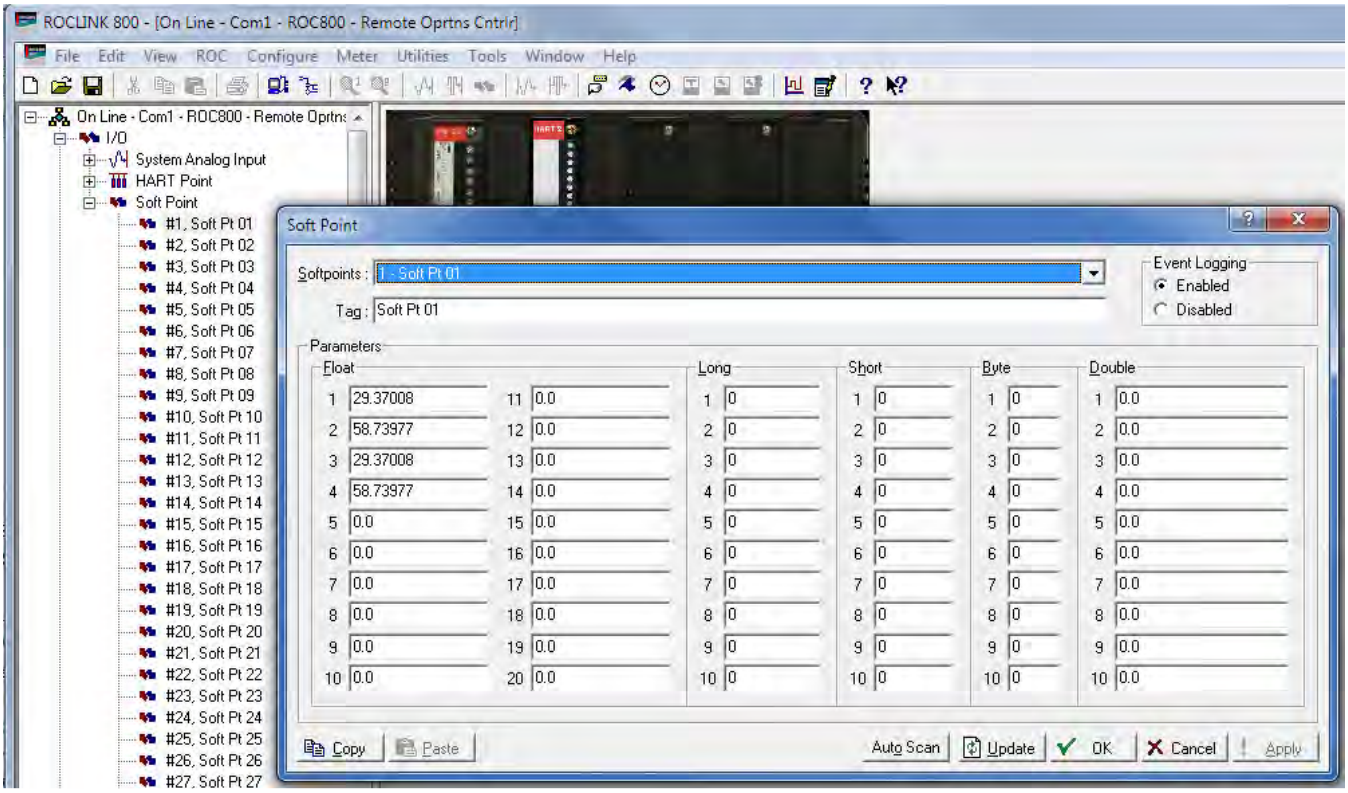
15.4.19 Repeat as required for the remaining parameters to be read from the device.

15.4.20 Return to Master Table tab and ensure that the Comm Status for each line is 8, indicating a Valid Slave Response.

[2] Select 'Short' for the Parameter type when setting up to read the unsigned integer communication registers 3000 through 3007 in the HMA.

15.4.21 To display the values,

15.4.22 Open the Soft Point dialog by selecting I/O \ Soft Point in the Configuration Tree window, then double-clicking on #1, Soft Pt 01.



15.4.23 Click on Update to read a single set of values from the device, or Auto Scan to repeatedly update the displayed values.

15.5. **Writing registers to the HMA**

15.5.1 Configure the ROC 800 to access a register in the HMA or attached HART device as for reading a register from the HMA (section 16.4).

15.5.2 When setting up the row in the Configure \ MODBUS \ Master Table tab, use Function Code 16 – Preset Multiple Registers for multi-byte parameters, or 6 – Preset Single Register for single-byte parameters.

15.5.3 Click Update to send the new setting to the ROC 800.

15.5.4 Open the Soft Point dialog by selecting I/O \ Soft Point in the Configuration Tree window, then double-clicking on #1, Soft Pt 01.

15.5.5 Highlight the value to be changed and enter the new value.

15.5.6 Click on Update to send the new value to the device.

15.5.7 Return to the Configure \ MODBUS \ Master Table tab.

15.5.8 Change the Function Code for the parameter to 3 – Read Holding Registers or 4 – Read Input Registers as appropriate.

15.5.9 Click on Update to send the new setting to the device.

15.5.10 Return to the Soft Point dialog by selecting I/O \ Soft Point in the Configuration Tree window, then double-clicking on #1, Soft Pt 01.

15.5.11 Click on Update to confirm that the device has accepted the new value.

16. ABB Totalflow XRC – Modbus RTU / ASCII

The following procedure applies to operation with both RTU and ASCII communication. The choice of communication protocol is made in step 17.1.1 for the HMA settings and in step 17.3.10 for the ABB Totalflow XRC. The Modbus RTU protocol is used for the following.

16.1. Initial HMA Configuration

16.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values desired for Modbus communication with the XRC. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

16.2. Physical Connections

16.2.1 Connect the XRC to a computer using a USB-A to USB-B cable.

16.2.2 Connect an appropriate power supply to the battery terminal (J16) of the XRC.

16.2.3 Connect the HMA to a 9 – 30 VDC power supply via terminal block TB1.

16.2.4 Connect an RS-485 communications cable between the COM1 terminal block (lower position of J6) of the XRC and the RS-485 terminal block (TB2) of the HMA. The RS485+ terminal of the HMA should be connected to the BUS+ of the TotalFlow terminal block. The – terminals should be connected correspondingly. See section 17.3.11.

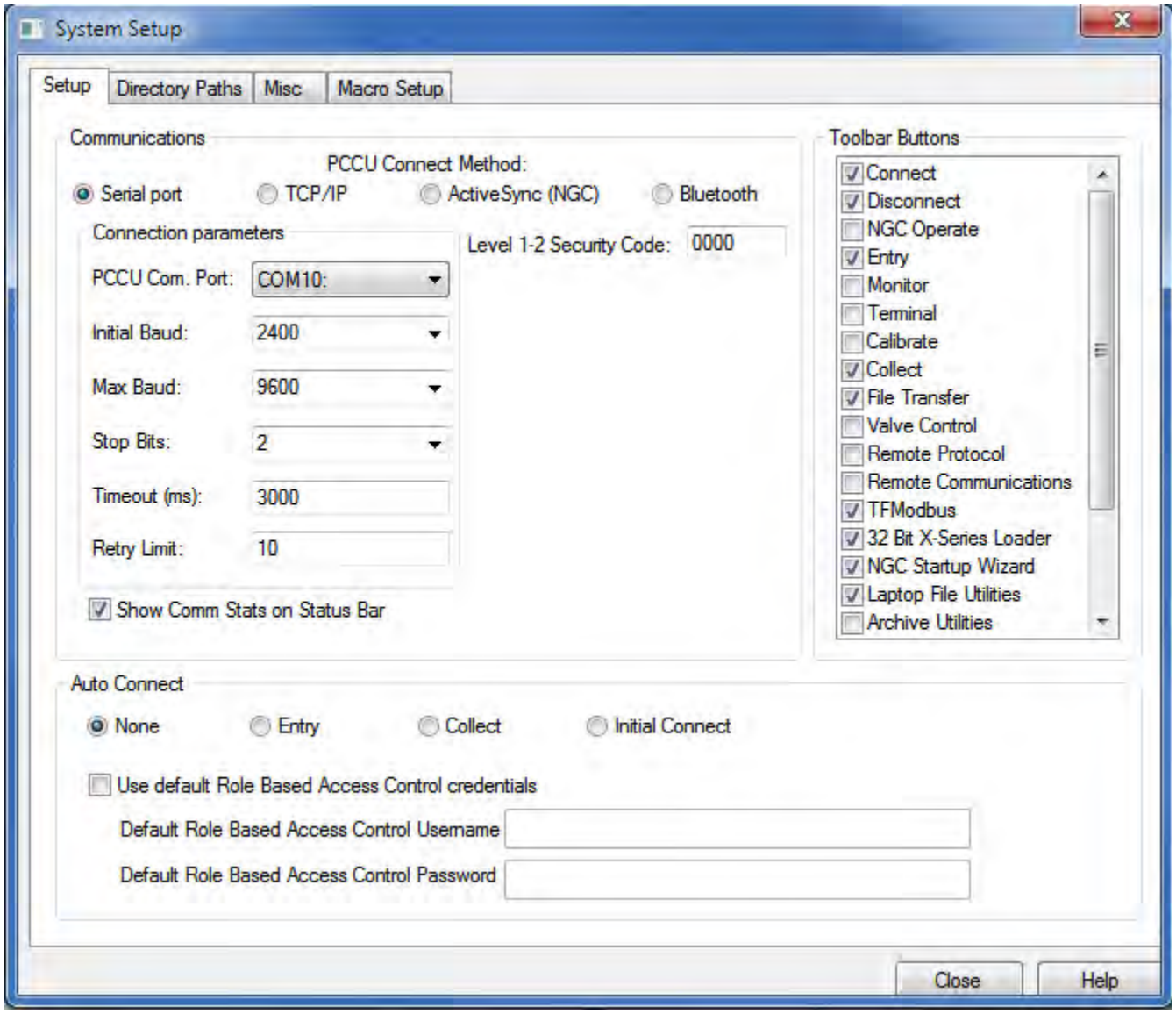
16.2.5 Ensure that the appropriate communication module is inserted into the Comm 1 receptacle (XA1).

16.2.6 Connect a 120Ω resistor between the two RS-485 terminal block positions of the last HMA on the bus.

16.3. Initial XRC Configuration

16.3.1 Start the PCCU32 application.

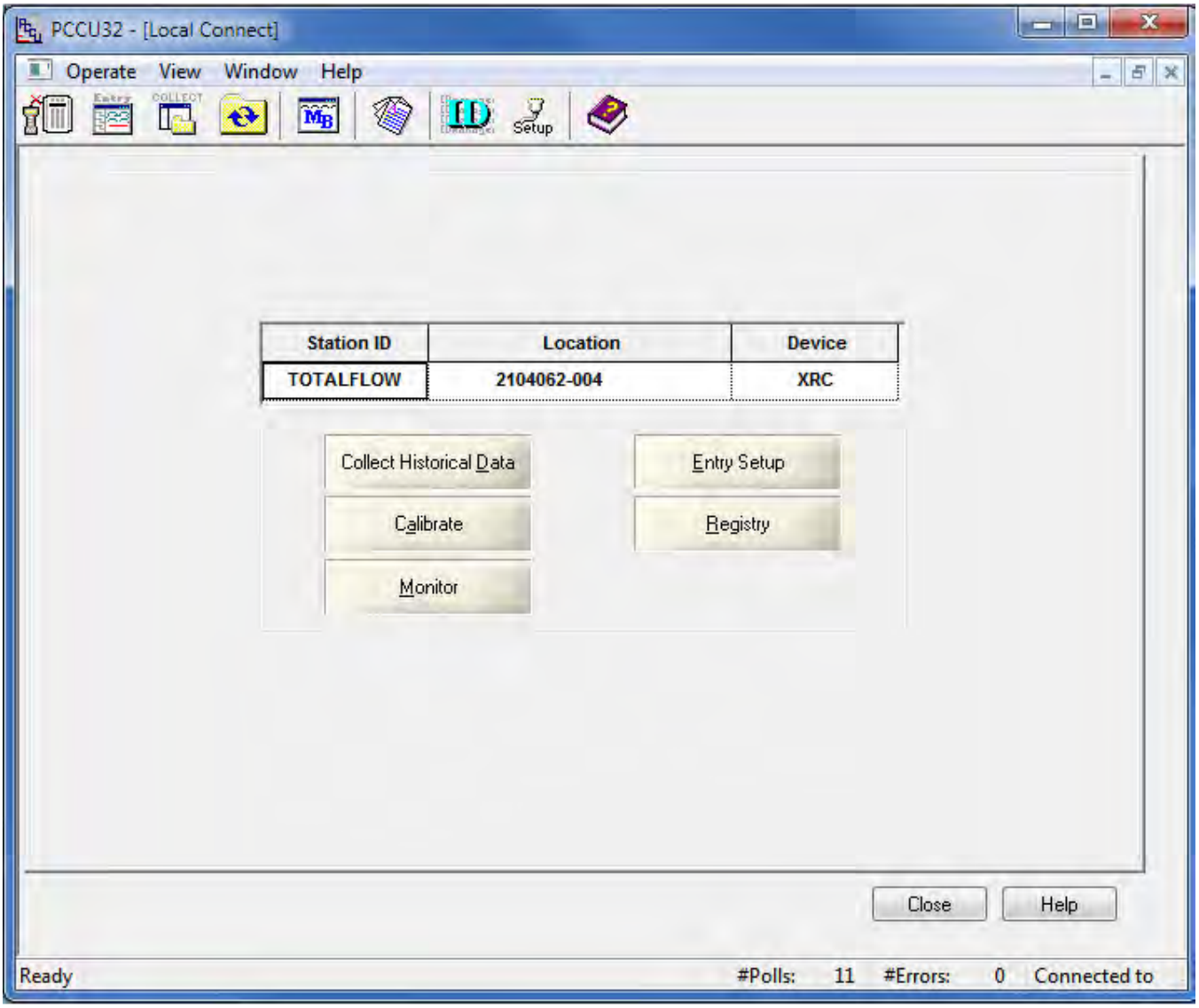
16.3.2 Select on Operate \ Setup \ System Setup in the PCCU32 Menu bar. A dialog will appear allowing for communication settings between the PCCU32 application and the XRC.



16.3.3 Select the COM port number corresponding to the XRC. The proper COM port number can be identified by navigating to the Device Manager in Windows and expanding the Ports entry.

16.3.4 Click Close.

16.3.5 Select on Operate \ Connect to Totalflow in the PCCU32 Menu bar.



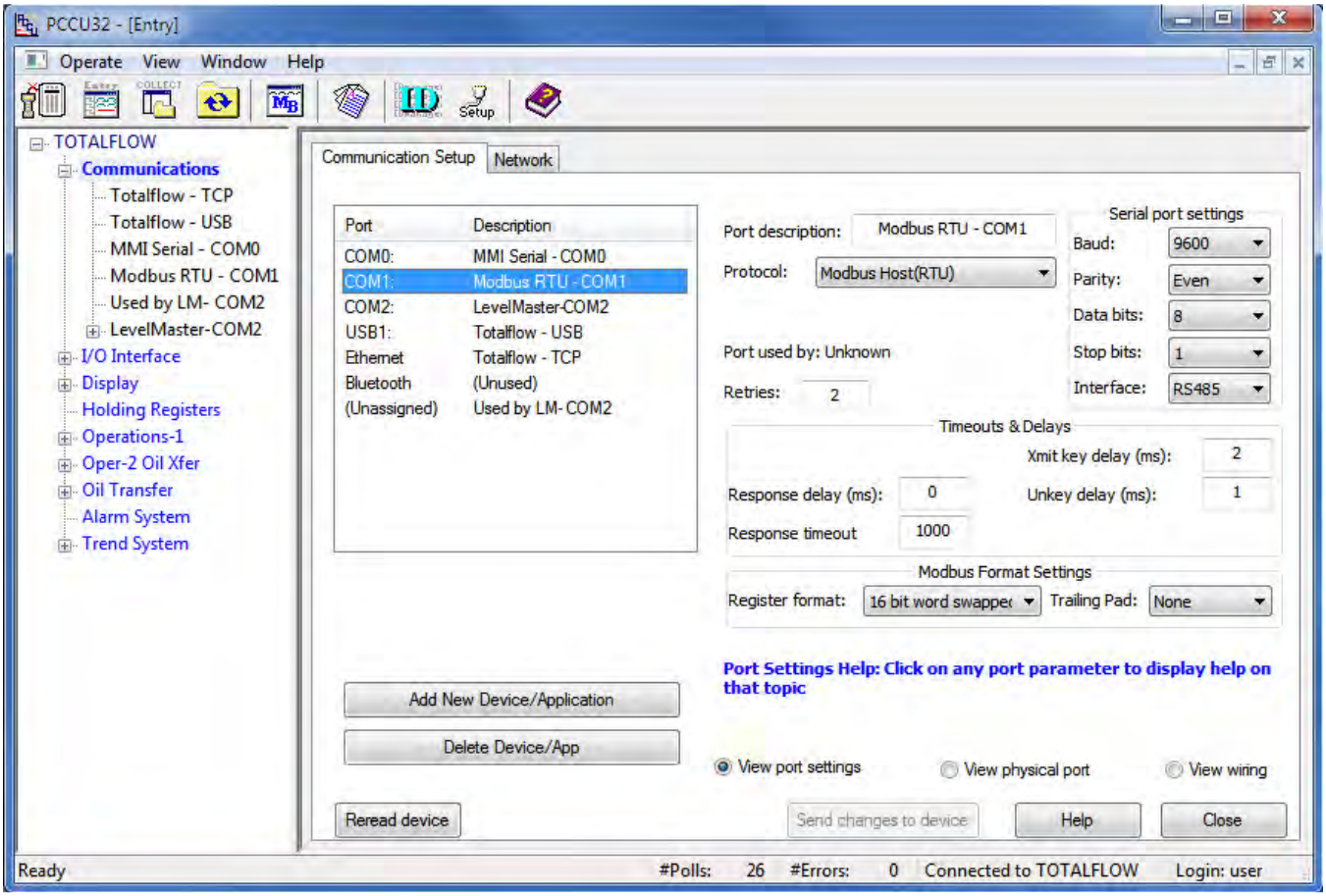
16.3.6 Select Entry Setup from the Local Connect initial dialog.

16.3.7 Select View \ Advanced from the PCCU32 menu bar.

16.3.8 Click on Communications in the tree-view window.

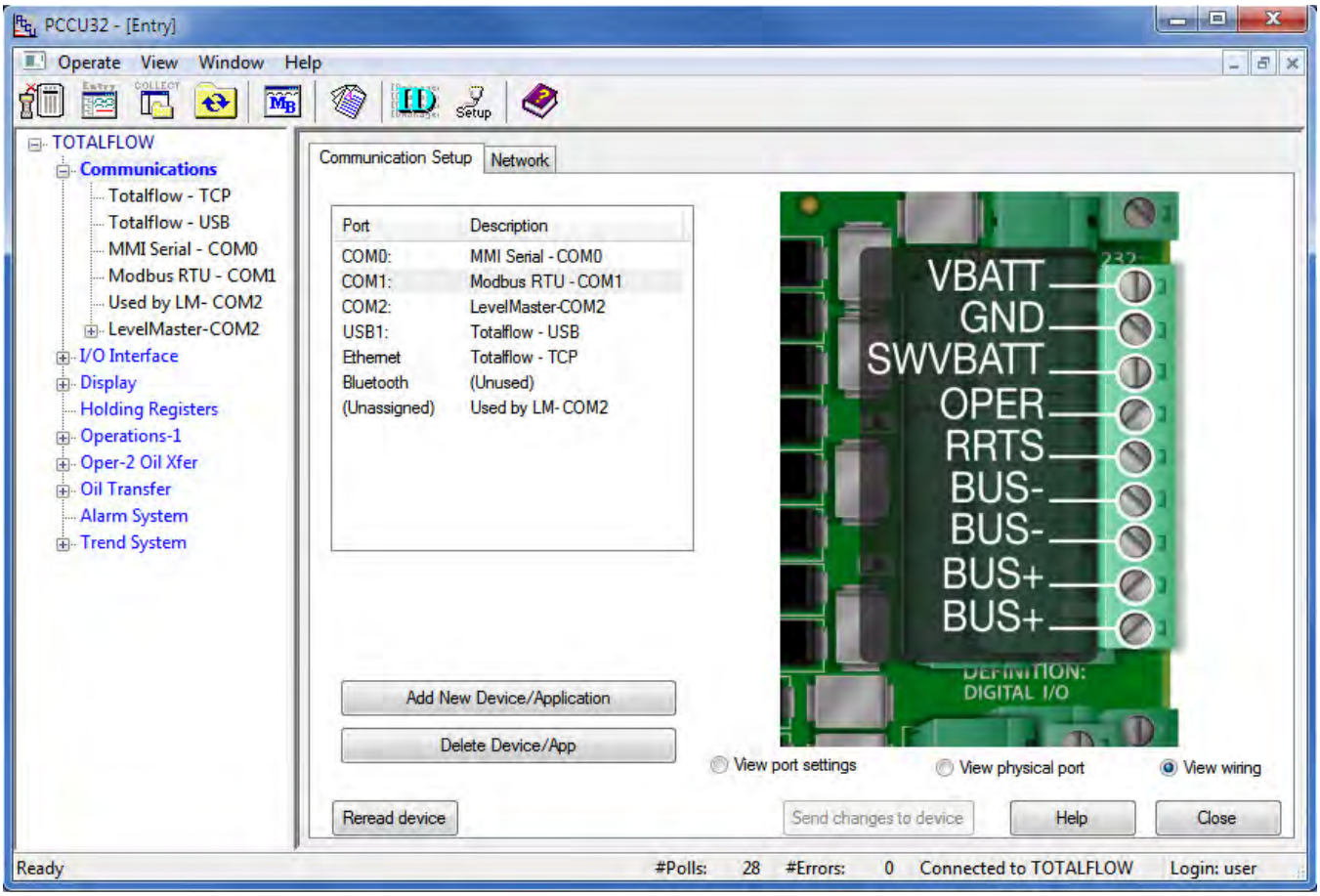
16.3.9 Click on the Port name associated with Modbus RTU.

16.3.10 Ensure that the communications settings match the settings of the HMA performed in step 17.1.1. For example,



16.3.11 Click on ‘Send changes to device’ after all settings are changed and verified.

16.3.12 The terminal block connections on the XRC can be verified by clicking on the View wiring radio button. Note that the RS485+ terminal of the HMA should be connected to the CTS/BUS+ position of the TotalFlow terminal block. The – terminals should be connected to the DCD/BUS- position of the TotalFlow terminal block.



16.4. **Reading registers from the HMA**

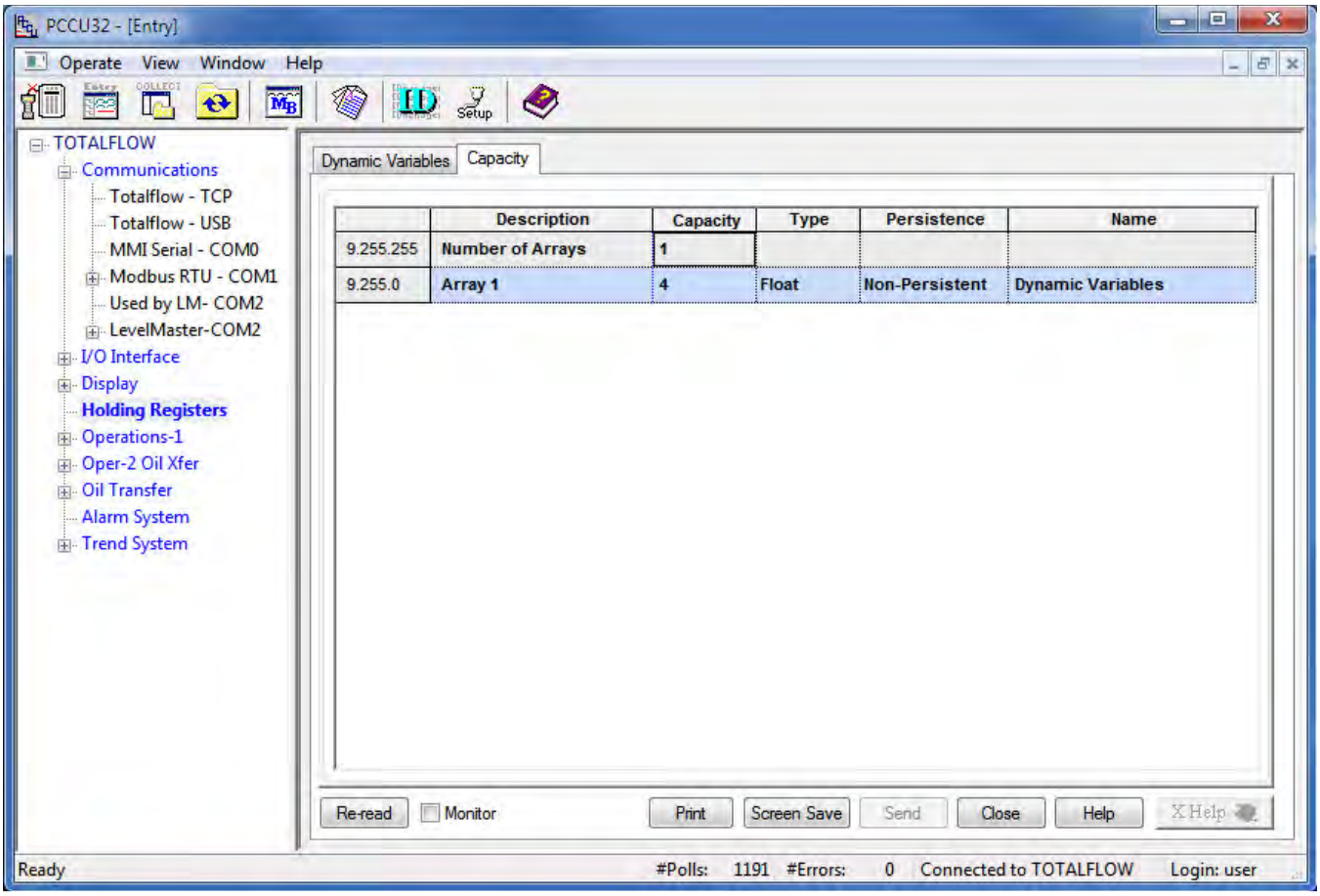
16.4.1 The followings steps demonstrate how to read the PV, SV, TV and QV from a HART device attached to the HMA. When making any changes to the settings, click on Send at the bottom of the window to write them to the XRC.

16.4.2 Select Holding Registers from the tree-view window of the PCCU32.

16.4.3 Select the Capacity tab.

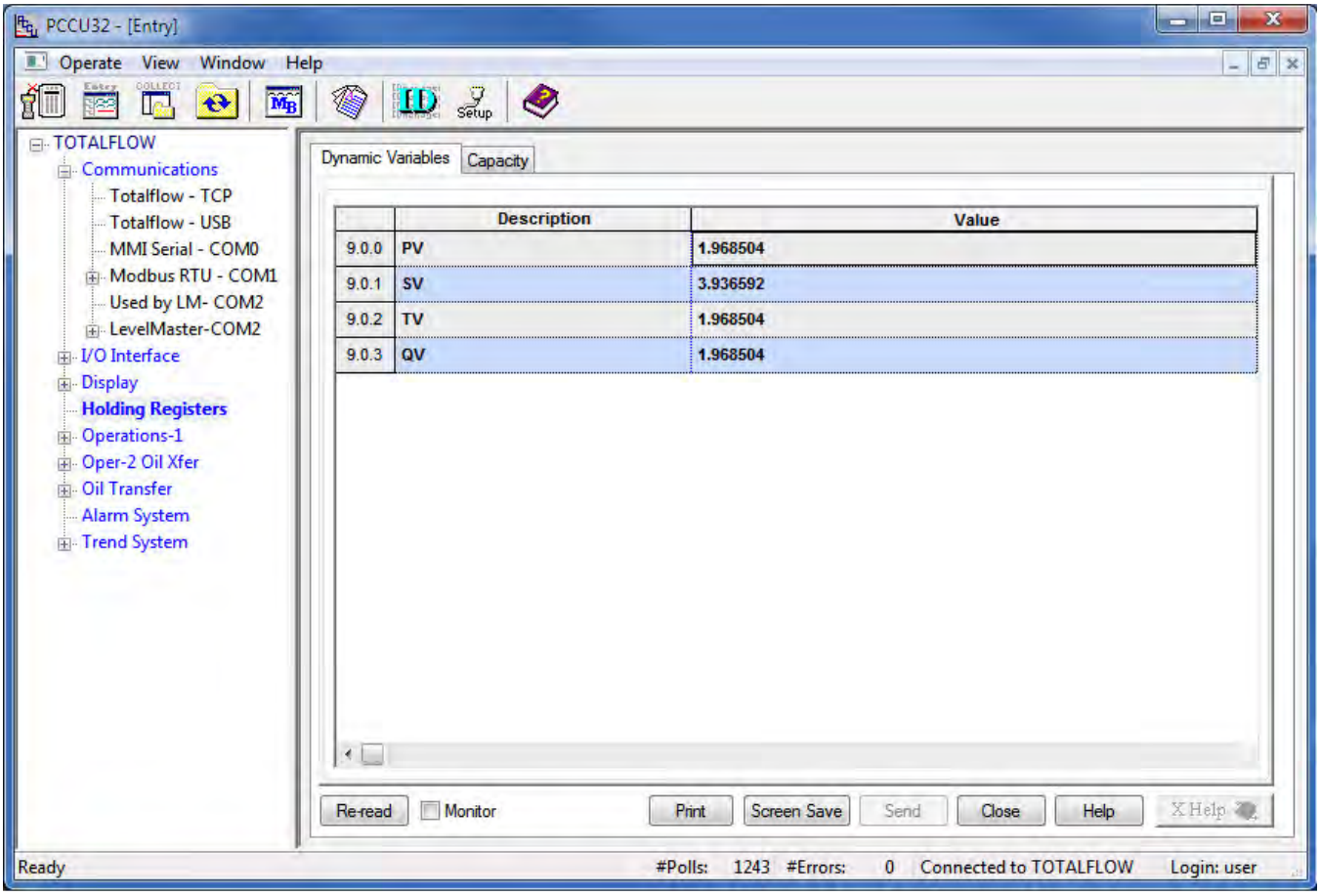
16.4.4 Set the Capacity for the Number of Arrays to 1.

16.4.5 Set the Capacity for Array 1 to '4', the Type to 'Float', the 'Persistence' to 'Non-Persistent', and the Name to 'Dynamic Variables'.



16.4.6 Select the Dynamic Variables tab.

16.4.7 Change the description of the four registers to ‘PV’ through ‘QV’.

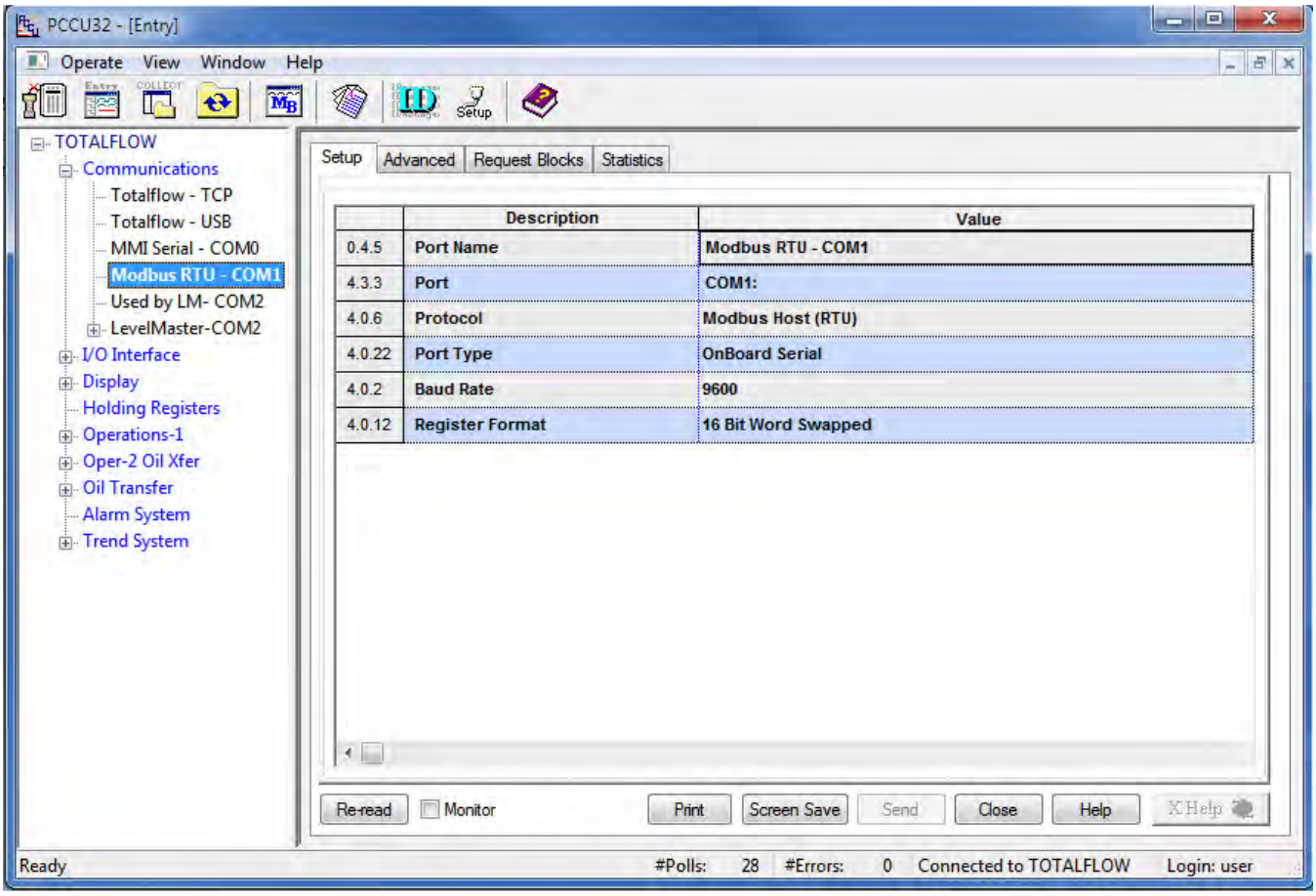


16.4.8 Note the Register numbers displayed in the first column of the table. They will be used when setting the Request Blocks in a later step.

16.4.9 Select Communications \ Modbus RTU in the tree-view window.

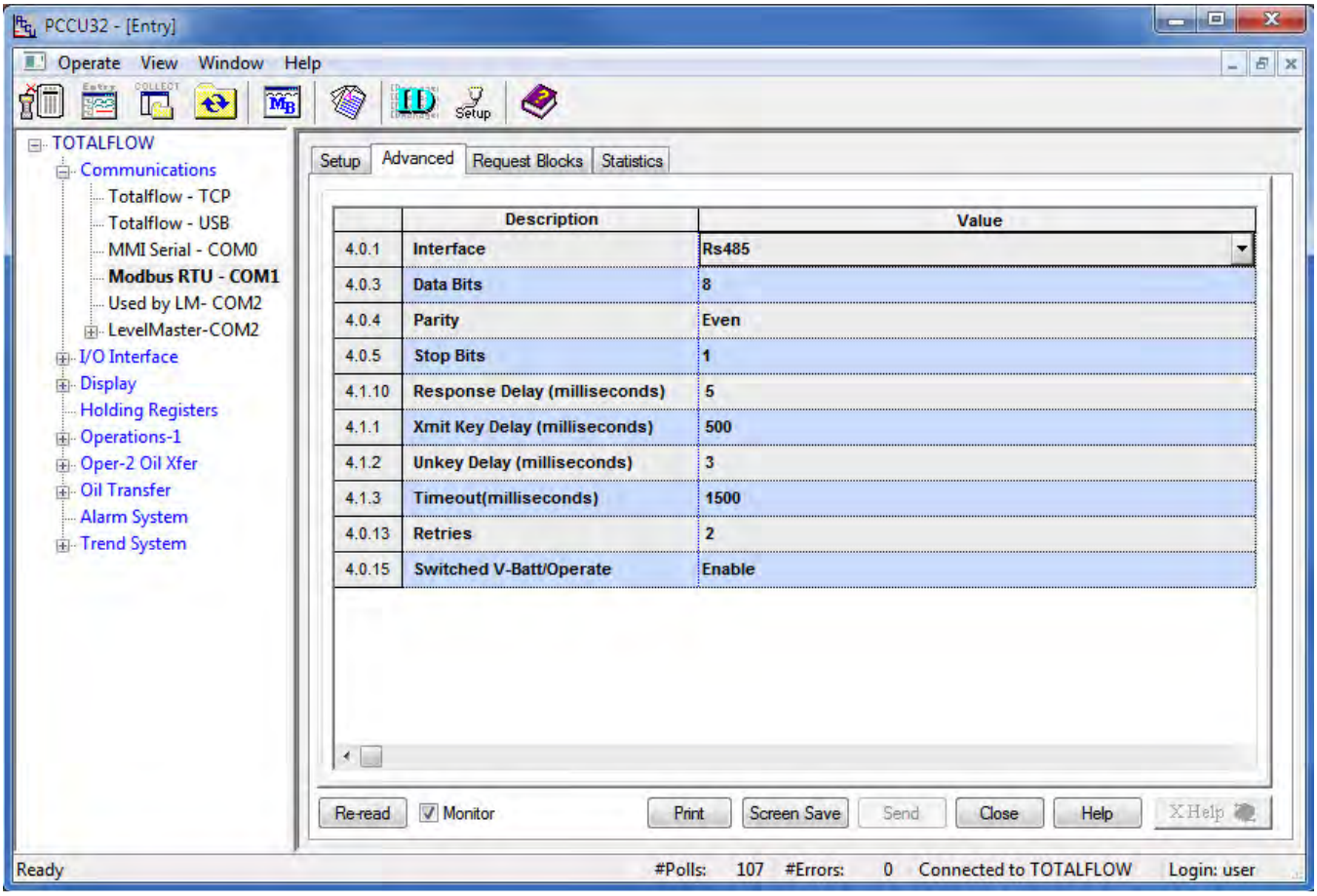
16.4.10 For the Setup tab,

16.4.11 Ensure that the Protocol and Baud Rate match the selections made in step 17.1.1.



16.4.12 For the Advanced tab,

16.4.13 Ensure that the Data Bits, Parity and Stop Bits match the selections made in step 17.1.1.



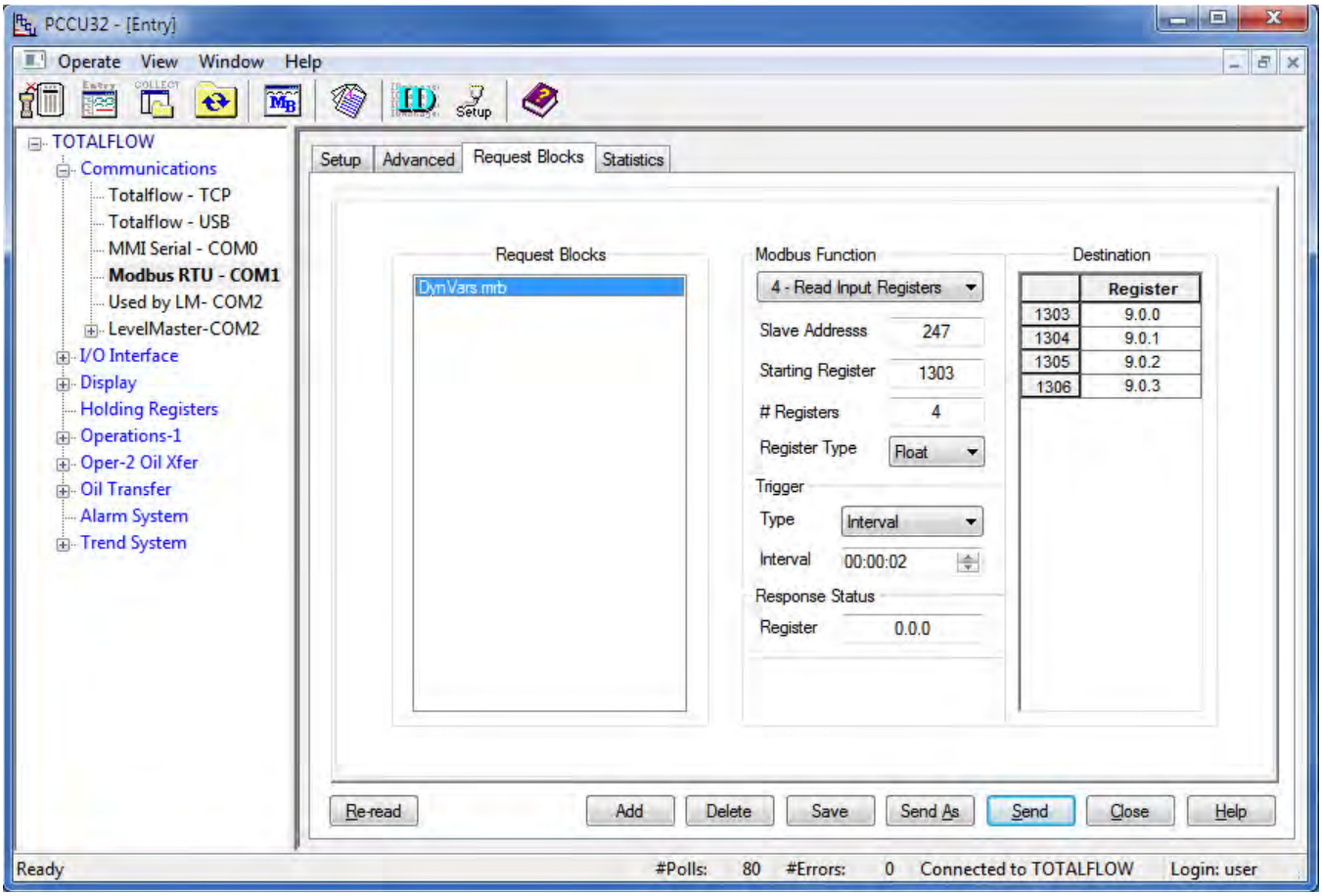
16.4.14 Ensure that the Unkey Delay is less than 7 milliseconds as the HMA typically responds within about 8 milliseconds. If the Unkey Delay time is too long, the XRC will start listening for a response after the HMA has already started transmitting. As a result, the XRC will not recognize the response.

16.4.15 For the Request Blocks tab,

16.4.16 Set the Slave Address to match the address of the HMA (if in HMA mode), or an attached device (if in Device mode).

16.4.17 Select '4 – Read Input Registers' from the Modbus function drop-down.

16.4.18 Set the Starting Register to a value 1 greater than the desired starting Modbus register. Refer to Appendices F through S for register numbers of the HMA and attached HART devices.



16.4.19 Set the # Registers to equal the total number of Dynamic Variables to be read. Note that in this case, 4 Dynamic Variables are to be read so that a value of 4 is entered even though the total number of 16-bit Modbus registers that will be read is 8.

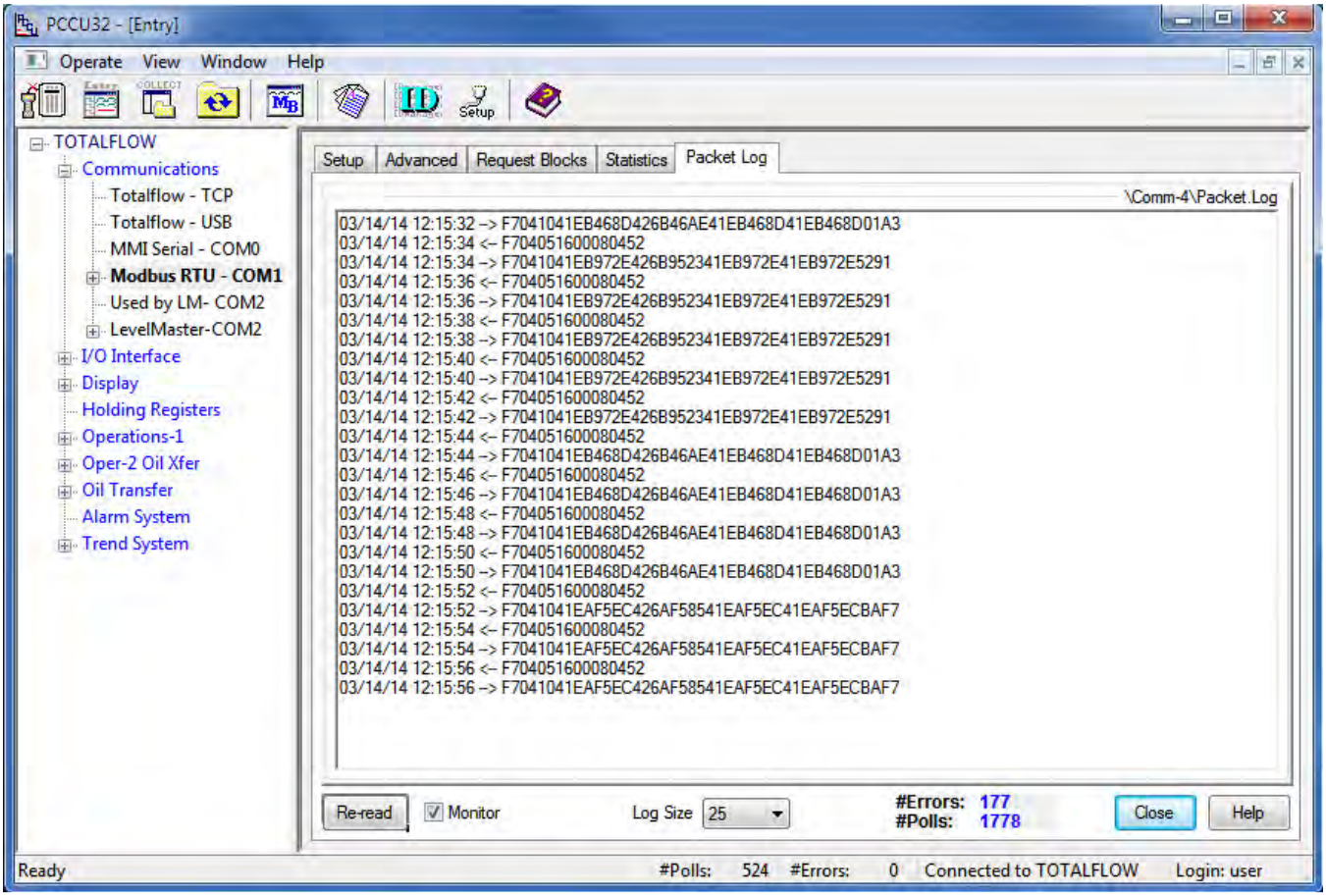
16.4.20 Set the Register Type to Float.

16.4.21 Set the Trigger Type to Interval and the Interval time to the desired sampling rate.

16.4.22 Set the Destination Registers to the register numbers from step 17.4.8.

16.4.23 Click on Send to update the RTU.

16.4.24 To check if transmissions and responses are being made, select View \ Expert from the PCCU32 Menu bar. This mode displays a Packet Log tab when selecting Communications \ Modbus RTU from the tree-view window.



16.4.25 Set the Log Size to 25, and check the Monitor checkbox. The log should start updating with the XRC commands being sent out and the responses from the HMA.

16.4.26 Right-click in the clear area between the Monitor checkbox and the Log Size drop-down. Select a shorter interval screen refresh interval if desired

16.4.27 To display the values,

16.4.28 Select Holding Registers from the tree-view window of the PCCU32.

16.4.29 Select the Dynamic Variables tab.

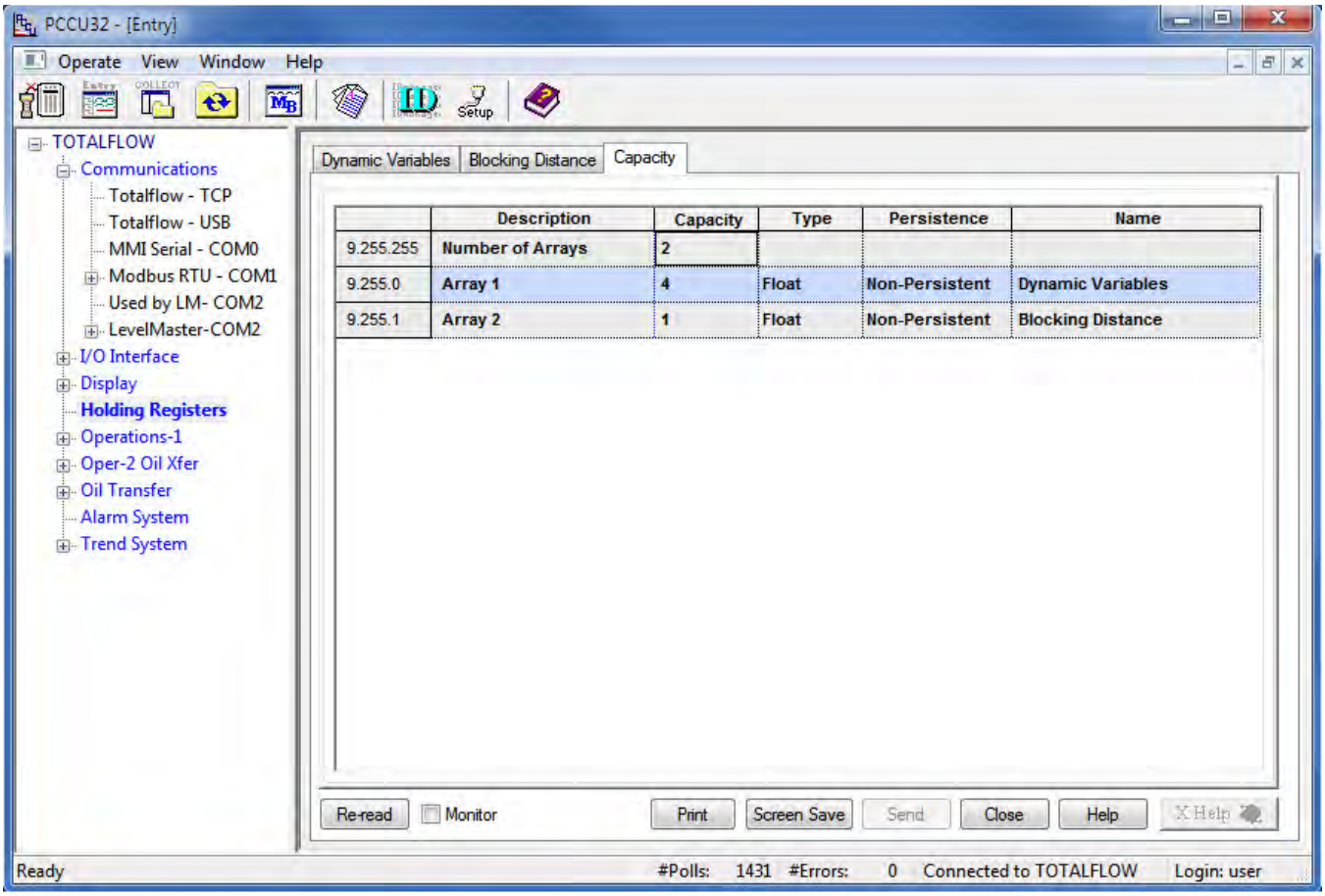
16.4.30 Click on Re-read to obtain a single set of readings from the HMA, or check the Monitor checkbox to repeatedly read values from the HMA at the Interval specified in the Request Blocks tabs in step 17.4.21.

16.5. **Writing registers to the HMA**

16.5.1 The followings steps demonstrate how to change a parameter in a HART device attached to the HMA. The Blocking Distance parameter is used as the example. When making any changes to the settings, click on Send at the bottom of the window to write them to the XRC.

16.5.2 Select Holding Registers from the tree-view window of the PCCU32.

16.5.3 Select the Capacity tab.

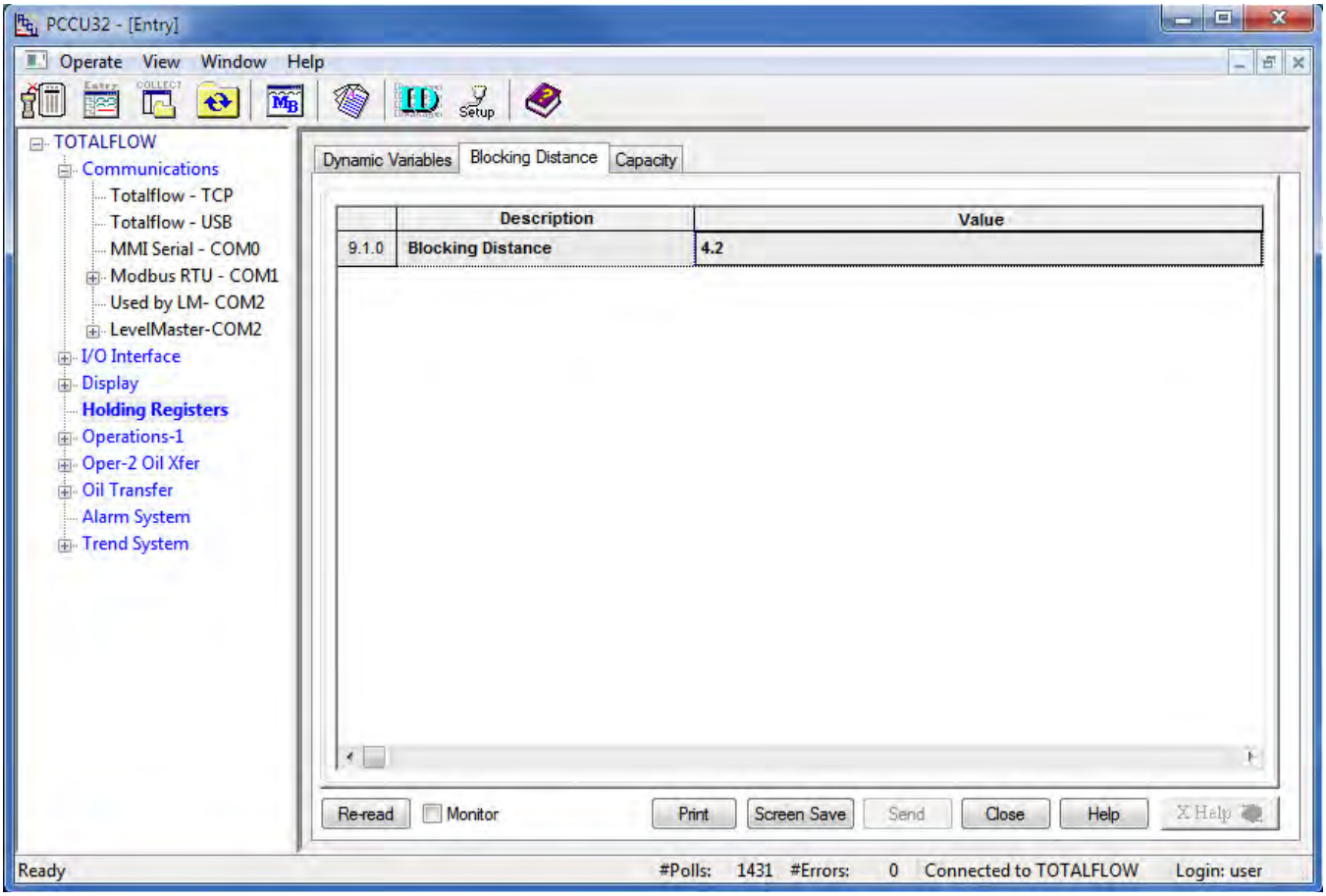


16.5.4 Set the Capacity for the Number of Arrays to 2.

16.5.5 Set the Capacity for Array 2 to ‘1’, the Type to ‘Float’, the ‘Persistence’ to ‘Non-Persistent’, and the Name to ‘Blocking Distance’.

16.5.6 Select the Blocking Distance tab.

16.5.7 Change the description of the register to ‘Blocking Distance’.

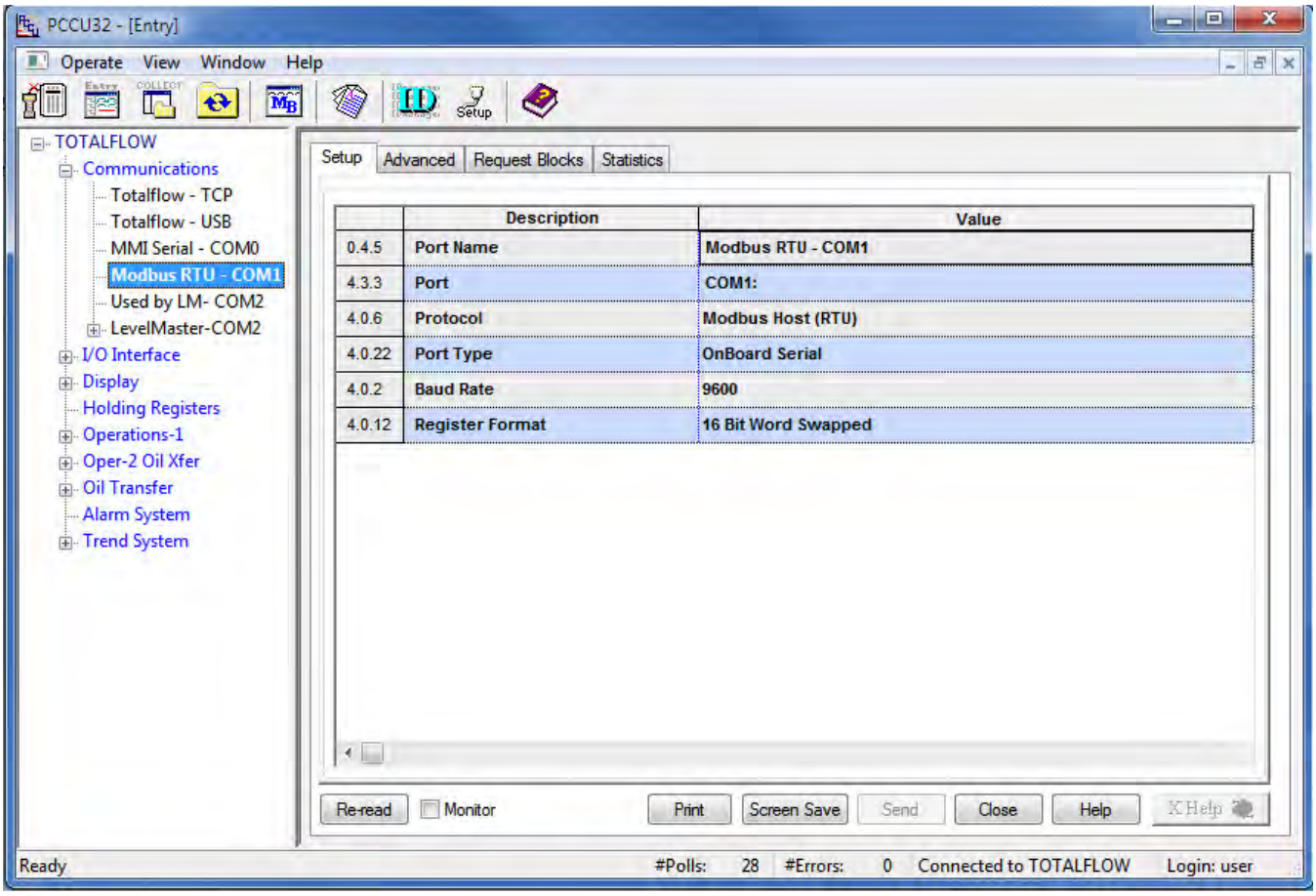


16.5.8 Note the Register number displayed in the first column of the table. It will be used when setting the Request Block in a later step.

16.5.9 Select Communications \ Modbus RTU in the tree-view window.

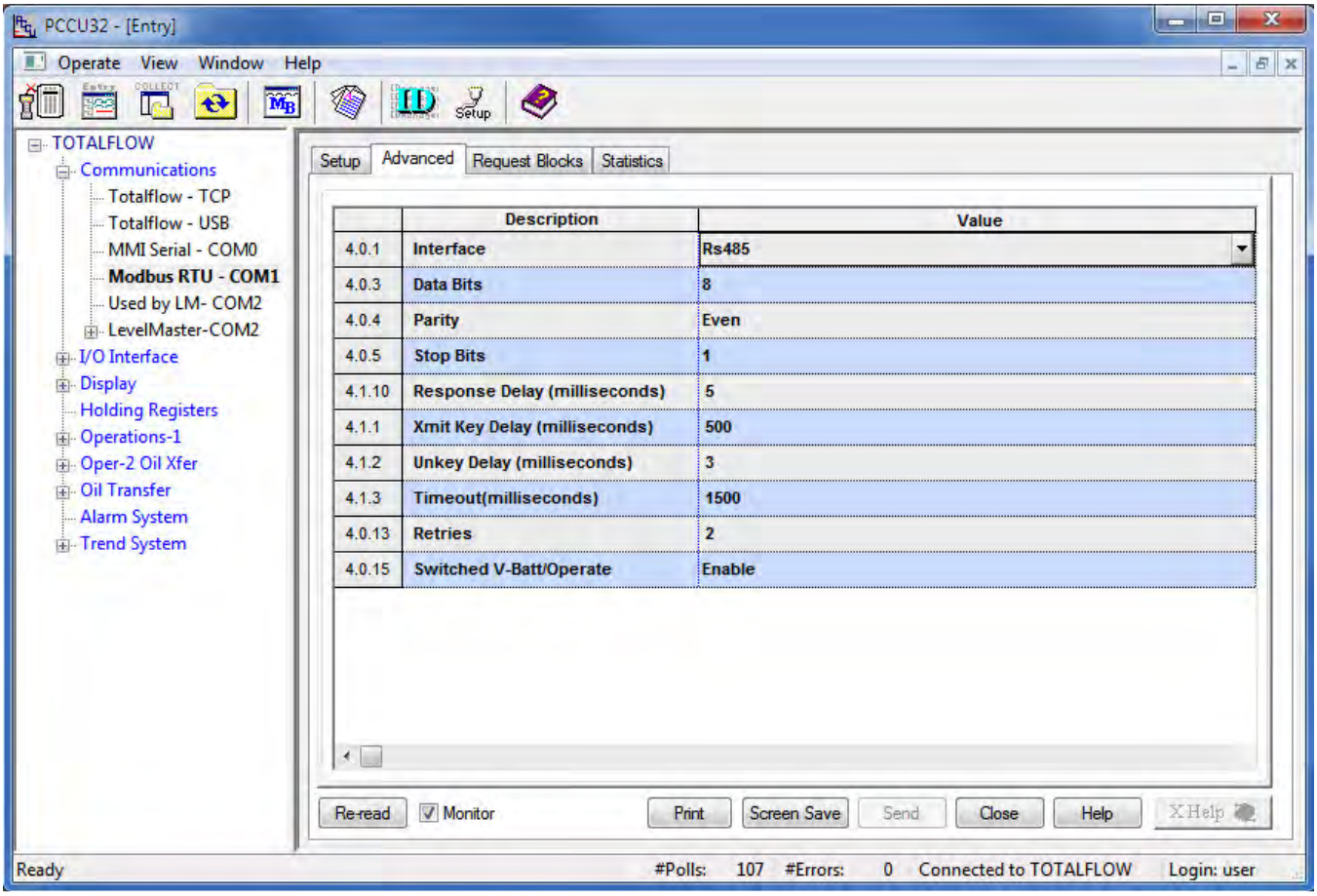
16.5.10 For the Setup tab,

16.5.11 Ensure that the Protocol and Baud Rate match the selections made in step 17.1.1.



16.5.12 For the Advanced tab,

16.5.13 Ensure that the Data Bits, Parity and Stop Bits match the selections made in step 17.1.1.



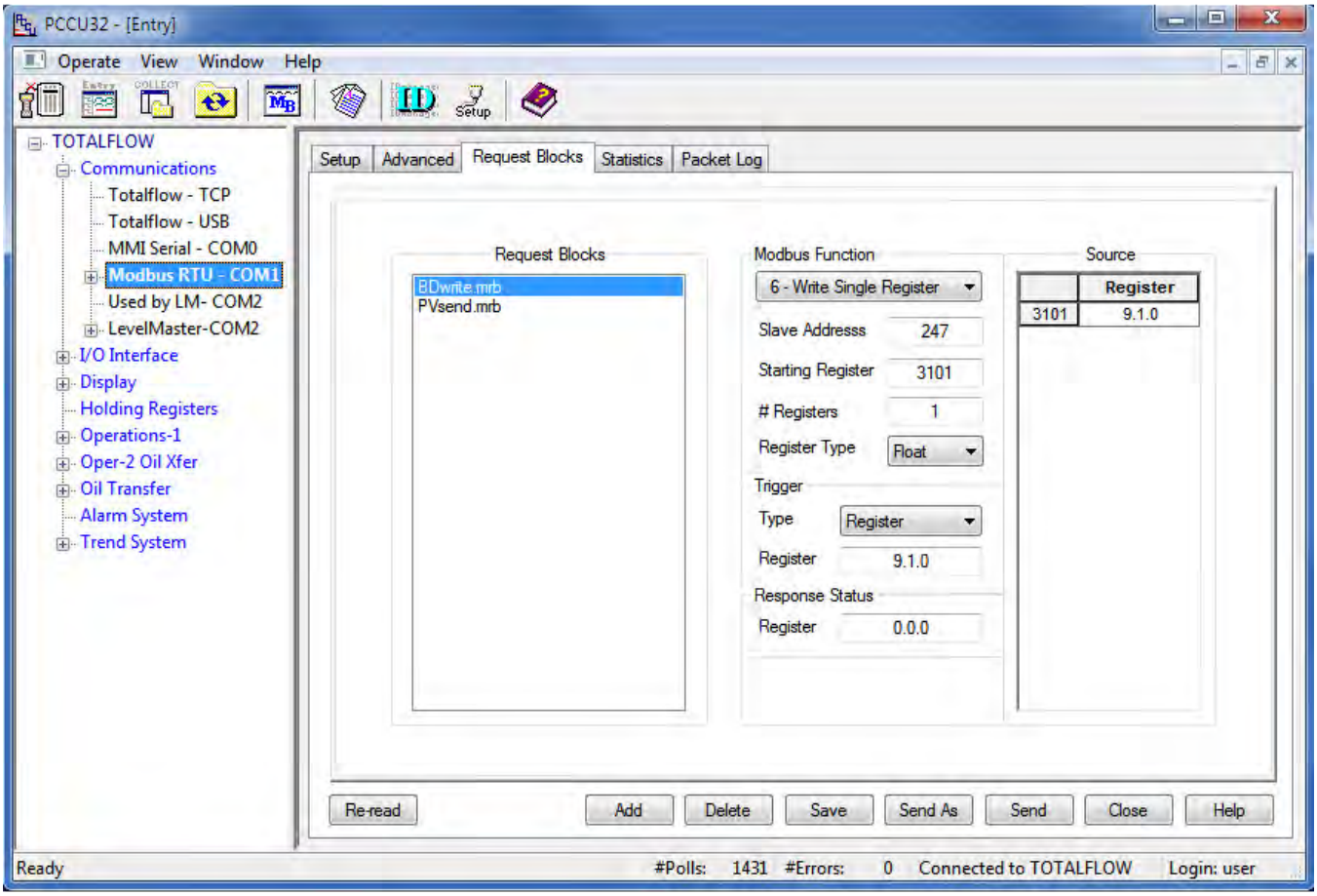
16.5.14 Ensure that the Unkey Delay is less than 7 milliseconds as the HMA typically responds within about 8 milliseconds. If the Unkey Delay time is too long, the XRC will start listening for a response after the HMA has already started transmitting. As a result, the XRC will not recognize the response.

16.5.15 For the Request Blocks tab,

16.5.16 Select '6 – Write Single Register' from the Modbus function drop-down.

16.5.17 Set the Slave Address to match the address of the HMA (if in HMA mode), or an attached device (if in Device mode).

16.5.18 Set the Starting Register to a value 1 greater than the desired starting Modbus register. Refer to Appendices F through S for register numbers of the HMA and attached HART devices.



16.5.19 Set the # Registers to 1. Note that in this case, 1 float value is to be written so that a value of 1 is entered even though the total number of 16-bit Modbus registers that will be read is 2.

16.5.20 Set the Register Type to Float.

16.5.21 Set the Trigger Type to Register and the Register number to the register number from step 17.5.8. This will cause the write to be sent when the assigned register is changed from the Holding Registers menu.

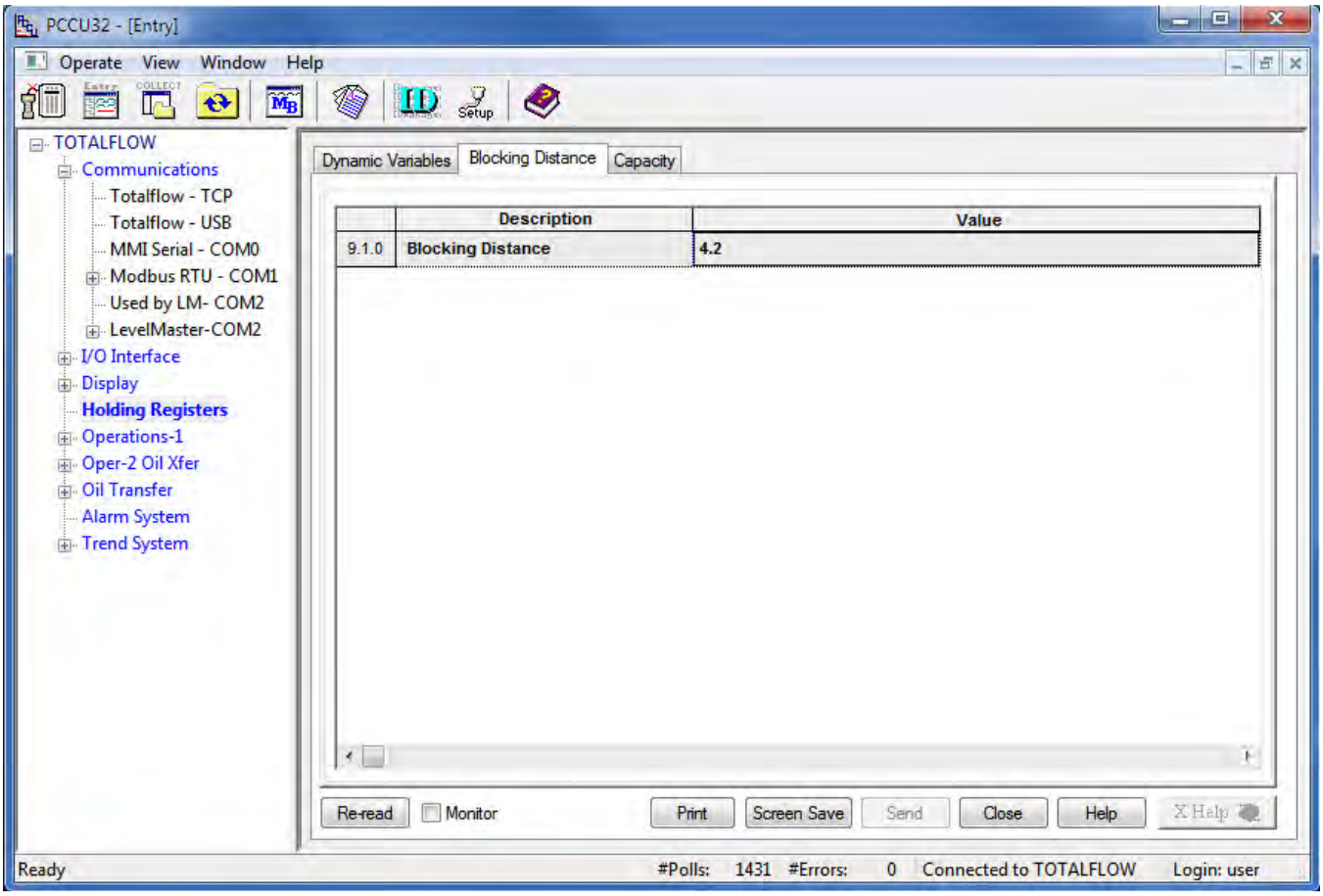
16.5.22 Set the Source to the register number from step 17.5.8.

16.5.23 Select a name for the Request Block if prompted.

16.5.24 Select Holding Registers from the tree-view window of the PCCU32.

16.5.25 Select the Blocking Distance tab.

16.5.26 Change the Value to the desired distance.



16.5.27 Click on Send at the bottom of the window.

16.5.28 To check if the value has been accepted, follow the steps in section 17.4 changing selections as needed to create a request block to read the Blocking Distance parameter from the HMA or attached HART device.

17. ABB Totalflow XRC – LevelMaster

The ABB Totalflow XRC is only capable of sending and receiving command Uxx?. Note that with the LevelMaster protocol, the HMA operates only in the Device mode. Therefore, the ID in the request blocks must be set to the attached HART device's Poll Address rather than that of the HMA. The XRC displays the first float value returned by Command Uxx? as Level 1 (the Upper Level for Magnetrol Devices) and the second float value as Level 2 (typically the Interface Level for Magnetrol devices). Accordingly, it is recommended to configure the attached Magnetrol HART device for PV as Level, and SV as Interface level. The Echo Strength from the attached transmitter is displayed as the Temperature in the tank view diagram of the Communications \ LevelMaster menu in the PCCU application.

17.1. Initial HMA Configuration

17.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for LevelMaster communication with the XRC. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

17.2. Physical Connections

17.2.1 Connect the XRC to a computer using USB-A to USB-B cable.

17.2.2 Connect an appropriate power supply to the battery terminal (J16) of the XRC.

17.2.3 Connect the HMA to a 9 – 30 VDC power supply via terminal block TB1.

17.2.4 Connect an RS-485 communications cable between the COM2 terminal block (upper position of J6) of the XRC and the RS-485 terminal block (TB2) of the HMA. The RS485+ terminal of the HMA should be connected to the BUS+ of the TotalFlow terminal block. The – terminals should be connected correspondingly. See section 18.3.14.

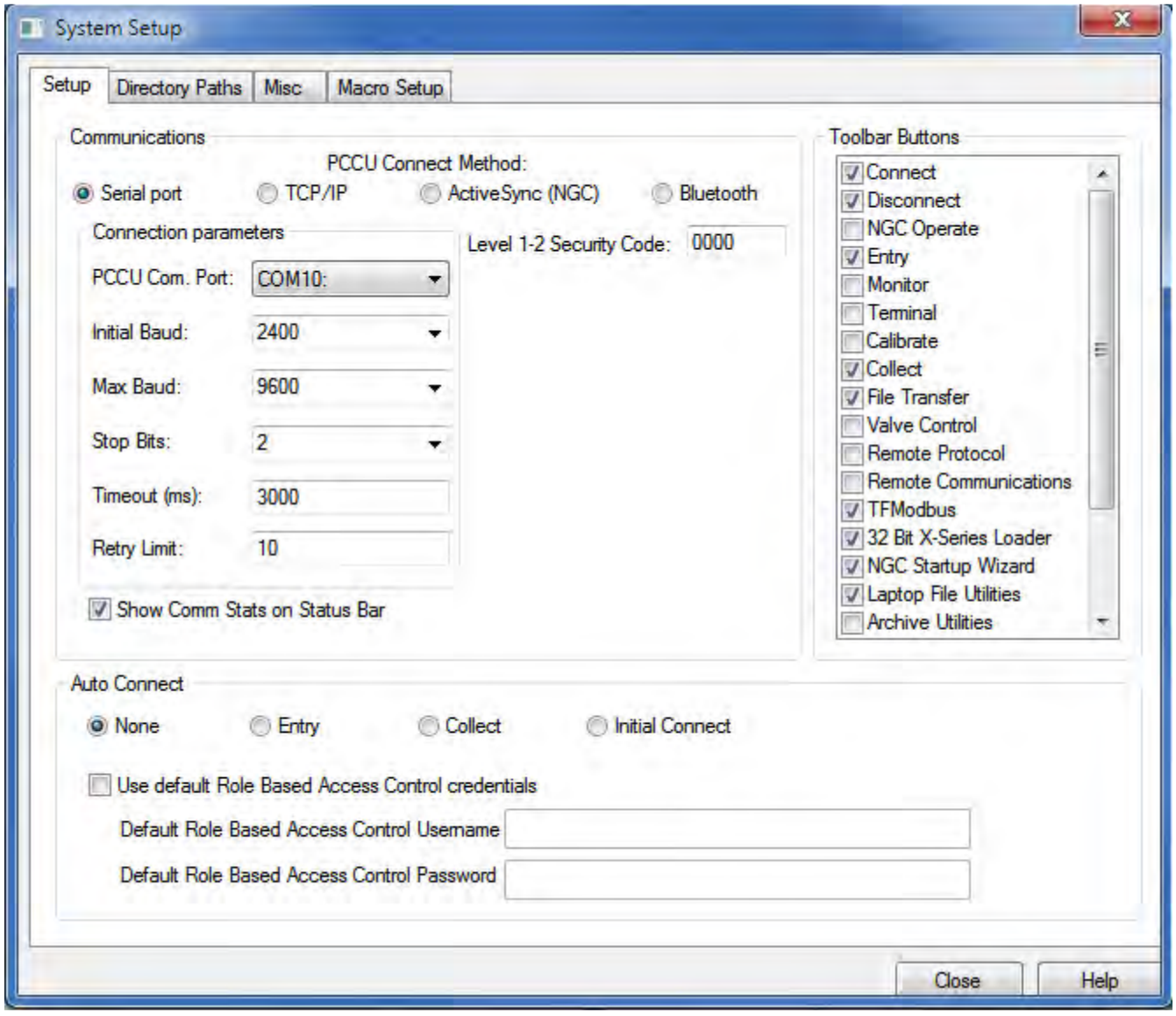
17.2.5 Ensure that the appropriate communication module is inserted into the Comm 2 receptacle (XA2).

17.2.6 Connect a 120Ω resistor between the two RS-485 terminal block positions of the last HMA on the bus.

17.3. **Initial XRC Configuration**

17.3.1 Start the PCCU32 application.

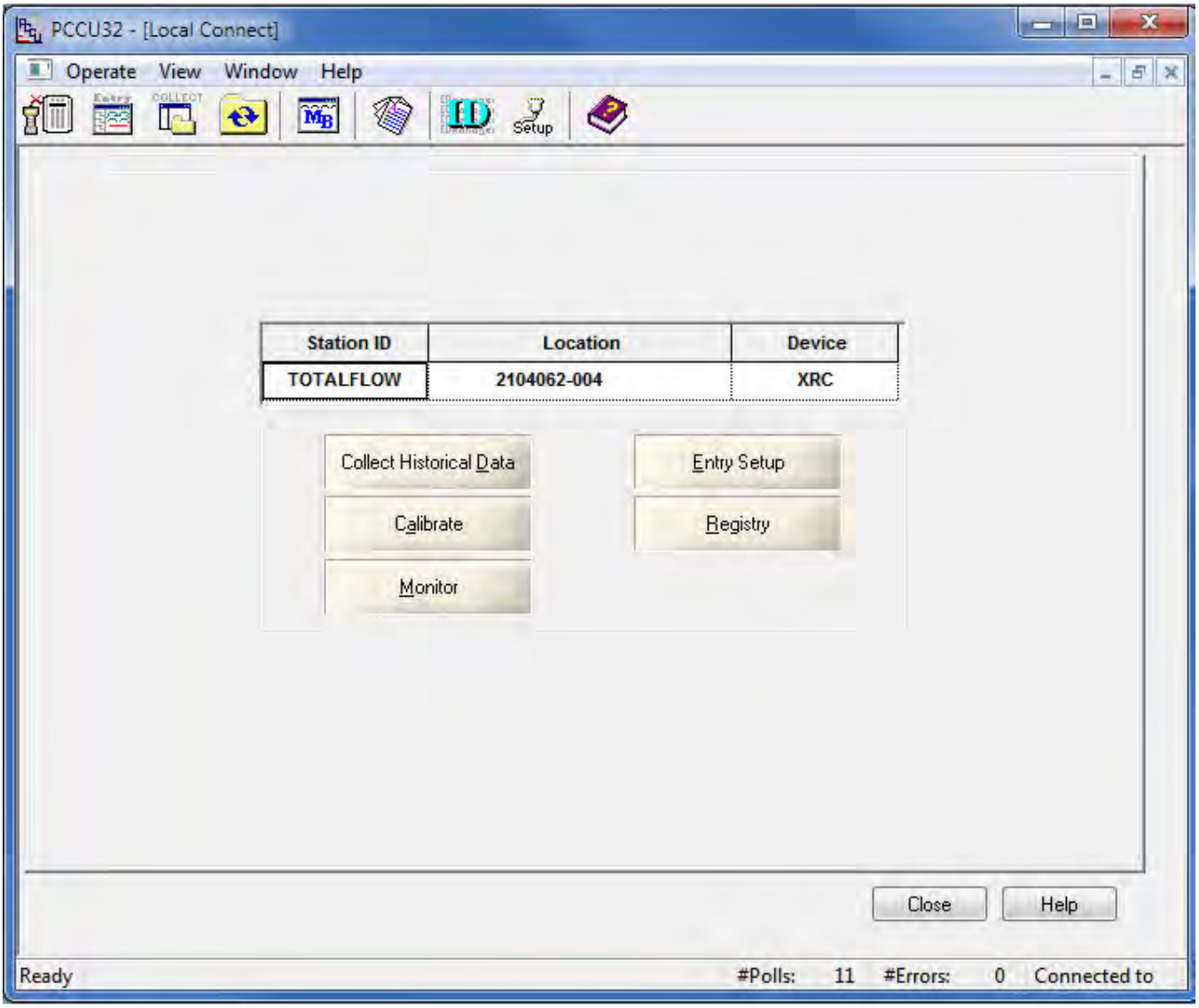
17.3.2 Select on Operate \ Setup \ System Setup in the PCCU32 Menu bar. A dialog will appear allowing for communication settings between the PCCU32 application and the XRC.



17.3.3 Select the COM port number corresponding to the XRC. The proper COM port number can be identified by navigating to the Device Manager in Windows and expanding the Ports entry.

17.3.4 Click Close.

17.3.5 Select on Operate \ Connect to Totalflow in the PCCU32 Menu bar.



17.3.6 Select Entry Setup from the Local Connect initial dialog.

17.3.7 Select View \ Advanced from the PCCU32 menu bar.

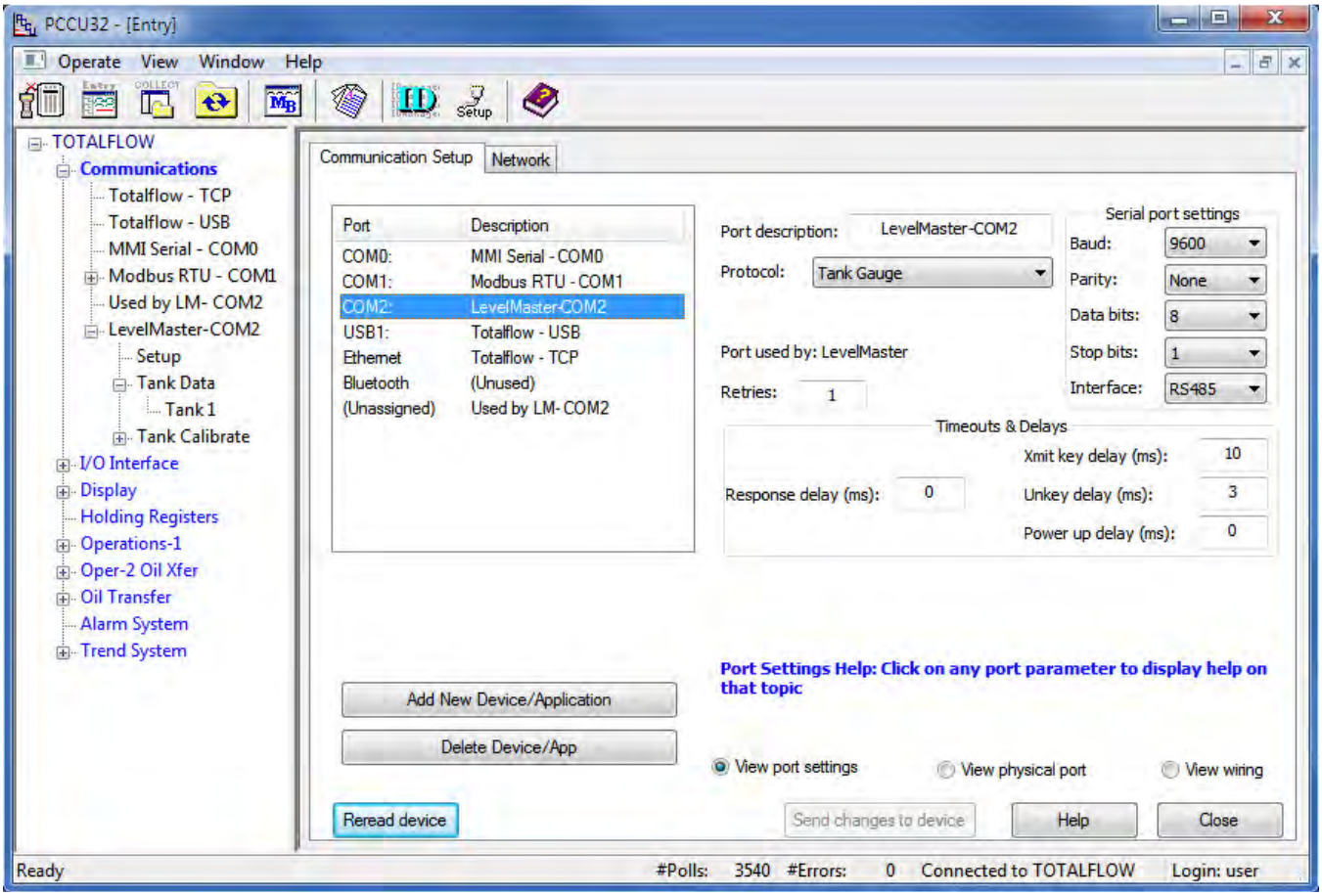
17.3.8 Click on Communications in the tree-view window.

17.3.9 Click on the Port name associated with Modbus RTU.

17.3.10 Select ‘Tank Gauge’ for the Protocol.

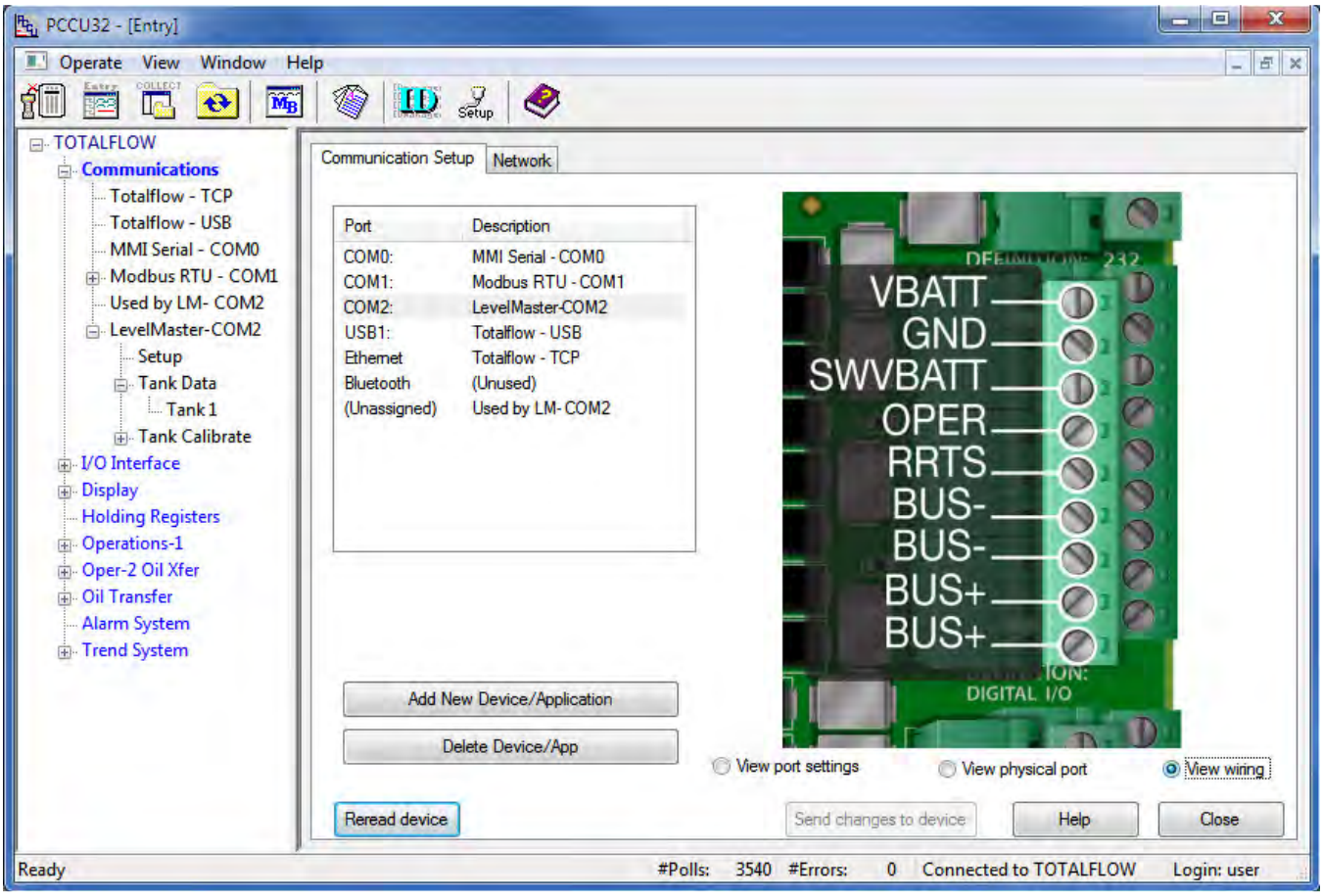
17.3.11 Set the Unkey delay to 3 ms.

17.3.12 Ensure that the communications settings match the settings of the HMA performed in step 18.1.1. For example,



17.3.13 Click on ‘Send changes to device’ after all settings are changed and verified.

17.3.14 The terminal block connections on the XRC can be verified by clicking on the View Wiring radio button. Note that the RS485+ terminal of the HMA should be connected to the CTS/BUS+ position of the TotalFlow terminal block. The – terminals should be connected to the DCD/BUS- position of the TotalFlow terminal block.



17.4. **Reading registers from the HMA**

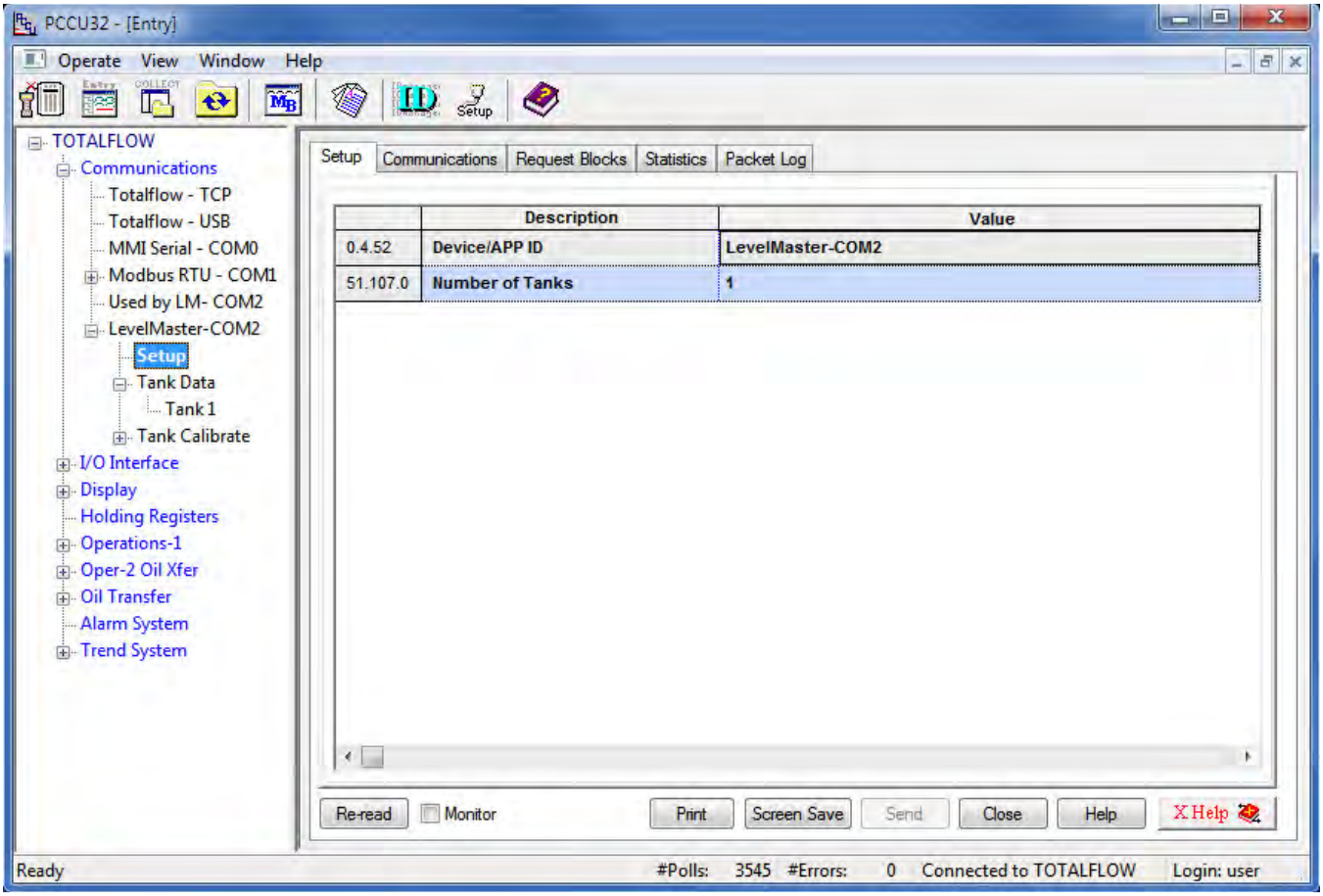
17.4.1 The followings steps demonstrate how to read the PV, SV, Echo Strength, Errors and Warnings from a HART device attached to the HMA. When making any changes to the settings, click on Send at the bottom of the window to write them to the XRC.

17.4.2 Select Communications \ LevelMaster \ Setup in the tree-view window of the PCCU32.

17.4.3 For the Setup tab,

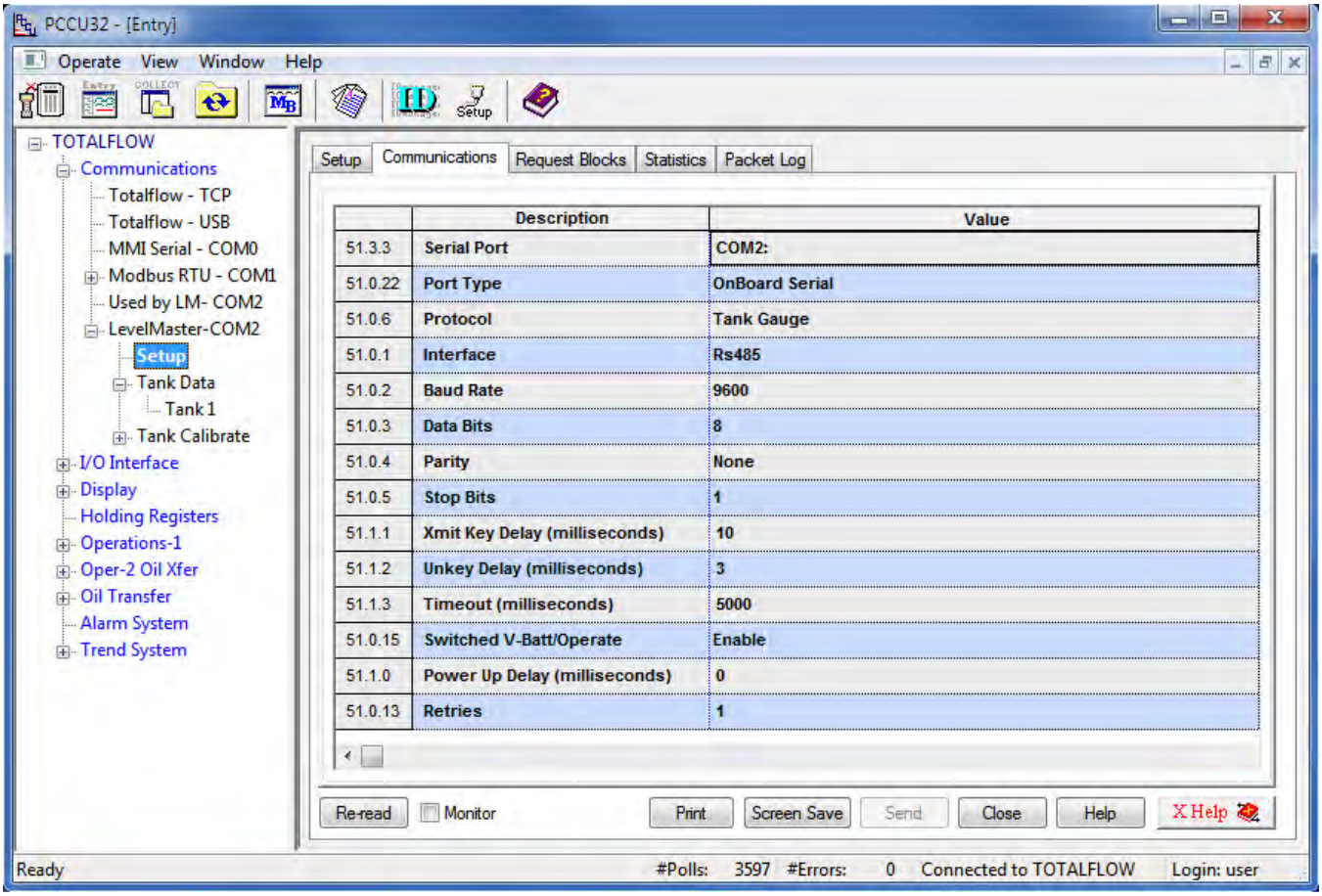
17.4.4 Set the Number of Tanks to the number of attached HART devices to be read.

17.4.5 Click on 'Send'.



17.4.6 For the Communications tab,

17.4.7 Ensure that the communication settings match the selections made in steps 18.1.1 and 18.3.12.

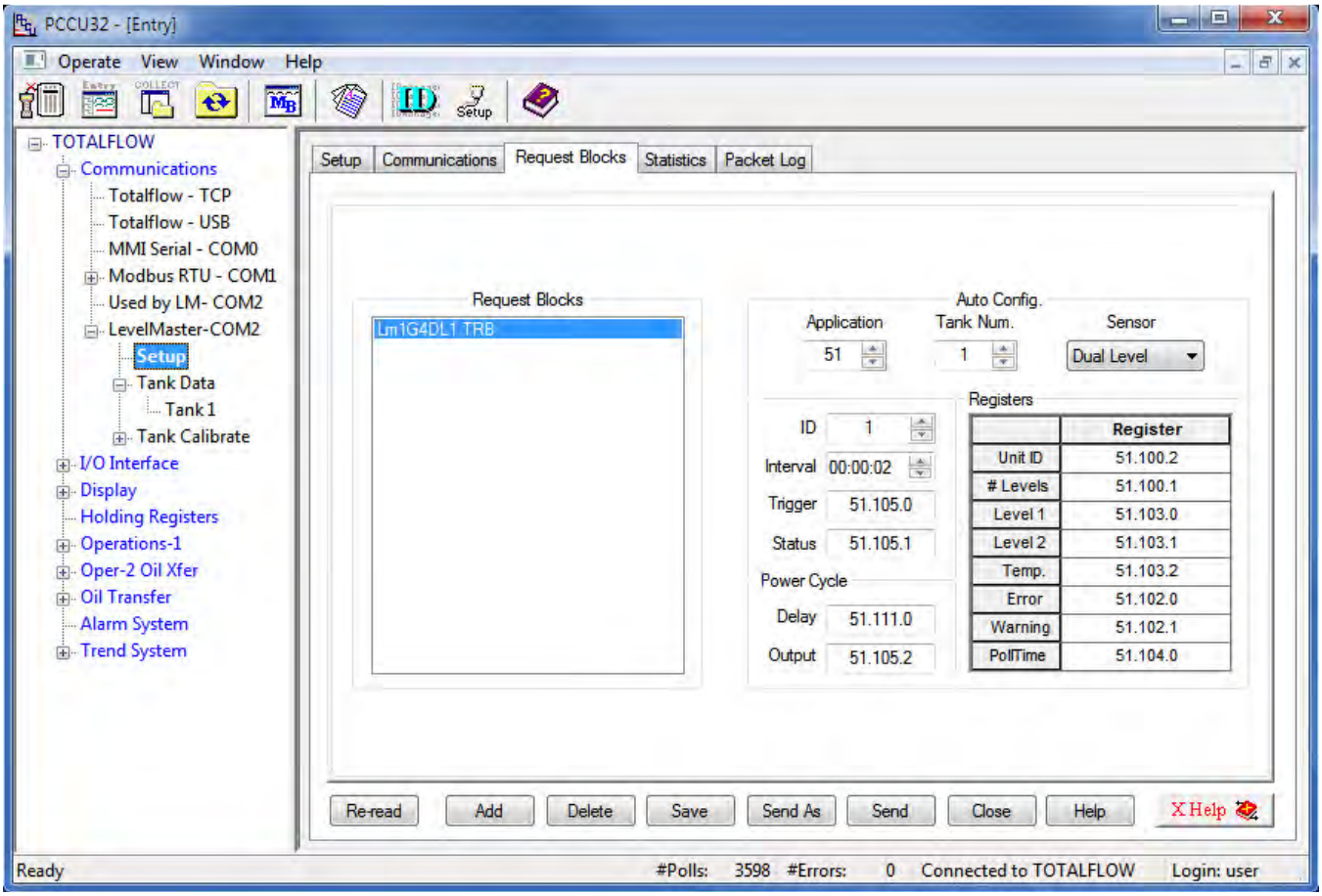


17.4.8 For the Request Blocks tab,

17.4.9 In the Auto Config group menu, set the Application to 51, the Tank Num. to the appropriate value for the attached HART device, and the Sensor to 'Dual Level'. The HMA always returns a Dual Level response to Command Uxx? to provide data for the SV output of the attached HART device.

17.4.10 In the Registers group menu, set the ID to the Poll Address of the attached HART device to be read for that Tank Num. (Note that due to limitations of the LevelMaster protocol, the HMA only operates in the Device mode for that protocol.)

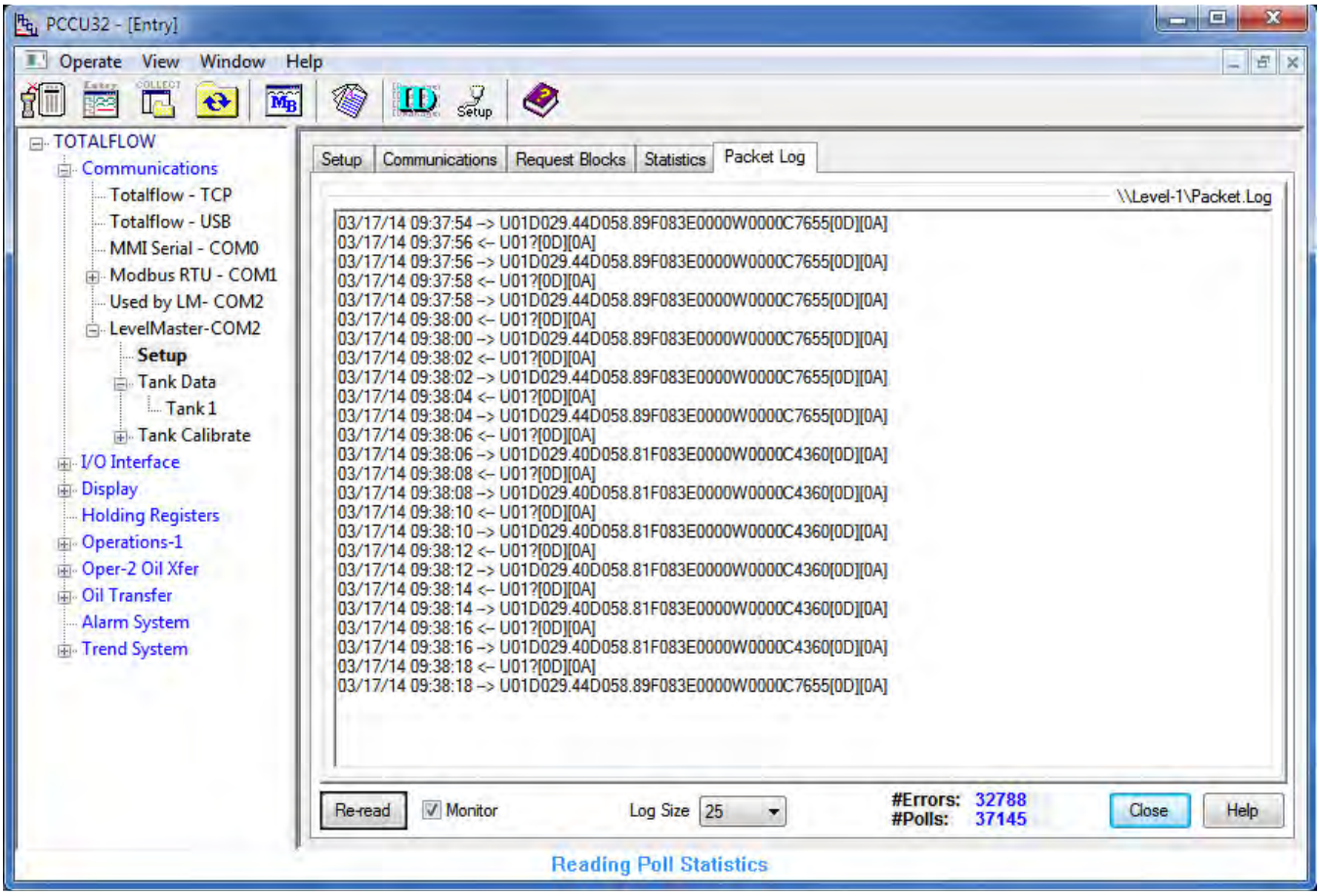
17.4.11 Click on 'Send'.



17.4.12 To check if transmissions and responses are being made, select View \ Expert from the PCCU32 Menu bar. This mode displays a Packet Log tab when selecting Communications \ Modbus RTU from the tree-view window.

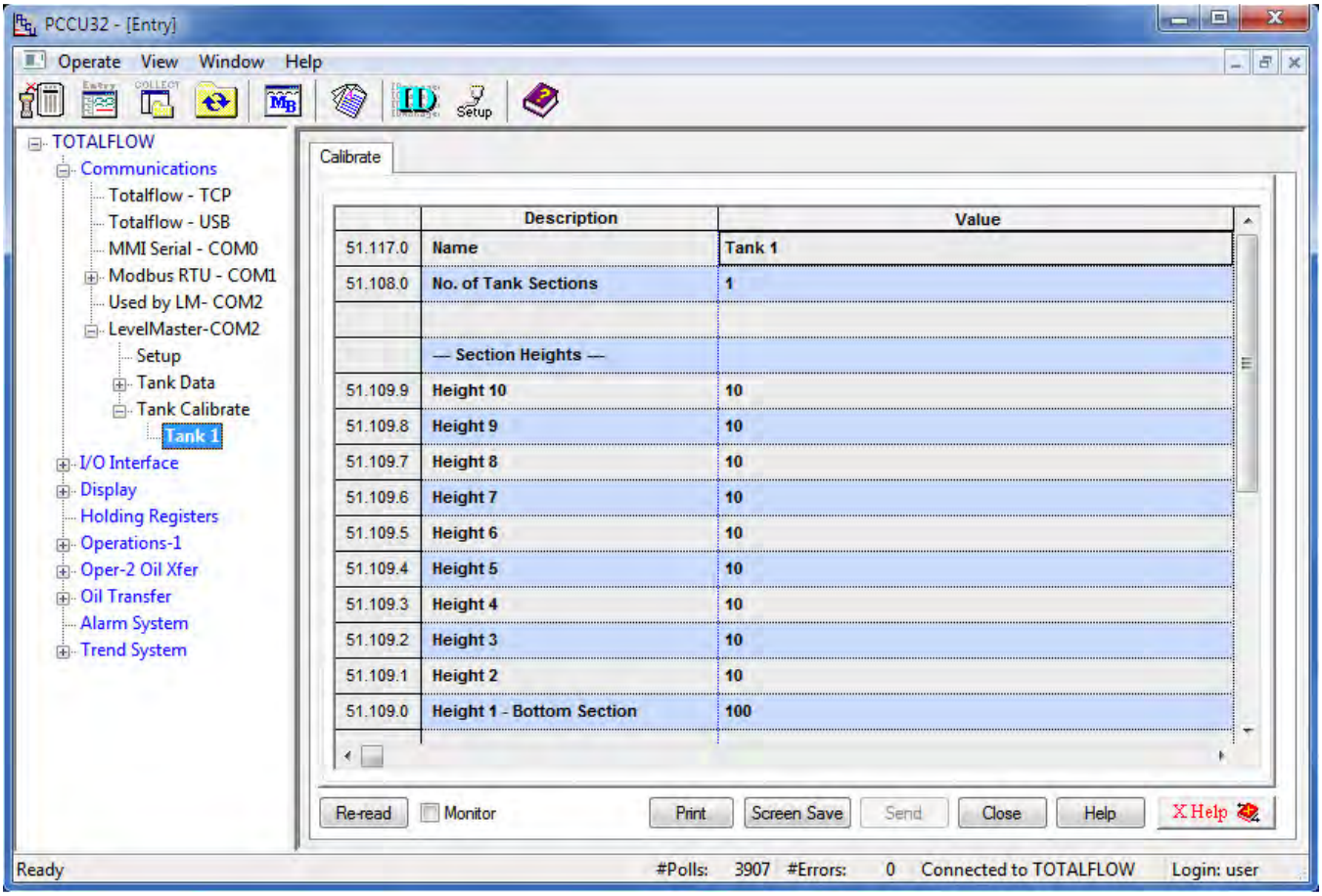
17.4.13 Set the Log Size to 25 and check the Monitor checkbox. The log should start updating with the XRC commands being sent out and the responses from the HMA.

17.4.14 Right-click in the clear area between the Monitor checkbox and the Log Size drop-down. Select a shorter interval screen refresh interval if desired.



17.4.15 To display the values,

17.4.16 Select Communications \ LevelMaster \ Tank Calibrate \ Tank x from the tree-view window of the PCCU32.

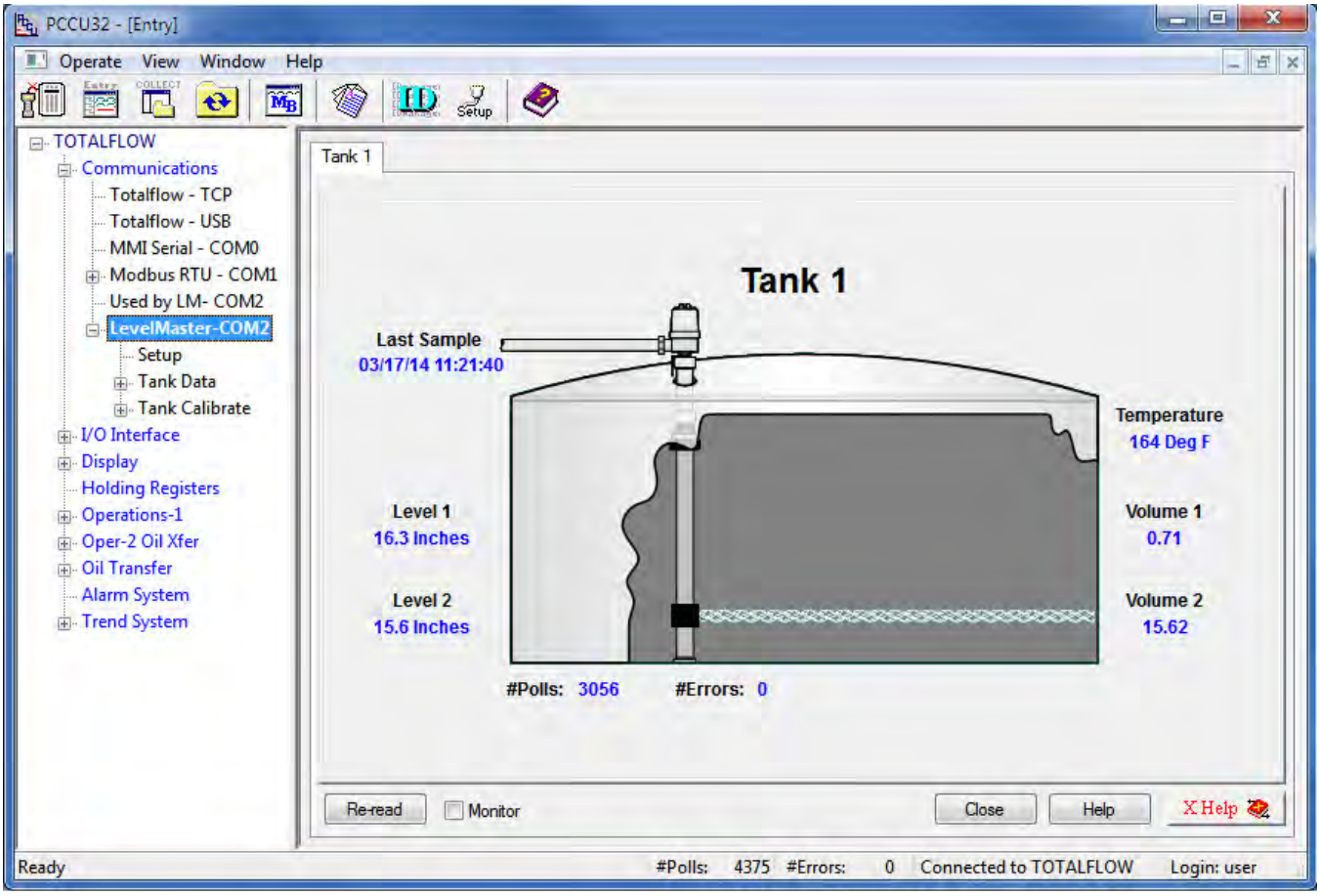


17.4.17 Set the number of Tank Sections in row 51.108.x.

17.4.18 For each tank section, set the height of that section in rows 51.109.x

17.4.19 For each tank section, enter the Factor in rows 51.110.x. The Factor value is the number of barrels per ¼ inch of height in that section. By clicking on the Help button of the PCCU32 and searching for 'tank calibration', a more detailed explanation of the calibration process can be obtained.

17.4.20 Select Communications \ LevelMaster from the tree-view window of the PCCU32.



17.4.21 Click on Re-read to obtain a single set of readings from the HMA, or check the Monitor checkbox to repeatedly read values from the HMA at the Interval specified in the Request Blocks tabs in step 18.4.9.

17.4.22 In the example above, the attached device has the Measurement Type set to Interface, the PV set to the Level reading and SV set to the Interface Level reading. The Upper Level reading from the device (PV is sent as Float 1 of Command Uxx?) is displayed as Level 1. The Interface Level reading from the device is displayed as Level 2. The Echo Strength from the device is displayed as the Temperature. The Volume 1 value is computed from the difference between the Level 1 and Level 2 readings. The Volume 2 value is computed from the Level 2 reading. The level to volume conversion is determined by the settings made in steps 18.4.15 through 18.4.19.

17.4.23 If the Measurement Type of the device is set to Level, the Level 1 and Level 2 readings will be the same, Volume 1 will always be 0 and Volume 2 will represent the total volume.

17.4.24 Any Errors or Warnings from the attached HART device will appear under the bottom right section of the tank image.

17.5. **Writing registers to the HMA**

The ABB Totalflow XRC has no provisions for sending commands to LevelMaster devices other than the Uxx? command. Therefore, it is not possible to write registers in the attached HART devices.

18. ThermoScientific AutoPILOT PRO – Modbus RTU / ASCII

The following procedure applies to operation with both RTU and ASCII communication. The choice of communication protocol is made in step 19.1.1 for the HMA settings, and step 19.4.5. The Modbus RTU protocol is used for the following.

18.1. Initial HMA Configuration

18.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for RTU communication with the AutoPILOT PRO. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

18.2. Physical Connections

18.2.1 Connect the AutoPILOT PRO to a computer using a CHIT computer connection cable (ThermoScientific p/n 3-0446-090).

18.2.2 Connect an appropriate 12 VDC power supply to the terminals of TB-1 on the inside of the AutoPILOT PRO front panel.

18.2.3 Connect an RS-485 communications cable between the terminals of TB-16 of the AutoPILOT PRO and the RS-485 terminal block (TB2) of the HMA. The '+' terminal of the HMA should be connected to the TX+ terminal of TB-16. The '-' terminal of the HMA should be connected to the TX- terminal of TB-16.

18.2.4 On the main board of the AutoPILOT PRO, add a jumper to pins 15-16 of J39 to select 2-wire mode.

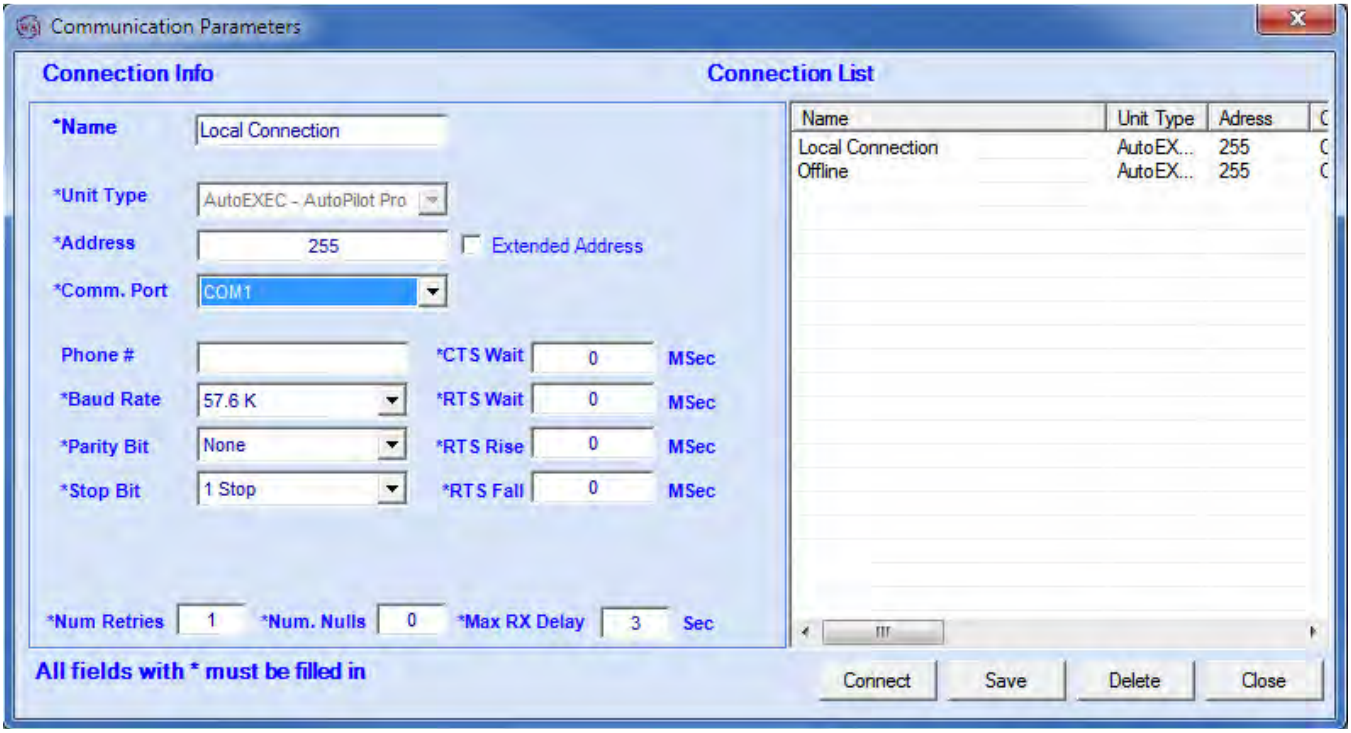
18.2.5 On the main board of the AutoPILOT PRO, add a jumper to J40 to select RS-485 mode.

18.2.6 Connect a 120Ω resistor between the two RS-485 terminal block (TB2) positions of the last HMA on the bus.

18.3. **Initial AutoPILOT PRO Configuration**

18.3.1 Start the AutoCONFIG application.

18.3.2 A dialog will appear allowing for communication settings between the AutoCONFIG application and the AutoPILOT PRO. This example uses 'Local Connection' as the connection profile name.



18.3.3 Select the COM port number corresponding to the CHIT cable.

18.3.4 Ensure that the other communication settings are set as desired. Note: The settings displayed above have been found to result in successful connection to the AutoPILOT PRO.

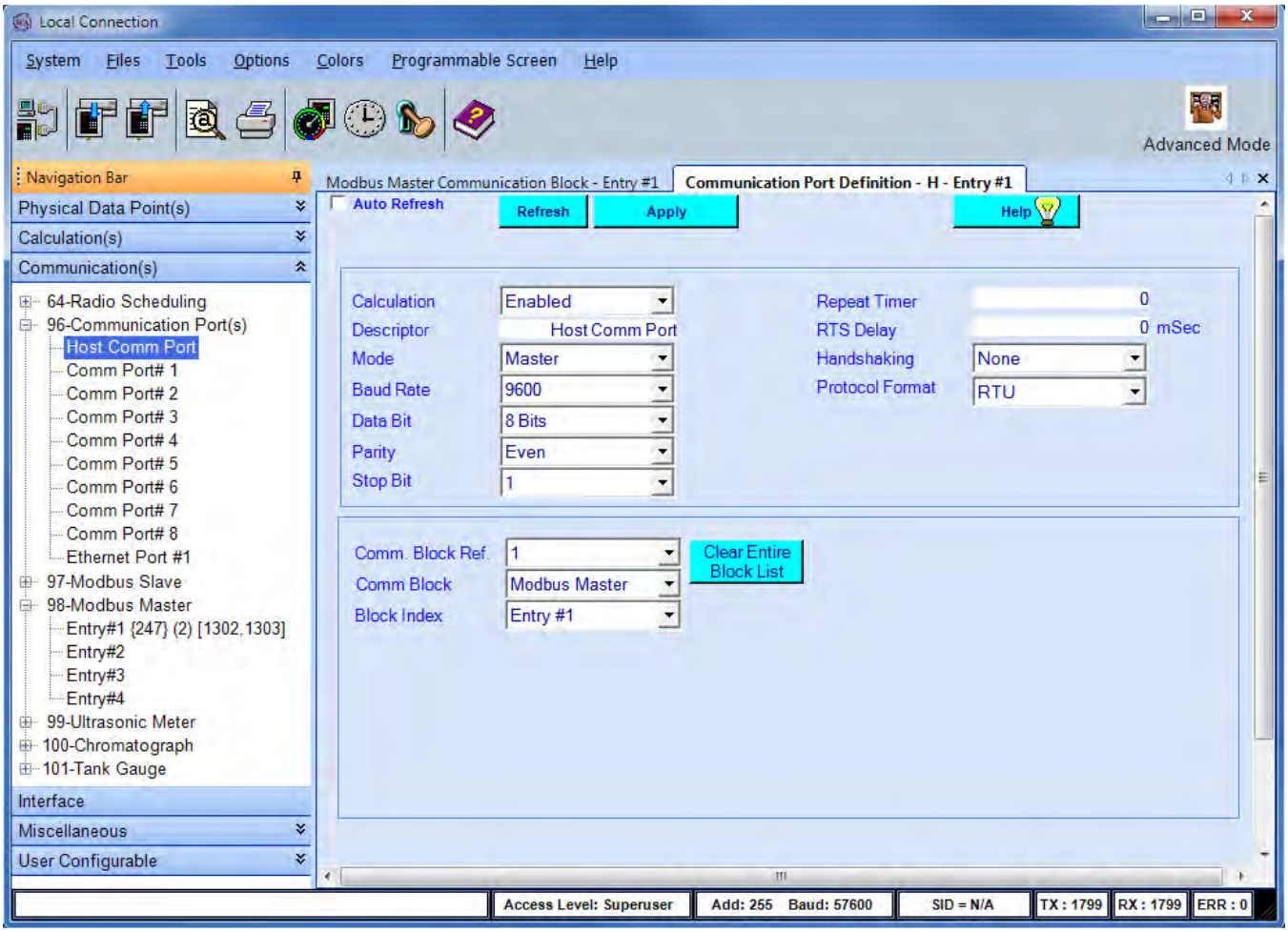
18.3.5 If any changes to the settings have been made, click on Save.

18.3.6 Click on Connect to establish communication with the AutoPILOT PRO.

18.4. **Reading registers from the HMA**

18.4.1 The followings steps demonstrate how to read the PV, SV, TV and QV from a HART device attached to the HMA. When making any changes to the settings, click on Apply at the top of the window to write them to the AutoPILOT PRO.

18.4.2 In the Navigation Bar, click on Communication(s), expand the 96-Communication Port(s) item, and then double-click on Host Comm Port.



18.4.3 Set Calculation to Enabled.

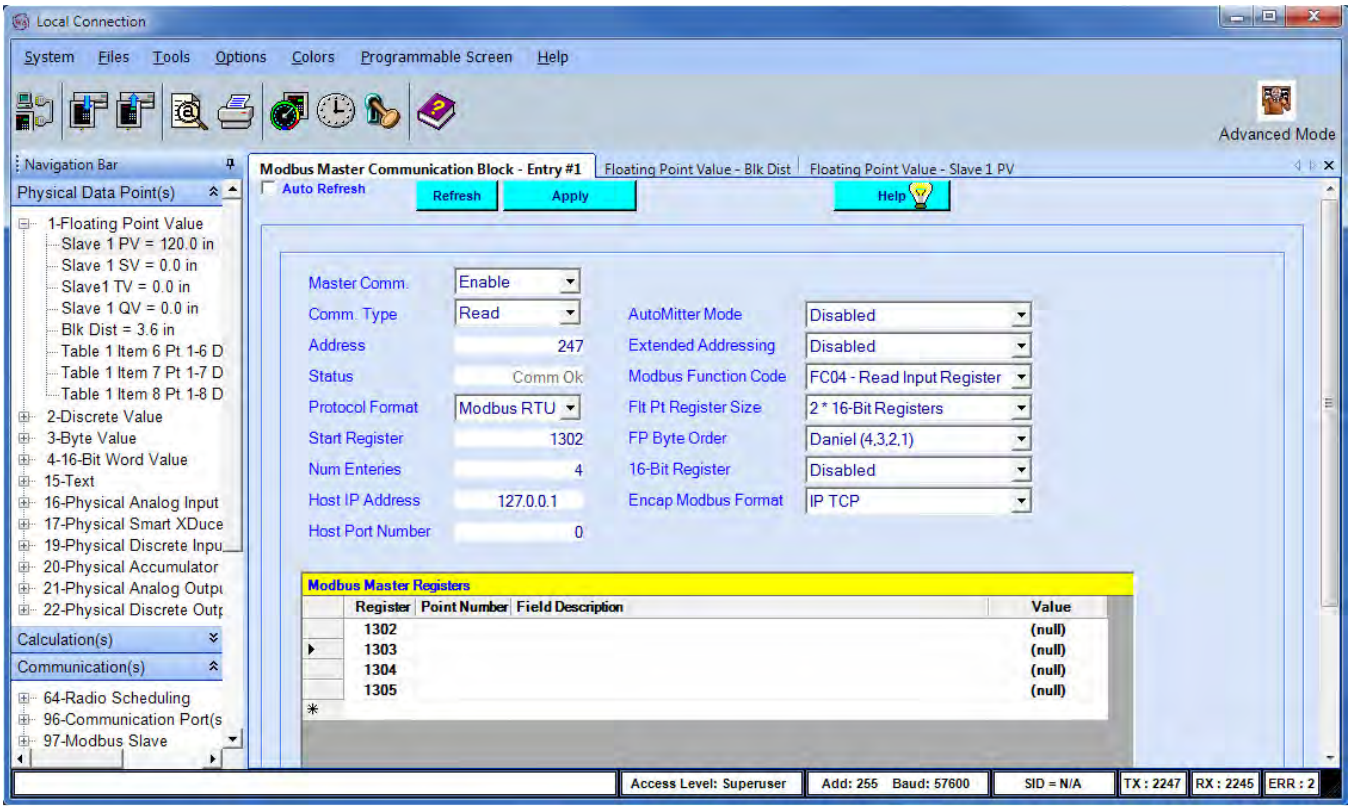
18.4.4 Set the Repeat Timer to the desired sampling interval in seconds.

18.4.5 Ensure that the communication settings match the selections made in step 19.1.1.

18.4.6 Set the Comm. Block Ref to 1, the Comm Block to Modbus Master, and the Block Index to Entry #1.

18.4.7 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.8 In the Navigation Bar, click on Communication(s), expand the 98-Modbus Master item, and then double-click on Entry#1.



18.4.9 Set Master Comm. to Enable.

18.4.10 Set Comm. Type to Read.

18.4.11 Set the Address to the Modbus address of the HMA.

18.4.12 Set the Start Register to 1302 (the start of the PV register for Slave 1 in the HMA).

18.4.13 Set the Num Entries to 4 (four 32-bit floating point numbers).

18.4.14 The Host IP Address, Host Port Number, AutoMitter Mode, Extended Addressing and Encap Modbus Format can be ignored.

18.4.15 Set the Modbus Function Code to FC04 - Read Input Register.

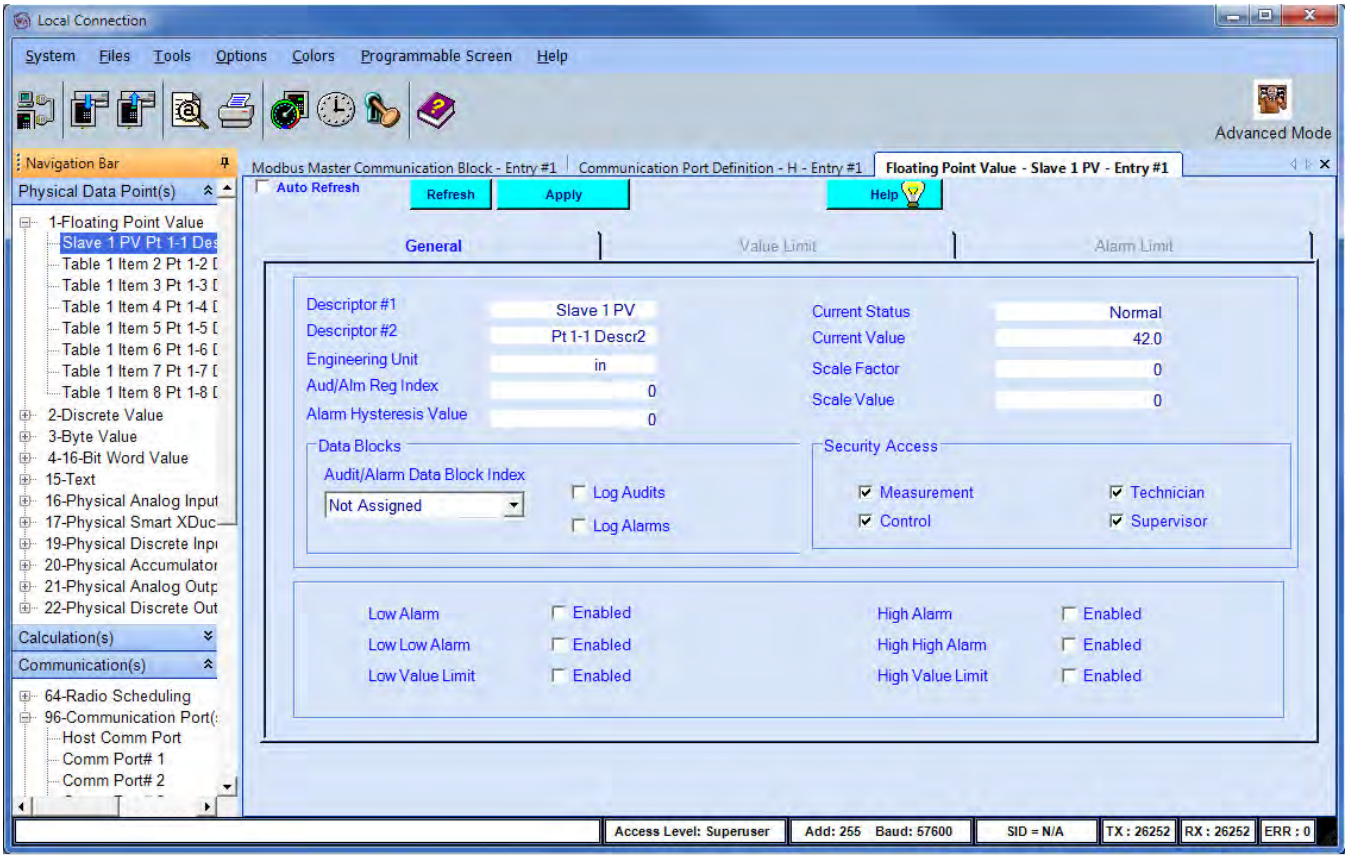
18.4.16 Set the Flt Pt Register Size to 2 * 16-Bit register, and the FP Byte Order to Daniel (4,3,2,1).

18.4.17 Set the 16-Bit Register to Disabled.

18.4.18 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.19 In the Navigation Bar, click on Physical Data Point(s), and expand the 1-Floating Point Value item.

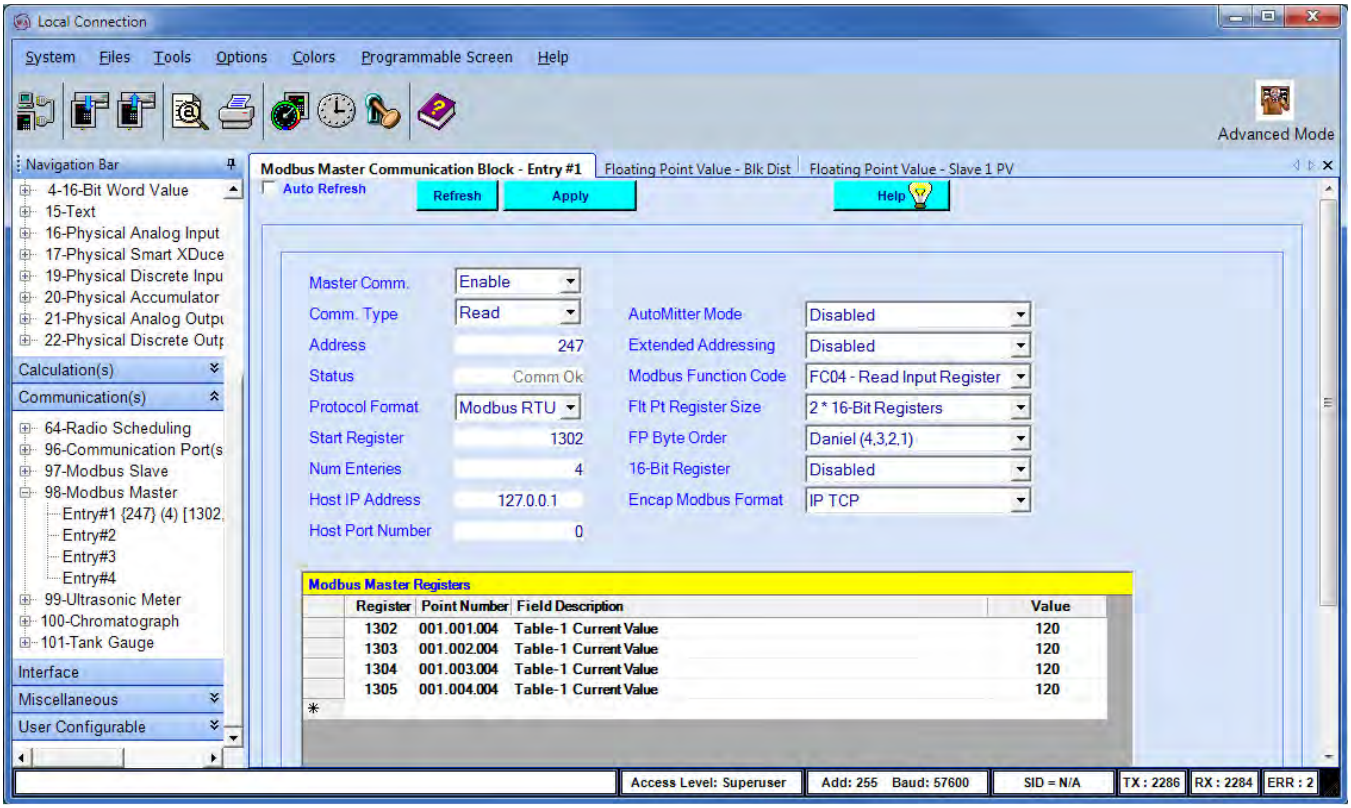
18.4.20 Double click on the Table 1 Item 1 entry, change Descriptor #1 to 'PV', and Engineering Unit to correspond to the level units in use by the HART transmitter to be read.



18.4.21 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.22 Right click on the Slave 1 PV entry in the Navigation Bar and select Copy.

18.4.23 Double click on the Entry #1 listing in the Communication(s) \ 98-Modbus Master section of the Navigation Bar.



18.4.24 Right click on the Register number 1302 cell and select Paste.

18.4.25 To set up the SV, TV and QV readings, repeat steps 19.4.19 through 19.4.24 using Table 1 items 2 to 4. Paste the SV into address 1304, TV into address 1306 and QV into address 1308.

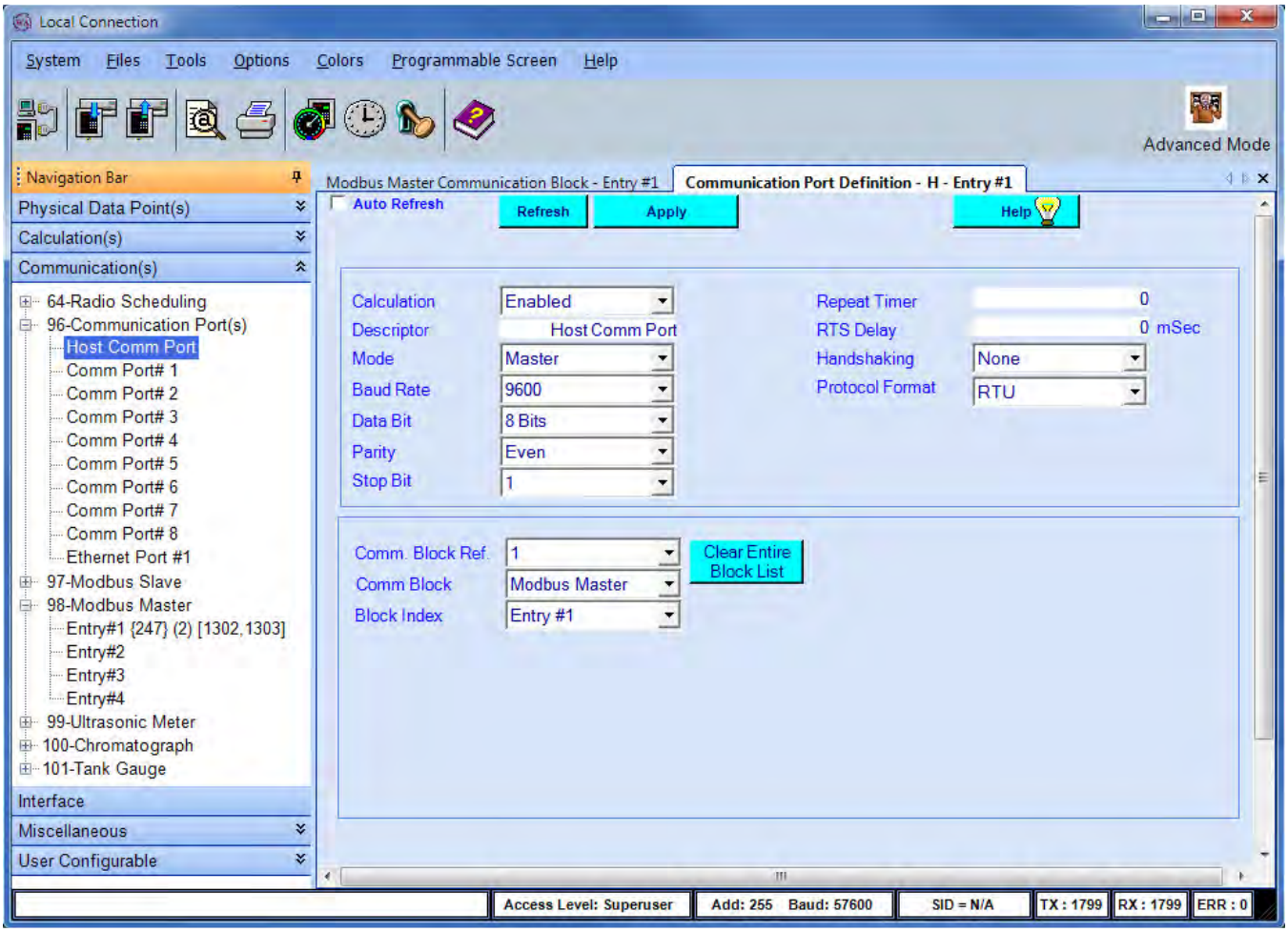
18.4.26 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.27 Check on Auto Refresh to start the AutoPILOT PRO to repeatedly read the values from the device.

18.5. **Writing registers to the HMA**

18.5.1 The followings steps demonstrate how to write the Blocking Distance to a HART device attached to the HMA. When making any changes to the settings, click on Apply at the top of the window to write them to the AutoPILOT PRO.

18.5.2 In the Navigation Bar, click on Communication(s), expand the 96-Communication Port(s) item, and then double-click on Host Comm Port.



18.5.3 Set Calculation to Enabled.

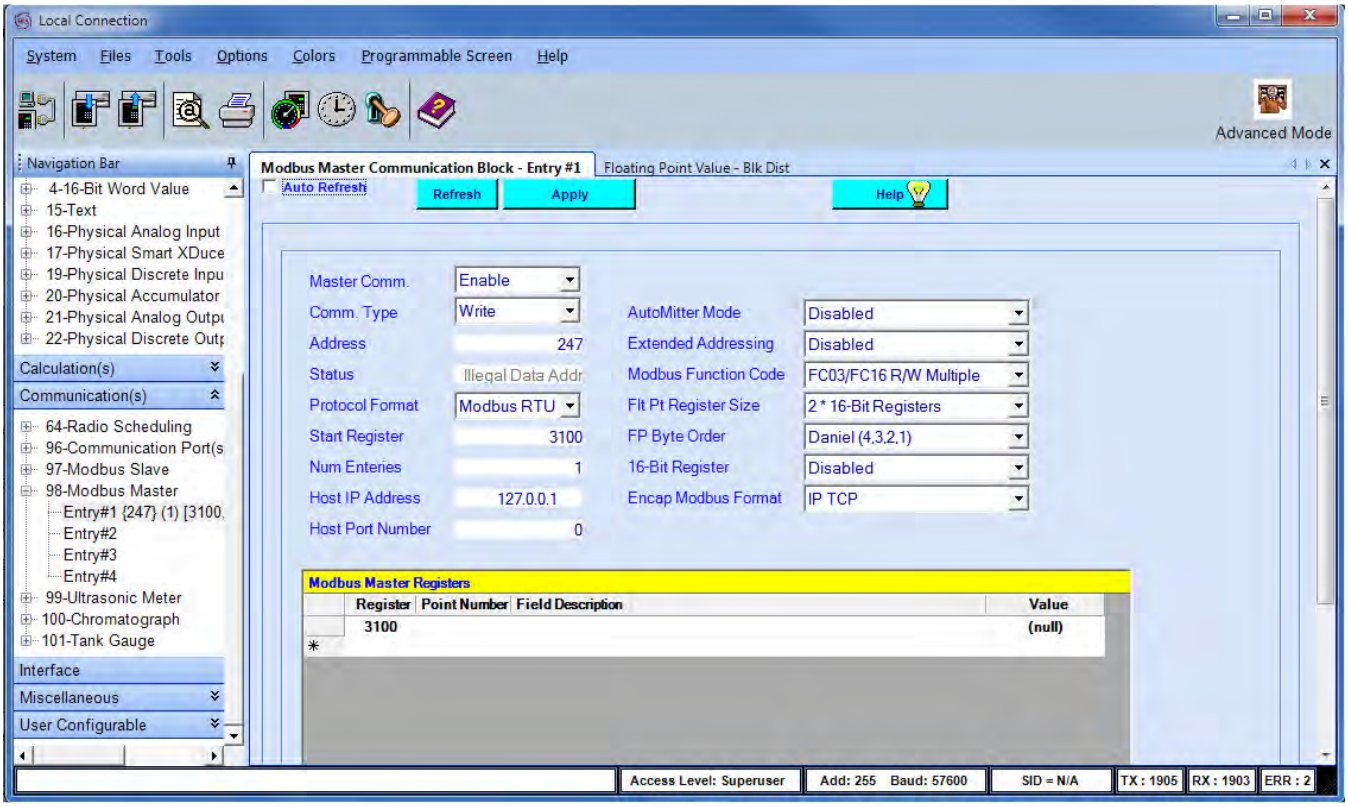
18.5.4 Set the Repeat Timer to the desired sampling interval in seconds.

18.5.5 Ensure that the communication settings match the selections made in step 19.1.1.

18.5.6 Set the Comm. Block Ref to 1, the Comm Block to Modbus Master, and the Block Index to Entry #1.

18.5.7 Click on Apply to send the settings to the AutoPILOT PRO.

In the Navigation Bar, click on Communication(s), expand the 98-Modbus Master item, and then double-click on Entry#1.



18.5.8 Set Master Comm. to Enable.

18.5.9 Set Comm. Type to Write.

18.5.10 Set the Address to the Modbus address of the HMA.

18.5.11 Set the Start Register to 3100 (the start of the Blocking Distance register for Slave 1 in the HMA).

18.5.12 Set the Num Entries to 1 (one 32-bit floating point number).

18.5.13 The Host IP Address, Host Port Number, AutoMitter Mode, Extended Addressing and Encap Modbus Format can be ignored.

18.5.14 Set the Modbus Function Code to FC03/FC16 R/W Multiple for reading input registers.

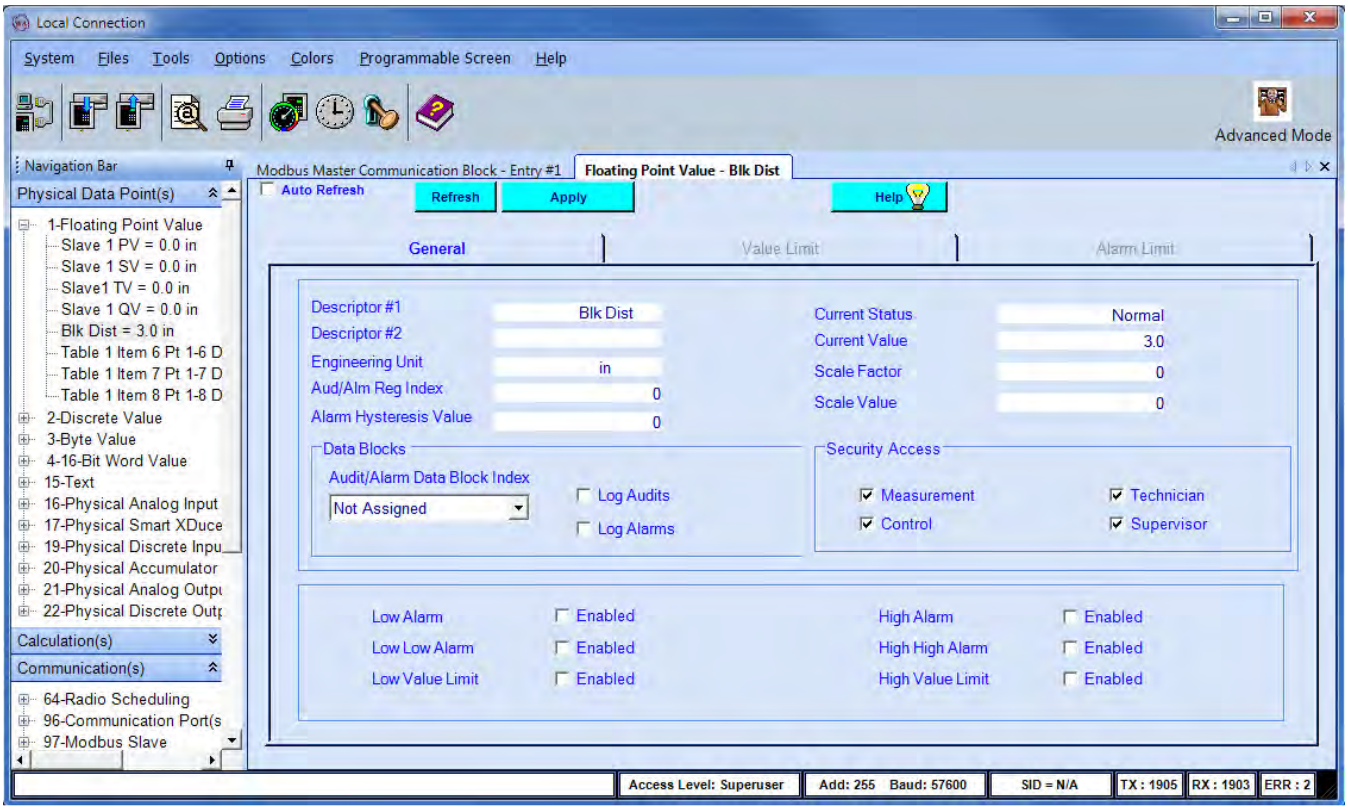
18.5.15 Set the Flt Pt Register Size to 2 * 16-Bit Registers, and the FP Byte Order to Daniel (4,3,2,1).

18.5.16 Set the 16-Bit Register to Disabled.

18.5.17 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.18 In the Navigation Bar, click on Physical Data Point(s), and expand the 1-Floating Point Value item.

18.5.19 Double click on the Table 1 Item 5 entry, and change Descriptor #1 to 'Blk Dist' and Engineering Unit to correspond to the level units in use by the HART transmitter to be read.

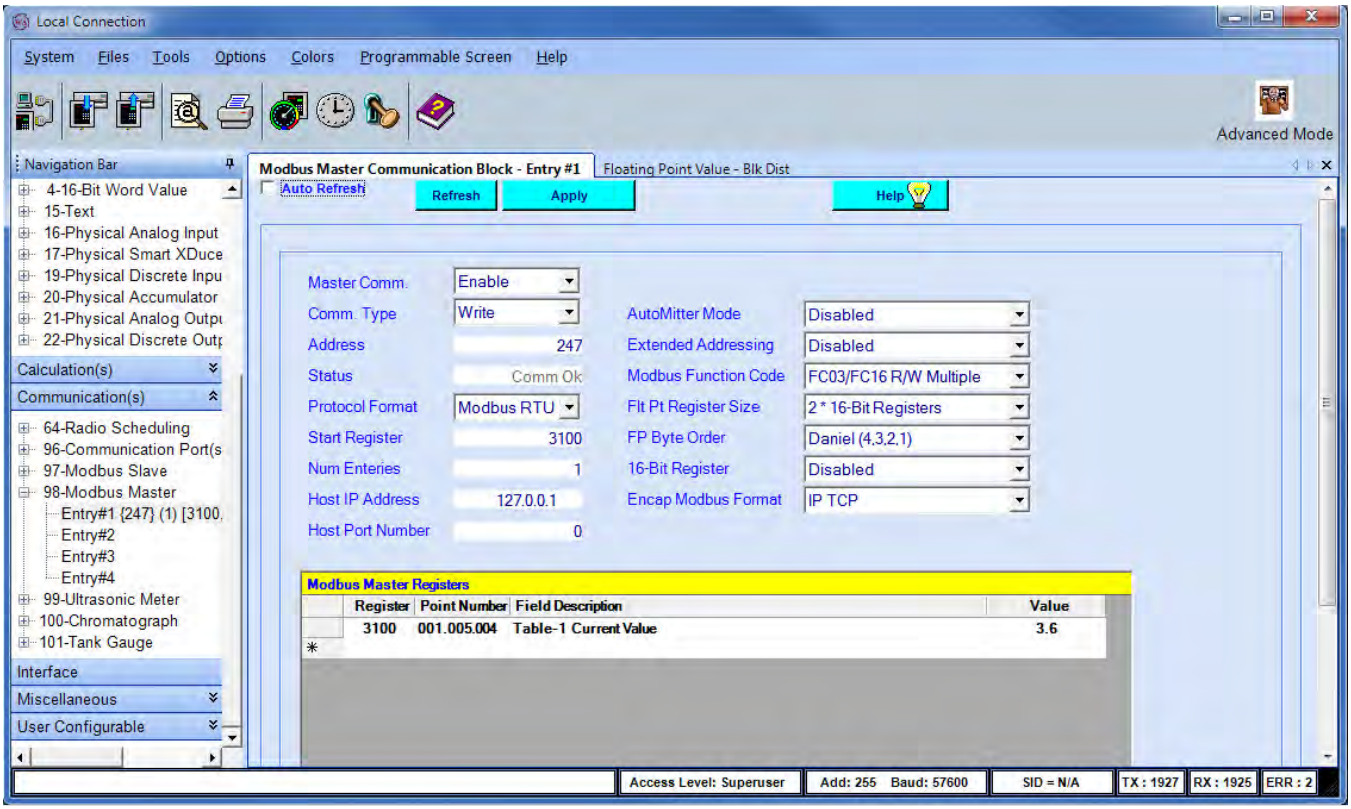


18.5.20 Enter the value to be sent to the device in the Current Value textbox.

18.5.21 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.22 Right click on the Slave 1 Blk Dist entry in the Navigation Bar and select Copy.

18.5.23 Double click on the Entry #1 listing in the Communication(s) \ 98-Modbus Master section of the Navigation Bar.



18.5.24 Right click on the Register number 3100 cell and select Paste.

18.5.25 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.26 Click on Refresh to command the AutoPILOT PRO to send the value to the device.

18.5.27 Change the Comm. Type to Read.

18.5.28 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.29 Click on Refresh to confirm that the device has accepted the new value.

APPENDICES

A. HMA Terminal Block Layout

Notes:

A. For Modbus devices using ‘A’ and ‘B’ for the RS-485 connection, connect ‘A’ to the ‘+‘ position of the RS-485 terminal block, and ‘B’ to the ‘-’ position.
B. The RS-485 terminal block is used as the RS-232 terminal block when the positions 3 and 4 DIP switches are set to the RS-232 mode. See Appendix B. Connect the RS-232 TX line to the ‘+‘ position of the RS-485 terminal block, and the RX line to the ‘-‘ position.
C. It is recommended that any wires connected to the HART terminal block be dressed such that there is some exposed wire. This will permit connecting a HART modem without breaking the HART loop if additional device configuration or troubleshooting is required.

B. HMA DIP Switch Settings

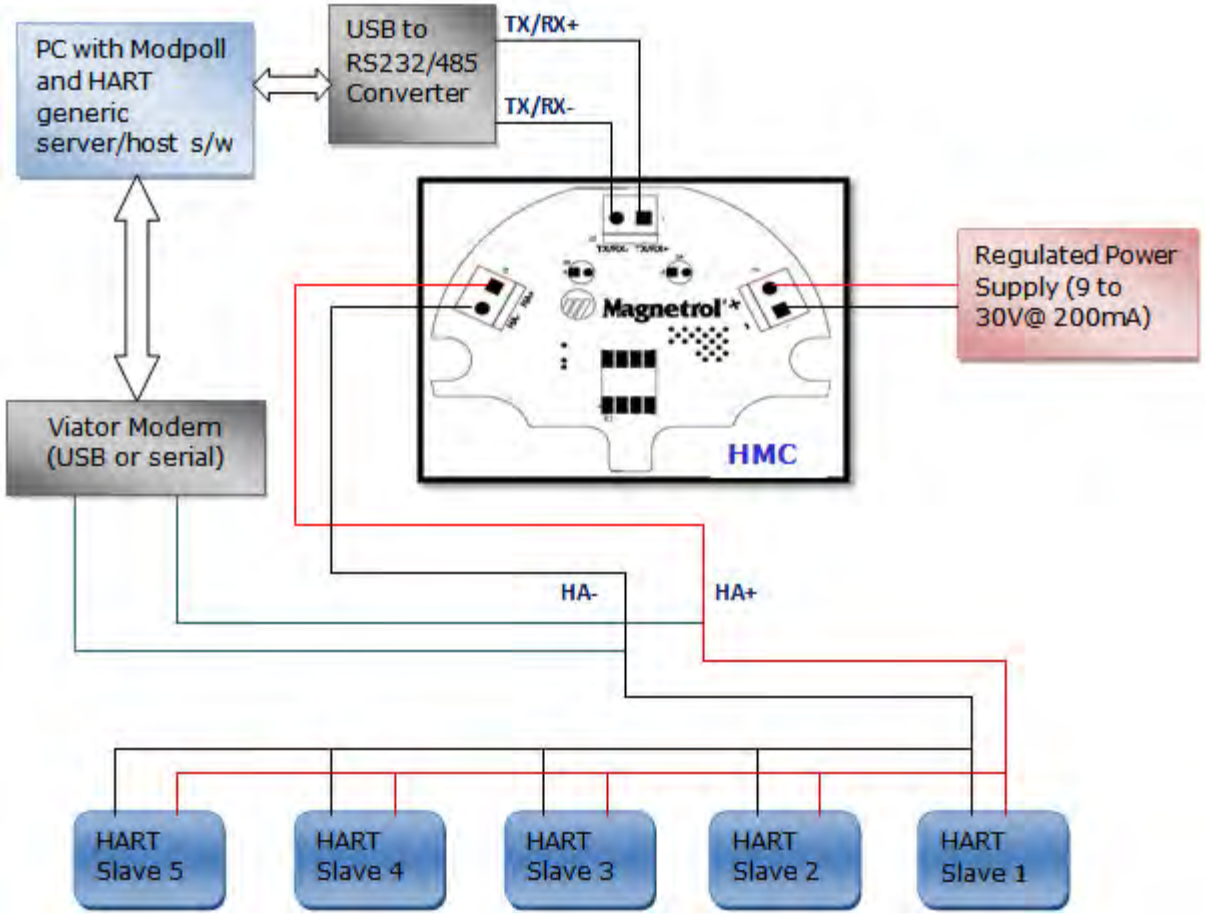
Position 1	ON	Normal mode
	OFF	Default configuration mode
Position 2	ON	Program mode
	OFF	Run mode
Position 3	OFF	RS485 mode
Position 4	ON	
Position 3	ON	RS232 mode
Position 4	OFF	

C. HMA LED Indicators

LED D5	Green: Indicates Power ON
LED D4	Red: Indicates Error (indicated by HMA status bits)

After power on, check the LED status. If the Red LED is ON then check the HMA status by reading Modbus register 1200.

D. HMA System Connection Diagram



E. Nomenclature Table

HMA Nomenclature	Modbus Poll Nomenclature
Data Type	Display
Number of Registers	Quantity
Modbus Register Type	Function
Modbus Register Number	Address

F. Modbus RTU Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	0
Slave address	UINT8	1	Holding	3001	1 to 247	247
Protocol Type	UINT8	1	Holding	3002	1	1
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	8
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	0
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	3
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	0
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	0
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

G. Modbus ASCII Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	0
Slave address	UINT8	1	Holding	3001	1 to 99	1
Protocol Type	UINT8	1	Holding	3002	2	2
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	7
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	0
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	3
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	0
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	0
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

H. LevelMaster Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	0
Slave address	UINT8	1	Holding	3001	1 to 247	247
Protocol Type	UINT8	1	Holding	3002	3	3
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	8
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	0
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	3
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	1
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	0
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

I. HART over RS485 Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	
Slave address	UINT8	1	Holding	3001	1 to 247	
Protocol Type	UINT8	1	Holding	3002	2	4
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	8
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	1
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	0
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	1
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	1
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

J. HMA Diagnostics Modbus Registers

Parameter	Modbus Register Info			Modbus Register	
	Data type	Number	Type	Number	Bit
Configuration data error	UINT8	1	Input	1200	0
No HART communications					1
Communication Mode (0 == RS232, 1 == RS485)					2
EEPROM failure					3
HMA Ready					4
Reserved/Unused					5
Reserved/Unused					6
Configured & connected Slaves mismatch (mismatch in number or mismatch in device identification)					7
Reserved/Unused	UINT8	1	Input		8
Buckboost Fail					9
Slave 1 malfunction (Comm error)					10
Slave 2 malfunction (Comm error)					11
Slave 3 malfunction (Comm error)					12
Slave 4 malfunction (Comm error)					13
Slave 5 malfunction (Comm error)					14
Configuration data area checksum error					15
Byte 3 bits - Reserved	UINT8	1	Input	1201	
Byte 4 bits - Reserved	UINT8	1	Input		
HMA Firmware Version	UINT8	8	Input	1205	
HMA Serial Number	UINT8	6	Input	1213	
Number of attached devices	UINT8	1	Input	1250	
Slave 1 Device Type	UINT8	1	Input	1251	
Slave 2 Device Type	UINT8	1	Input	1252	
Slave 3 Device Type	UINT8	1	Input	1253	
Slave 4 Device Type	UINT8	1	Input	1254	
Slave 5 Device Type	UINT8	1	Input	1255	
Slave 1 Poll Address	UINT8	1	Input	1256	
Slave 2 Poll Address	UINT8	1	Input	1257	
Slave 3 Poll Address	UINT8	1	Input	1258	
Slave 4 Poll Address	UINT8	1	Input	1259	
Slave 5 Poll Address	UINT8	1	Input	1260	

K. HMA Device Information Modbus Registers

Parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
Polling Address	UINT8	1	Input	1000	1000	1020	1040	1060	1080
Loop Current Mode	UINT8	1	Input	1001	1001	1021	1041	1061	1081
Device Type	UINT16	1	Input	1002	1002	1022	1042	1062	1082
Min Preambles in request	UINT8	1	Input	1003	1003	1023	1043	1063	1083
Protocol Rev	UINT8	1	Input	1004	1004	1024	1044	1064	1084
Device rev	UINT8	1	Input	1005	1005	1025	1045	1065	1085
S/w rev	UINT8	1	Input	1006	1006	1026	1046	1066	1086
H/W rev/physical sign code	UINT8	1	Input	1007	1007	1027	1047	1067	1087
Flags	UINT8	1	Input	1008	1008	1028	1048	1068	1088
Device ID	HEX	2	Input	1009	1009	1029	1049	1069	1089
Minimum Preambles in response	UINT8	1	Input	1011	1011	1031	1051	1071	1091
Max Device Variables	UINT8	1	Input	1012	1012	1032	1052	1072	1092
Reserved/Unused									
Extended field device status	UINT8	1	Input	1014	1014	1034	1054	1074	1094
Manufacturer code	UINT8	1	Input	1015	1015	1035	1055	1075	1095
Pvt Label Distributor code	UINT8	1	Input	1016	1016	1036	1056	1076	1096
Device Profile	UINT8	1	Input	1017	1017	1037	1057	1077	1097

L. Model 706, Model JM4 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	5	Input	1101-1105	1101 1105	1111-1115	1121-1125	1131-1135	1141-1145
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	8	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Advanced Password	UINT32	2	Input	2156	2156	2256	2356	2456	2556
Reserved/Unused									
HART entered password	UINT32	2	Holding	3110	3110	3210	3310	3410	3510
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Sensitivity	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Level Threshold code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Interface Level Threshold code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Level Threshold Amplitude	UINT8	1	Holding	3134	3134	3234	3334	3434	3534
Interface Threshold Amplitude	UINT8	1	Holding	3135	3135	3235	3335	3435	3535

Note: Reference Appendices U and V for SV and parameter code definitions.

M. Model 705 3x Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
	Data Type	Number	Type	Device Mode	HMA Mode				
					Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	4	Input	1101-1104	1101-1104	1111-1114	1121-1124	1131-1134	1141-1144
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	4	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Reserved/Unused									
User Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Sensitivity	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Negative Threshold code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Negative Threshold Amplitude	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Interface Lvl Thresh code	UINT8	1	Holding	3134	3134	3234	3334	3434	3534
Interface Lvl Thresh Amplitude	UINT8	1	Holding	3135	3135	3235	3335	3435	3535

N. Model R82 R2 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value				1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	2	Input	1101-1102	1101-1102	1111-1112	1121-1122	1131 - 1132	1141-1142
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	6	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Reference Distance	Float	2	Holding	3104	3104	3204	3304	3404	3504
Level Unit code	UINT8	1	Input	2142	2142	2242	2342	2442	2542
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
TVG Min	UINT16	1	Holding	3122	3122	3230	3330	3430	3530
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Dielectric Range code	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Turbulence code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Rate of Change code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Foam code	UINT8	1	Holding	3134	3134	3234	3334	3434	3534

O. Model RX5 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value				1302	1302	1312	1322	1332	1342
PV units code	UINT8	1	Input	104	104	124	144	164	184
Command 48 status bytes	UINT8	1	Input	1101	1101	1111	1121	1131	1141
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	6	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Distance	Float	2	Input	2150	2150	2250	2350	2450	2550
Echo Strength	Float	2	Input	2153	2153	2253	2353	2453	2553
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Dielectric Range code	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Turbulence code	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Rate of Change code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Foam code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533

P. Model 355 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	2	Input	1101-1102	1101-1102	1111-1112	1121-1122	1131-1132	1141-1142
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	6	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Range	Float	2	Holding	3104	3104	3204	3304	3404	3504
Level Unit code	UINT8	1	Input	2142	2142	2242	2342	2442	2542
Damping Value	Float	2	Holding	3106	3106	3206	3306	3406	3506
Reference Distance	Float	2	Holding	3108	3108	3208	3308	3408	3508
Level Unit code	UINT8	1	Input	2144	2144	2244	2344	2444	2544
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Peak Threshold	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
TVG	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Reserved/Unused									
Echo Strength	UINT8	1	Input	2160	2160	2260	2360	2460	2560

Q. Enhanced Jupiter Modbus Registers

HART parameter	Modbus Register Info			Modbus Register number					
	Data type	Number	Type		Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
Command 48 status bytes	UINT8	1	Input	1101	1101	1111-	1121	1131-	1141
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	4	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Trim Level	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Trim Ifc Level	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530

R. E3 Modulevel Modbus Registers

HART parameter	Modbus Register Info			Modbus Register number					
					HMA Mode				
	Data type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
PV units code	UINT8	1	Input	104	104	124	144	164	184
Command 48 status bytes	UINT8	4	Input	1101-1104	1101-1104	1111-1114	1121-1124	1131-1134	1141-1144
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	4	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Trim Level	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit Code	UINT16	1	Input	2140	2140	2240	2340	2440	2540
Process SG	Float	2	Holding	3102	3102	3202	3302	3402	3502
Trim SG	Float	2	Holding	3104	3104	3204	3304	3404	3504
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Operating Temperature	UINT16	1	Holding	3122	3122	3222	3322	3422	3522
Temperature units code	UINT8	1	Input	2160	2160	2260	2360	2460	2560

S. Model R96 Modbus Registers[3]

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	5	Input	1101-1105	1101 1105	1111-1115	1121-1125	1131-1135	1141-1145
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	8	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Top Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Bottom Blocking Distance	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Advanced Password	UINT32	2	Input	2156	2156	2256	2356	2456	2556
Reserved/Unused									
HART entered password	UINT32	2	Holding	3110	3110	3210	3310	3410	3510
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Dielectric Range code	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Turbulence code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Rate of Change code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Foam code	UINT8	1	Holding	3134	3134	3234	3334	3434	3534
Target Algorithm code	UINT8	1	Holding	3135	3135	3235	3335	3435	3535
Level Threshold Mode code	UINT8	1	Holding	3137	3137	3237	3337	3437	3537
Auto Threshold value	UINT8	1	Holding	3138	3138	3238	3338	3438	3538
Fixed Threshold value	UINT8	1	Holding	3139	3139	3239	3339	3439	3539

[3] For firmware version 1.6a0 and later.

T. LevelMaster Error and Warning Codes

Error Code	Model 705 3x R2	Model R82	Model 355	Enhanced Jupiter	E3 Madulevel	Model RX5
1	Software Fault	Dflt Parm Fact	Dflt Parm Sys	Snsr Brd Failed	Fault	Default Params
2	ADC Failure	Dflt Parm Sys	Dflt Parm Adv	No Signal	Fault 2	No Fiducial
3	EEPROM Error	Dflt Parm Adv	Dflt Parm I/O	Float 1 Fail	Secondary Fault Lo	Echo Lost
4	Default Params	Dflt Parm I/O	Dflt Parm Fact	Default Params	Default Params	Safety Zone Alarm
5	No Ramp	Dflt Parm HART	Dflt Parm HART	Loop Failure	Loop Failure	CPU Failure
6	Loop Fail	Dflt Strap Tbl	Dflt Strap Tbl	Float 2 Fail	Secondary Fault Hi	EE Read Failure
7	Fid Shift	Dflt Parm Total	Dflt Parm Total	Fault 2	Primary Fault	EE Write Failure
8	Ramp Slope	Cnfg Conflict	Cnfg Conflict	Fault1	Core Drop	Software Erro
9	Lvl Below Probe End	RF Brd Failure	Hardware Failure			
10	No Probe	Loop Failure	Fa			
11	No Fiducial	Fault 2	Temperature Failure			
12	Safety Zone Alarm	Safe Zone Alrm	Blocking Distance			
13	No Signal	Echo Lost	Hi Volume Alrm			
14	EoP < Probe End	High Flow Alrm	High Flow Alrm			
15	EoP > Probe End	Hi Volume Alrm	Safe Zone Alarm			
16	High Vol Alarm	Fault 1	Echo Lost			
Warning Code						
1	Warning 1	Initializing	Warning 1	Warning 2	Warning 1	Factory Cal Req'd
2	Seal Leak	Warning 4	Low VDC at 20 mA	Warning 1	Cal Span Warning	Fiducial Unclear
3	Fid Spread	LowVDC@20mA	Noise	Hi Temperature	Calib Req'd	Corrupt Targ Rej
4	Warning 2	Warning 3	High Elec Temp	Low Temperature	Hi Temperature	No False Targ Rej
5	High Elec Temp	No Echo Rej	Low Elec Temp	System Warning	Lo Temperature	Button Failure
6	Low Elec Temp	Echo Rej Crpt	Echo Rej Crpt	Trim Req'd	Trim Req'd	Warning 04
7	Cal Req'd	Echo Rej Invl	Echo Rej Invl	Initializing	Initilaizing	Warning 02
8	EoP Low	Echo Rej Disable	Initializing	Calib Req'd	Warning 2	Warning 01
9	Trim Req'd	Echo Rej Insf	System Code			
10	No Target	Warning 2				
11	Warning 4	High Elec Temp				
12	Initializing	Low Elec Temp				
13	May Be Flooded	Rate Of Change				
14	Dry Probe	Warning 1				
15	Weak Signal	System Code				
16	System Warning					

Error Code	Model 706	Model JM4	Model R96
1	Software Error	SW Error (Main)	Software Error
2	RAM Error	RAM Error (Main)	RAM Error
3	ADC Failure	ADC Error (Main)	ADC Failure
4	EEPROM Error	EEPROM Error	EEPROM Error
5	Analog Board Error	CoP in Flash Mode	Analog Board Error
6	Analog Output Error	SW Conflict (CoP)	Analog Output Error
7	Spare 1	Spare 1	Spare 1
8	Default Parameters	Analog Board Error	Default Parameters
9	No Probe	SW Error (CoP)	No Antenna
10	No Fiducial	RAM Error (CoP)	Spare 2
11	No Echoes	ADC Error (CoP)	No Fiducial
12	Upper Echo Lost	Spare 2	Too Many Echoes
13	Spare 2	Analog Ouput Error	Safety Zone Alarm
14	EoP > Probe End	No Probe	Echo Lost
15	Level Below Probe End	Probe Memory Error	Spare Indicator 3
16	EoP Below Probe End	Probe Info Corrupt	Configuration Conflict
17	Safety Zone Alarm	Spare 3	High Volume Alarm
18	Config Conflict	New Probe	Spare Indicator 4
19	Hi Volume Alarm	Default Parameters	Initializing
20	Hi Flow Alarm	No Float Detected	Configuration Changed
21	Spare 3	Spare 4	Spare Indicator 5
22	Initializing	Config Conflict	Ramp Slope Error
23	Analog Output Fixed	Hi Volume Alarm	High Electronics Temp
24	Config Changed	Spare 5	Low Electronics Temp
25	Spare 4	Extra Float Detected	Calibration Required
26	Spare 5	2nd Float Missing	Echo Rejection Invalid
27	Spare 6	Initializing	Spare Indicator 6
28	Ramp Interval Error	Config Changed	Inferred Level
29	Hi Elec Temp	Spare 6	Adjust Analog Output
30	Lo Elec Temp	Xmtr Calib Req'd	Low Supply Voltage
31	Calib Req'd	Spare 7	Spare Indicator 7
32	Echo Rej Invalid	Temp Calib Req'd	Spare Indicator 8
33	Spare 7	Hi Elec Temp	Marginal Echo
34	Inferred Level	Lo Elec Temp	Hi Surface Velocity
35	Adj Analog Output	Spare 8	Spare Indicator 9
36	Totalizer Data Lost	Spare 9	Spare Indicator 10
37	No Probe Target	Adj Analog Output	Sequence Record
38	Low Supply Voltage	Low Supply Voltage	
39	Dry Probe	Spare 10	
40	Spare 8	Lo Echo Strength	
41	Lo Echo Strength	Lo Ifc Echo Strength	
42	Lo Ifc Echo Strength	Hi Noise / LvlThresh	
43	Spare 9	Hi Noise / IfcThresh	
44	Spare 10	Spare 10	
45	Sequence Record	Sequence Record	

Note: Diagnostics mapped to the NE 107 Failure category will appear as a LM Error, those mapped to other categories will appear as a LM Warning.

U. Level Unit Codes

Code	44	45	47	48	49
Unit	feet	meters	inches	centimeters	millimeters

V. Parameter Codes

SV Code	Model 706	Model JM4	Model 705 3x R2	Model R82 R2	Model 355	E3 Modulevel
0	Level	Level	Level	Level	Level	Level
1	Ifc Level	Ifc Level	Volume	Volume	Flow	Ifc Level
2	Ifc Thickness	Ifc Thickness	Ifc Level	Distance	Volume	Density
3	Volume	Volume	Ifc Volume	Echo Strength	Head	
4	Flow	Fill Rate		Flow	Distance	
5	Distance	Distance		Head	Totalizer R	
6	Echo Strength	Echo Strength		Totalizer R	Totalizer NR	
7	Head	Elec Temp		Totalizer NR	Process Temp	
8	Totalizer R	Ifc Echo Strength			Custom Unit	
9	Totalizer NR					
10	Elec Temp					
11	Ifc Echo Strength					
12	Probe Buildup					

SV Code	Enhanced Jupiter	Model R96				
0	Level	Level				
1	Ifc Level	Volume				
2		Distance				
3		Echo Strength				
4		Temperature				
5		Signal Margin				
6						
7						
8						
9						
10						
11						
12						

Threshold Code	Model 706	Model JM4	Model 705 3x R2			
0	Auto Largest	Auto Largest	Fixed			
1	Fixed	Fixed	CFD			
2	Auto Upper	Sloped				
3	Sloped					

Dielectric Range Code	Model R82 R2	Model RX5	Model R96			
0	1.7 - 3	1.7 - 3	Below 1.7			
1	3 - 10	3 - 10	1.7 - 3			
2	10 - 100	10 - 100	3 - 10			
			10 - 100			

Turbulence Code	Model R82 R2	Model RX5	Model R96			
0	None	None	None			
1	Light	Light	Light			
2	Medium	Medium	Medium			
3	Heavy	Heavy	Heavy			

Rate of Change Code	Model R82 R2	Model RX5	Model R96			
0	< 5 in/min	< 5 in/min	< 5 in/min			
1	5 - 20 in/min	5 - 20 in/min	5 - 20 in/min			
2	20 - 60 in/min	20 - 60 in/min	20 - 60 in/min			
3	> 60 in/min	> 60 in/min	> 60 in/min			

Foam Code	Model R82 R2	Model RX5	Model R96			
0	None	None	None			
1	Light	Light	Light			
2	Medium	Medium	Medium			
3	Heavy	Heavy	Heavy			

Target Algorithm	Model R96					
0	First Peak					
1	Largest Peak					

Lvl Thresh Mode	Model R96					
0	Auto Largest					
1	Fixed					

About Modbus

Our Mission

The Modbus Organization is a group of independent users and suppliers of automation devices that seeks to drive the adoption of the Modbus communication protocol suite and the evolution to address architectures for distributed automation systems across multiple market segments. The Modbus Organization will also provide the infrastructure to obtain and share information about the protocols, their application and certification to simplify implementation by users resulting in reduced costs.

Organization

The Modbus Organization is a membership-based trade association, incorporated as "Modbus Organization, Inc." under the laws of the Commonwealth of Massachusetts, USA and recognized by the U.S. Internal Revenue Service as a nonprofit organization under Internal Revenue Code 501(c)(6). Donations to the organization are not deductible as charitable contributions but may be deductible as a business expense. The Modbus Organization's annual IRS Form 990 is available upon request via our contact page, providing the complete name, address, and e-mail address of the requesting organization or individual.

Our Member Logo

Our membership logo symbolizes a round table, meaning that we invite all our members to participate in the technical and educational activities of our organization. Suppliers large and small, system integrators, end users, open source developers, educators and other interested parties are all invited to join in the discussions that will take the Modbus protocol into the future.

Our Activities

The Modbus Organization engages in a broad range of activities relating to the maintenance and proliferation of the Modbus protocol. Some of these activities include:

- Participation in standards activities worldwide.
- Leading the evolution of the Modbus protocol and its variants.
- Encouraging and assisting the use of Modbus across a broad spectrum of physical layers and transmission media.
- Maintaining and evolving a conformance testing program to insure greater interoperability of Modbus devices.
- Providing information to users and supplers alike to help them be successful in their use of Modbus.
- Engaging in educational and promotional efforts including trade shows, newsletters, this website, and other outreach activities.

Our Invitation

Our invitation is to you, as a Modbus user or supplier, to join in our activities, share in the benefits of Modbus Organization membership, and help us bring Modbus into the future. We are committed to maintaining Modbus as the world's leading protocol for industrial automation, and invite you to take your place at our roundtable.

For more information about Modbus Organization membership, please see our Membership Flyer and Membership Application. Refer to our contact page (http://modbus.org/contact.php) for ways to get in touch - we'd be glad to hear from you!

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