TechnipFMC

MANUAL

Smith Meter® AccuLERT II ID-2000

Installation / Operation Manual

Bulletin MN02008 Issue/Rev. 0.2 (4/06)

Receipt of Equipment

When the equipment is received, the outside packing case should be checked immediately for any shipping damage. If the packing case has been damaged, the local carrier should be notified at once regarding his liability. Carefully remove the unit from its packing case and inspect for damaged or missing parts.

If damage has occurred during shipment or parts are missing, a written report should be submitted to the Customer Service Department, TechnipFMC, Erie, Pennsylvania 16510.

Prior to installation, the unit should be stored in its original packing case and protected from adverse weather conditions and abuse.

Caution

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this Instruction Manual, may cause interference to radio communications. It has not been tested to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

Proprietary Notice

TechnipFMC will not be held responsible for loss of liquid or of damage of any kind or from any cause to the person or property of others, or for loss or profit, or loss of use, or any other special, incidental, or consequential damages caused by the use or misapplication of the contents stated herein.

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Safety Precautions

Electrical

General

When an instrument is supplied in Explosion Proof / Flame Proof Instrument Housing, it is the design intention that the housing is to be directly coupled to a turbine meter with Explosion Proof / Flame Proof pick-up bosses.

Note: *If interfacing to a turbine meter that is not rated Explosion Proof / Flame Proof but rather Intrinsic Safe, then an approved Intrinsic Safe barrier must be used according to the manufacturer's control drawing between the meter sensing device and the AccuLERT.*

Caution: To prevent ignition of hazardous atmospheres, disconnect the instrument from the supply circuit before opening the housing. Keep the instrument housing tightly closed when circuits are in operation.

Warning: This instrument contains an internal battery-powered circuit. To prevent ignition of hazardous atmospheres, do not open the enclosure unless the area is known to be non-hazardous.

United States and Canadian Installations

(a) A conduit seal off fitting is required within 18" of the enclosure. All wiring must comply with applicable local and national electrical codes.

(b) Any unused entry must be suitably blocked with an listed/certified plug

European EU (CENELEC) Installations

CE **0539** Ex **II 2G** D **01ATEX 130943**

Instrument is certified as:
EEx d IIB T6 Tamb = - 40°C to + 70°C

a) Cable entry must be in accordance to EN 50018:2000 Section 13.1. For systems utilizing cable glands, the gland and/or thread adaptor must be EEx certified. The cable end must be securely installed and, depending on the cable type, be properly protected from mechanical damage.

b) Conduit Entry must be in accordance to EN 50018:2000 Section 13.2. For systems utilizing conduit, an EEx certified sealing device must be used immediately at the entrance of the enclosure.

c) Any unused entry must be suitably blocked with an EEx certified plug.

Australian Installations

a) Wiring must be in accordance to AS 2380.1 and AS 2380.2 and shall be terminated in an appropriate way, which will comply with the requirements for Class 1 Zone 1 installations.

b) Any unused entry must be suitably blocked with a certified plug.

Instruments Supplied in DIN Rail Housings (No Electrical Safety Approvals)

When the AccuLERT is supplied in a General Purpose housing, it must be installed in a suitable enclosure to protect it from the environment.

Note: *If interfacing to a turbine meter that is not rated Explosion Proof / Flame Proof but rather Intrinsic Safe, then an approved Intrinsic Safe barrier must be used according to the manufacturer's control drawing between the meter sensing device and the AccuLERT.*

Note: *One typical example of an Intrinsic Safe barrier designed for the NAMUR interface would be a Pepperl + Fuchs Model KFD2-SOT2-Ex2. For more information, visit http://www.am.pepperl-fuchs.com/.*

Introduction

The AccuLERT is a real time diagnostic tool developed for liquid or gas turbine meters which affords a critical improvement in custody measurement and metering accuracy.

Traditionally, turbine meters are proved on a periodic basis against known volume to determine repeatability and meter factor. Unfortunately the traditional methods cannot detect measurement problems in a real time mode as they occur. They require careful monitoring of meter performance by an operator, as this data is very important and confirms the measurement accuracy of the meter.

Turbine meters are influenced by many factors which alter their accuracy and repeatability. Common factors are debris collecting on blades or shroud, bent or broken blades, worn bearings, dry bearings, and hydraulic problems such as flashing, pulsation, swirl, etc.

If any of these factors are out of tolerance, or are an influence, the error source must be found and corrected. This task could be very extensive and time consuming, and could include the removal of the meter from the line to facilitate remote proving. Additionally hydraulic problems may not be detected by the proving process.

Proving is an important process to guarantee meter accuracy, unfortunately it can only detect certain turbine meter problems after they occur. To enhance measurement accuracy, and reduce loss, turbine meter problems need to be detected as they happen in real time.

With a properly installed and configured turbine meter, the AccuLERT monitors the signature which is used as a baseline condition. This baseline condition is programmed into the AccuLERT. When the turbine meter's real-time signature exceeds the programmed tolerance (pre-defined baseline signature), the AccuLERT signals the operator by a programmable switch contact and/or through the communications link showing that an error has been detected. This alarm identifies the most probable cause of the detected problems as they are occurring in real time. Additionally all alarms are stored in the AccuLERT historical alarm file.

The AccuLERT provides the operator or supervisory system with real time data that can be used to prevent turbine meter problems from going undetected for long periods of time. The historical data can also be used to set up preventive maintenance programs to ensure trouble free operation of the turbine meter.

Theory of Operation

Turbine meters are machined accurately to ensure repeatability and performance. The turbine meter signature is not dependent on the product being used. It is controlled by the following factors: the blade's angle and spacing between each other (linearity), bearing resistance in relation to rotational momentum (meter factor), and hydraulic flow characteristics such as excessive pulsation, flashing and swirl (repeatability).

The AccuLERT monitors the pulse rise period ratio, fall period ratio, and the standard deviation. In addition, it monitors the velocity of approach for each blade individually as the turbine meter rotor rotates. The pulsation factor is provided by monitoring the time for one revolution and comparing it to the previous revolution. The AccuLERT monitors the highest error that occurs every second and compares the value to the entered turbine meter signature (baseline signature). If the error is out of tolerance, and the error repeats every second for as long as the programmed sensitivity time, then the alarm condition is signaled. In order to clear this alarm condition, the turbine meter error must be clear for the period of sensitivity factor time.

Functions and Capabilities

Turbine Meter Diagnostic

The primary function of the AccuLERT is to monitor turbine meter irregularities on-line in a real time mode. It monitors the pulse period, the phase angle, the standard deviation, and changes of blade signature and rotational speed. This procedure detects turbine meter problems such as missing blades, clogged shroud, turbine wobble, bent blades, and normal wear and tear. A complete diagnostic report for the turbine condition is provided on demand or on a time set basis.

Signal Preamplifier

Secondary functions of the AccuLERT include serving as a signal preamplifier, the raw signal from the Turbine meter is amplified into a square wave output that can be used by other ancillary equipment. The amplitude of the square wave depends on the externally applied power supply voltage to the AccuLERT. The applied supply voltage cannot exceed 28 volts DC and cannot fall below 10 volts DC.

Smart Transmitter

A secondary function of the AccuLERT is to output the pulse accumulator data serially to the host computer using Modbus protocol. Data such as batch and diagnostic information are available through the serial link. The serial link is user configurable RS-232 or RS-485. Termination resistors are available for multi-drop RS-485 configurations.

System Backup

The AccuLERT is fitted with non-volatile battery-backed RAM for data storage. This includes hourly data, daily data, accumulator data, diagnostic data, batch data, and alarms. Configuration parameters are stored in EEPROM memory.

Batching

The batching function is user programmed on a time set basis or on demand. All accumulators, alarms, and turbine diagnostics are stored for auditing purposes. All batch information can be retrieved by a PC using the factory-supplied Windows-based computer program (Modbus Explorer) or Modbus protocol.

Direction Indication

Direction indication is available for bi-directional turbine meters fitted with dual pickup transducers. The flow direction is detected by means of a highly accurate quadrate decoder (if the AccuLERT is programmed for phase detection in the Parameter Entry Menu). Built-in hysteresis allows the AccuLERT to delay the direction output update until steady conditions are present. This function reduces the accumulator errors that occur as a result of turbine jitters or low flow rate direction errors. Minimum frequency for direction indication is 10 Hz. Optional direction indication can be achieved through the use of the programmable control input, for applications with turbines that only have one pick-up transducer.

Control Outputs and Inputs

The AccuLERT has additional output and input functions that are user programmable. Two open collector transistor switch outputs are supported with up to 50 mA at 24 volts with 1.2 watts maximum heat dissipation. One status input is supported with a Vdc rating up to 48. Voltage has to exceed 9 volts to be logic true. Functions provided are listed in the Status Inputs and Switched Outputs menu selections.

***Note**: All inputs and outputs can be operated with isolated or non-isolated power.*

Security

In applications that require system security for programmed values, a software and hardware security lock can be initiated. The security code is set up using the factory-supplied Windows-based program, or through Modbus communications using custom user written software as in the case of a supervisor computer system. When security is enabled and the supplied Modbus Explorer program is utilized, the message "Enter Security Code" will be displayed on the top line of the screen until the correct code is entered. If the wrong code is entered, "Wrong Security" will be displayed. When the correct security code is entered the message "Enter Security Code" will disappear and the information on the screen can be modified. Additional security can be afforded by programming the control input as a security switch, in which case the user supplied key switch would need to be enabled and the software security code entered before any of the parameters could be modified. Security codes can be programmed for the following screens:

- Parameters Entry
- Turbine Meter Diagnostics Entry
- Setting of Switch Outputs
- Setting of Status Inputs
- Setting Security Codes
- Date and Time
- Linearization Curve
- End Batch
- Reset Cumulative Totalizer
- Weights and Measures.

Data Collection Method

Data is collected as part of the AccuLERT's processing cycle. This data is then analyzed to determine what problems, if any, the turbine may be experiencing. It is very important to understand that the AccuLERT only "sees" the timings of the blades, buttons, or slots as they pass the pickup transducer. Primarily, the AccuLERT is looking for inconsistent turning of the rotor.

How is the data collected?

What is collected and what isn't?

The following describes the method used to collect the data from the pickup transducer.

1. The first part of every second is spent collecting data. For computations, the AccuLERT needs 300 blades, buttons, or slots to pass the pickup

transducer. If less than 300 blades, buttons, or slots are counted in the first second, the AccuLERT will wait for the beginning of the next second to capture the remaining data. Once again, if the count is less than 300, the AccuLERT will wait for the beginning of the next second to finish capturing data. This will continue until 300 data points have been captured or five seconds have passed. This means that for input frequencies above 60Hz, 300 data points from the high side of the sine wave and 300 data points from the low side of the sine wave will be captured.

2. Data will be collected every second, but not all data is used for analysis.

3. Once the data points have been collected, the analysis and posting of the data occurs.

4. The cycle repeats.

Signature Fields, Flow Zones and Flow Thresholds

As has been stated, the AccuLERT is a real time diagnostic tool for evaluating turbine meter performance during operation. It has also been explained that this is done utilizing baseline Signature Fields. The Signature Fields are determined by the blade or button timings at a known "good operating condition."

The Signature Fields consist of the following:

- Blade Average Deviation
- Blade Maximum Deviation
- Integral Deviation
- Ratio Deviation
- Bearing Average Deviation
- Bearing Maximum Deviation.

It has been recognized that at various flow rates throughout the usable flow range* of the turbine meter, the turbine meter will react differently (i.e., at one given flow rate the Signature Field may differ from another flow rate). In order to evaluate the turbine meter accurately over the entire rated flow range, the flow range needs to be broken down into smaller usable sections. These sections are defined as the Flow Zones. By using multiple Flow Zones the meter signature can be at a finer resolution than if only one Flow Zone was available.

*Typical Turbines Meters offer 10:1 turndown flow ranges.

Because multiple Flow Zones are required, the next problem for the AccuLERT is to recognize the Flow Zone within which the meter is operating, or the trigger point between the Flow Zones. This trigger point has been defined as the Flow Rate Threshold.

1. The AccuLERT has six programmable thresholds (four on Revision 1.0 firmware or lower), located in the Diagnostics submenu tab of the Configuration directory. The operator must determine what the maximum operational flow rate will be for the meter and then divide the maximum flow rate by 7 to determine the values for the six thresholds.

   Example: If the maximum flow rate that the meter will be operated at is 3500 Units/Hour, take 3500 / 7 = 500 Units / Hour.

   Threshold 1 would be set for 500 Units / Hour.
   Threshold 2 would be set for 1000 Units / Hour.
   Threshold 3 would be set for 1500 Units / Hour.
   Threshold 4 would be set for 2000 Units / Hour.
   Threshold 5 would be set for 2500 Units / Hour.
   Threshold 6 would be set for 3000 Units / Hour.

2. The AccuLERT has seven Signature Field Zones. The Zones are divided by the six thresholds as explained above. The following example uses the above thresholds to illustrate.

   Example: Zone 1 will be active if the flow rate is between the minimum flow rate programmed and 500 Units/Hour. Zone 2 will be active if the flow rate is between 501 and 1000 Units/Hour. Zone 3 will be active if the flow rate is between 1001 and 1500 Units/Hour. Zone 4 will be active if the flow rate is between 1501 and 2000 Units/Hour. Zone 5 will be active if the flow rate is between 2001 and 2500 Units/Hour. Zone 6 will be active if the flow rate is between 2501 and 3000 Units/Hour. Zone 7 will be active if the flow rate is between 3001 and the maximum programmed flow rate.

3. With the threshold information programmed into the AccuLERT, the Signature Fields can be determined by either of two methods, Manual or Auto.

Manual Method For Deriving Turbine Signature

As previously explained, the Turbine Signature is used as the bench mark to determine the performance of the meter.

In order to eliminate nuance alarms from occurring it is recommended that a factor of 1.1 (10% increase) be multiplied by the individual error values (Blade Average Deviation, Blade Maximum Deviation and Integral Deviation) in each Flow Zone. These increased error values are to be used as diagnostic limits.

A factor of 1.5 (15% increase) should be multiplied by the individual error values (Ratio Deviation, Bearing Average Deviation, Bearing Maximum Deviation) in each Flow Zone. These increased error values are to be used as diagnostic limits.

Procedure

1. Run the turbine meter in each of the predetermined Flow Zones for a period that represents a common mode of operation.

2. Retrieve the past day's historical data.

3. Note the peak error values for each of the six error fields in each of the seven Flow Zones in the past day's historical file and program the diagnostic limits accordingly with the factor applied.

Example

1. The historical file shows that the Blade Average Deviation had a maximum value of 4% in Flow Zone 1. Set the maximum error limit for alarm to be the 4% error value plus the additional 10% factor.

   Blade Average Deviation = (4% x 1.1 = 4.4%)

2. The AccuLERT will alarm if changes exceed 4.4% for Blade Average Deviation.

3. Repeat this process for each of the six error values in the seven Zones

4. If the alarm occurs, proving the turbine is recommended to determine if the turbine meter is still within tolerance/consistency.

Common liquid turbine errors range as follows:

Blade/Linearity	Consistency	Bearing/Repeat
Avg < 2.50%	Integral <.75%	Avg < 3.00%
Max < 4.00%	Ratio < 2.00%	Max < 4.00%

Auto Method For Deriving Turbine Signature

When the auto feature is used to generate the signature fields for a given "zone", what is the program doing? The process is described below.

Note: The Auto Mode can be initialized by the Modbus Explorer program from the Diagnostics submenu of the Configuration page.

When the AccuLERT is in Auto Mode, it will collect 300 samples from each of the seven Flow Zones as the flow rates permit. It will then apply the Turbine Error Tolerance Percent as programmed under the Configuration / Diagnostics submenu in the Modbus Explorer program.

For example, if the meter is flowing at a rate of 580 Units/Hour, using the previous threshold example, Zone 2 will collect 300 data points and perform the calculations on the collected data to determine the error values for the six Signature Fields for Zone 2. It then will then automatically apply the factor (value entered in the Turbine Error Tolerance Percent field) to each of the error values for the six Signature Fields. As discussed under "Manual Method for Deriving Turbine Signature," the factor is used to eliminate nuance alarms. Valid entries for the Turbine Error Tolerance Percent field are between 0 and 15.

If the flow rate changes to move out of the Flow Zone before the data points are collected, the Signature Fields will not be updated. When the flow rate is increased enough to fall within the next Flow Zone, data will be collected and the Signature Fields will be updated. This process will continue for any empty Signature Field as long as the flow rate falls within the Flow Zone. The micro code for the AccuLERT is designed to take the average value from the 300 data points within a given zone.

1. When the first zone finishes collecting its 300 samples, the signature values are computed, the factor is applied from the value entered in the Turbine Error Tolerance Percent field and displayed in the signature fields.

2. The lower limit for Zone #1 is based on the Turbine Diagnostic Minimum Frequency.

3. The upper limit for Zone #7 (Zone #5 for Revision 1.0 firmware or lower) is based on the Turbine Maximum Flow Rate.

Alarm Processing

Alarms result from conclusions derived from collected data and numerical analysis. Any parameter that exceeds the established signature will elicit some type of response from the AccuLERT. All alarm messages require that the alarm be present longer than the time value (in seconds) specified in Sensitivity Factor Seconds as programmed under the Configuration / Diagnostics submenu in the Modbus Explorer program.

The following is a description of the conditions that trigger the twelve possible alarms of the AccuLERT.

Bent Blade Alarm

This occurs if the following conditions are met:

1. The calculated blade/linearity average (Blade Average Deviation %) is greater than the entered maximum error value for blade/linearity average **AND**
2. The calculated blade/linearity maximum (Blade Maximum Deviation %) is greater than the entered maximum error value for blade/linearity maximum.

Non-Uniform Flow Alarm

This occurs if the following conditions are met:

1. The calculated bearing/repeatability average (Bearing Average Deviation %) is greater than the entered maximum error value for bearing/repeatability average **AND**
2. The calculated bearing/repeatability maximum (Bearing Maximum Deviation %) is greater than the entered maximum error value for bearing/repeatability maximum

OR

The calculated consistency integral (Integral Deviation %) is greater than the entered maximum error value for consistency integral.

Bearing Alarm

This occurs if the following condition is met:
The calculated consistency ratio (Ratio Deviation %) is greater than the entered maximum error value for consistency ratio.

Wrong Setup Alarm

This occurs if the following conditions are met:

1. There is NO Bent Blade alarm **AND**
2. The calculated consistency integral (Integral Deviation %) **is greater than** the entered maximum error value for consistency integral **AND**
3. The calculated blade/linearity average (Blade Average Deviation %) **is greater than** the entered maximum error value for blade/linearity average **AND**
4. The calculated blade/linearity maximum (Blade Maximum Deviation %) **is less than** the entered maximum error value for blade/linearity maximum

OR

1. The calculated blade/linearity average (Blade Average Deviation %) **is less than** the entered maximum error value for blade/linearity average **AND**
2. The calculated blade/linearity maximum (Blade Maximum Deviation %) **is greater than** the entered maximum error value for blade/linearity maximum.

OR

1. There is no bearing alarm **AND**
2. The calculated consistency integral (Integral Deviation %) **is greater than** the entered maximum error value for consistency integral **AND**
3. The calculated bearing/repeatability average Bearing Average Deviation %) **is greater than** the entered maximum error value for bearing/repeatability average **AND**
4. The calculated bearing/repeatability maximum (Bearing Maximum Deviation %) **is less than** the entered maximum error value for bearing/repeatability maximum

OR

1. The calculated bearing/repeatability average (Bearing Average Deviation %) **is less than** the entered maximum error value for bearing/re-peatability average **AND**
2. The calculated bearing/repeatability maximum (Bearing Maximum Deviation %) **is greater than**

the entered maximum error value for bearing/ repeatability maximum.

Bad "A" Coil Alarm

This occurs if the following conditions are met:

The calculated "A" blade average deviation (consisting of the combined average of the Blade Average Deviation "high" pulse data and the Blade Average Deviation "low" pulse data) **is greater than** the entered maximum error value for blade/linearity average (Blade Average Deviation %).

OR

The calculated "A" blade maximum deviation (consisting of the combined average of the Blade Max Deviation "high" pulse data and the Blade Max Deviation "low" pulse data) **is greater than** the entered maximum error value for blade/linearity maximum (Blade Maximum Deviation %).

Bad "B" Coil

This occurs if the following conditions are met:

1. The calculated "B" blade average deviation (consisting of the combined average of the Blade Average Deviation "high" pulse data and the Blade Average Deviation "low" pulse data) **is greater than** the entered maximum error value for blade/linearity average (Blade Average Deviation %)

   OR

2. The calculated "B" blade maximum deviation (consisting of the combined average of the Blade Maximum Deviation "high" pulse data and the Blade Maximum Deviation "low" pulse data) **is greater than** the entered maximum error value for blade/linearity maximum (Blade Maximum Deviation %).

Missing "A" Pulses

This occurs if the following condition is met:

1. There are missing pulses on the "A" channel **as compared to** the "B" channel when the dual pickup function has been enabled (in other words, if "A" does not follow "B" or a "B" - "B" pulse sequence occurs.)

Missing "B" Pulses

This occurs if the following condition is met:

1. There are missing pulses on the "B" channel **as compared to** the "A" channel when the dual pickup function has been enabled. (In other words, if "B" does not follow "A" or an "A" - "A" pulse sequence occurs.)

Meter Over-Spin

This occurs if the following conditions are met:

The batch instantaneous flow rate **is greater than** the turbine maximum flow rate established on the Parameter Entry Menu.

Meter Down

This occurs if the following condition is met:

The meter frequency **is equal to** zero.

Accuracy

This occurs if the following conditions are met:

The accuracy alarm function is enabled when the Turbine Pickups selection on the Turbine Meter Diagnostic submenu is set to Independent. In this mode of operation the alarm is controlled by the comparison of the two meter pulse input channels within a user specified high and low tolerance value. This is also set on the Turbine Meter Diagnostic submenu. If the compared value of the two independent meter pulse inputs varies more than the high and low tolerance values, the alarm will be activated.

Example 1: Gas Turbine Meter with mechanical output shaft driving integral counter.

The Accuracy function can be used as a monitor that compares a low frequency input pulser to a high frequency input pulser. This feature is for use on gas turbine meters that have a mechanical output shaft driving a mechanical counter through a magnetic coupling. Typically, for a mechanical counter, there is a reed switch that closes a contact for every revolution of the right-hand wheel – one pulse per unit volume. Under certain conditions (for example, extremely cold weather) the mechanical drive shaft exiting the turbine meter can freeze up and become non-functional, causing the mechanical register to be inaccurate. This also increases the mechanical drag on the main rotor by the force required to cause the magnetic drive coupling to slip. The increased drag could cause under registration of the meter. For applications utilizing this type of meter, the high frequency pulser would be connected to input number one of the AccuLERT and the low frequency contact closure would be connected to input number two of the AccuLERT.

The main K-factor would be set to the name plate data for the high frequency pulser and the secondary K-factor would be set to the name plate value for the low resolution pulser. The Accuracy Alarm values (Configuration Screen Diagnostic Entry) would then be assigned limits. Recommended entries are 0.995 (99.5%) for the minimum alarm limit and 1.005 (100.5%) for the maximum alarm limit. If the mechanical shaft is not working properly, the Accuracy Alarm will be activated.

Example 2: Gas Turbine Meter with independent dual rotors which consist of the main rotor and sensing rotor. This type of meter is designed so that any change of rotation in the main rotor will influence the rotation of the sensing rotor. The pulsers from each rotor would be connected to the AccuLERT, and any difference in rotational velocity greater that the entered high and low accuracy values will signal an alarm.

Swirl

Swirl is a condition that can occur in the piping system of the turbine meter. The term describes the rotational or tangential velocity of fluid as it flows through a pipe. The angle at which the fluid impacts the turbine rotor blades is determined by the direction and degree of swirl, and will result in different rotor speeds from fluid flow in which there is no swirl. Typical causes of swirl are upstream protrusions or projections in the piping, or variations in piping configurations.

Swirl, as a dynamic condition, can be detected when the calculated Ratio Percent Deviation value increases and all other percent deviation values decrease. Because of the difficulty in detecting swirl, a separate set of diagnostic parameters have been made available in the AccuLERT. The Swirl Count Limit is utilized to count the number of data table calculations that must occur, and the number of times the Ratio Percent must be increasing with the other percentages decreasing during these occurrences, before the algorithm decides that a valid swirl condition exists. For example, a Swirl Count Limit of 3 out of 10 occurrences means that the Ratio Percent must be increasing (and others decreasing) for 3 consecutive times out of the last ten data table calculations before it can be considered valid.

Additionally, the Swirl Percent Change condition must be met. If the Swirl Percent Change is set to 3, then the Ratio Percent must increase by 3% for this condition to be met. For example, if the meter is operating in Zone 6 and the Ratio Percent in the diagnostic table is set for 2.28, then that value must go to at least 2.35 (and stay at that value or increase) while all other parameters are decreasing to meet the requirements for valid swirl detection. Logically, the meter frequency must also be above the minimum diagnostic frequency for any of the diagnostic functions to operate.

Preamplifier

The turbine preamplifier section of the AccuLERT amplifies the two channels of the turbine sine wave signals to a square wave output driver circuit that is capable of operating as a current sink or a current source. In addition, these square waves are passed to the CPU for diagnostics.

Note: *The pulse amplification circuitry is not dependent on the CPU operation in any way.*

Meter Input Signal Selection

Note: *Revision 9 or higher board assemblies (boards containing switches)*

Meter input signal selection is available through the dip switch settings. Meter input signal selections are independent for the two meter signal inputs. Refer to the table at the end of this section for switch settings.

In addition to the selectable inputs, the revision 9 board assembly supports amplifier gain selection. Refer to the table at the end of this section for more information.

Revision 8 or lower board assemblies only accept sine wave or pulse inputs which are determined by the connections on connector plug P1. The signal from the external signal source would be connected to pin 5 for channel one. The signal for channel two, if used, would be connected to pin 7. The common for the signal input would be connected to pin 2.

Sine Wave

Sine Wave input selection is used when interfacing directly to the reluctance pick-up coils typically found in liquid turbine meters.

Pulse

Pulse input selection is used when interfacing to a pre-amplified square wave signal, i.e., if the AccuLERT is mounted in a remote location from the turbine meter. Typically the turbine meter will utilize a preamplifier such as the Smith PA-6 in order to drive the signal long distances. The amplified meter pulse signals from the remote turbine meter are then supplied to the AccuLERT.

NAMUR

NAMUR input selection is used when interfacing directly to the HF sensors typically found in gas turbine meters.

Warning: The AccuLERT does not contain Intrinsic Safe barriers typically associated with NAMUR type sensors. If interfacing to a meter located in a hazardous area that is not rated Explosion Proof / Flame Proof, then the use of a certified Intrinsic Safe barrier will be required, connected according to the manufacturer's control drawing.

Contact / Open Collector

This input selection is used when interfacing directly to a dry type switch contact or an open collector transistor output. An example would be the Intrinsically Safe Barrier with open collector outputs. The circuit does not contain any series current limiting resistance.

Current Limited Contact or Limited Open Collector

This input selection is used when interfacing directly to the reed type switch contact typically found in the mechanical readout devices used on gas turbine meters. The circuits typically contain a series limiting resistor (approximately 100 ohms). Use this setting if interfacing to an open collector transistor circuit that contains a series limiting resistor.

Warning: The AccuLERT does not contain Intrinsic Safe barriers typically associated with this type of input. If interfacing to a meter located in a hazardous area that is not rated Explosion Proof / Flame Proof, then the use of a certified Intrinsic Safe barrier will be required, connected according to the manufactures control drawing.

Meter Input Signal Switch Settings
(Board assemblies with switches)

Input Selection	Pos 1	Pos 2	Pos 3	Pos 4	Pos 5	Pos 6
Reluctance Pick-up	OFF	ON	OFF	ON	OFF	OFF
Contact or Open Collector	ON	ON	OFF	ON	OFF	ON
Active Sensor	OFF	ON	OFF	ON	OFF	ON
NAMUR or Current Limited Contact	ON	OFF	ON	OFF	ON	ON

Note: Channel A selection switch is SW1
Channel B selection switch is SW2

Amplifier Gain Switch Settings
(Board assemblies with switches)

Gain Selection	Nominal Trip Voltage (mV)*	Input Type	Position 7	Position 8	Position 9	Position 10
X 100	20	Reluctance Pick-up Coil	ON	OFF	OFF	OFF
X50	40	Reluctance Pick-up Coil	OFF	ON	ON	OFF
X25	70	Reluctance Pick-up Coil	OFF	OFF	ON	ON
X18	110	Reluctance Pick-up Coil	OFF	OFF	OFF	ON
X10	200	Active Sensor, or Open Collector	OFF	OFF	OFF	OFF

**** Hysterisis is approximately 10% of nominal values***

Note: *Channel A selection switch is SW1*
Channel B selection switch is SW2

Default Switch Settings

Position	1	2	3	4	5	6	7	8
SW3	On	Off	Off	On	Off	On	X	X
SW4	On	On	On	On	X	X	X	X
SW5	On	Off	On	Off	On	Off	X	X
SW6	See Communications Switch Settings on Page 12						On	Off

Note: *These are factory default settings. Changing the settings for Switches 3 through 5 will result in faulty operation.*
Note: *See Communications section for Switch 6 settings.*

Start-up Procedures

1. The AccuLERT can be provided in either an explosion proof instrument housing or in a DIN rail mount housing intended for placement in another suitable enclosure to meet the EMC requirements.

2. After the mounting is complete, bring the wires from the reluctance type pickup coil A to turbine input #1 plus (pin 6) and minus (pin 5). If dual pickups are used, bring pickup coil B wires to turbine #2 plus (pin 8) and minus (pin 7).

   ***Note**: For board assemblies that utilize jumpers instead of switches, input #1 plus is pin 5 and minus is pin 6. Input #2 plus is pin 7 and minus is pin 8.*

3. As noted, the AccuLERT is also capable of processing a square wave input from either a separate preamplifier or an external transmitter, a NAMUR current type input or contact input. The same convention holds true for (+) and (-) terminals.

4. The AccuLERT requires one power source to operate the unit. The incoming power (10-24 Vdc) is wired into terminals 1 and 2 on the wiring connector. The positive terminal is wired from the power supply to terminal 1 and the negative terminal is wired from the power supply to terminal 2.

5. Connect the turbine square wave output to the host device, i.e., flow computer, RTU or other ancillary devices. Two outputs are available. The first one is designated as pickup #1 output (pin 3) and the second one is pickup #2 (pin 4) output. The return is common with turbine power return (pin 2). Both outputs are active if both transducers are connected. If only one pickup transducer is connected then only one pulse output is provided.

   ***Note:** Bi-directional meters requiring separate outputs for forward and reverse are available by programming the contact outputs in conjunction with the turbine output. The user must assign two contact outputs. One is assigned for the forward active high and the other is assigned for the forward active low. The user must route the pulse output through the contact output that is controlled by the switch setting.*

6. Communications to the AccuLERT can be either through RS-232 (factory default) or RS-485. If multiple AccuLERTs are to communicate with one personal computer or another type of communicating device, RS-485 communications must be used and the appropriate customer supplied RS-232 to RS-485 converter must be used. The software (Modbus Explorer) on the factory-supplied CD-ROM is a Windows-based program for a personal computer, used to set up and monitor the AccuLERT. Install the software by inserting it in the CD-ROM drive. Select "Run" from the Start Menu at the lower left-hand corner of the screen, then locate the file labeled "setup.exe" on the CD. Follow the prompts on the screen to install the software on the PC.

7. Once the program is installed on the operator's PC, it can be opened and files can be set up for each of the AccuLERTs at the site by assigning each a unique file name and by programming each ID-2000 with a unique address.

   ***Note:** When using 485 communications with multiple AccuLERTs, the units must be configured one at a time, with only one unit on the communications line at a time. Once individual AccuLERT ID numbers and communication parameters have been set, up to 32 AccuLERTs can be connected on the same 485 communication line.*

8. Configure an AccuLERT for communication by selecting the "Serial Communication" submenu tab on the Configuration Menu. Specify a unique identification number for the unit, as well as the Modbus type, baud rate, parity, and RTS Delay.

9. Once all information is correct, download the data to the AccuLERT by using the mouse to select the "Write All Pages to Instrument" button at the upper right hand corner of the screen.

Installation Using RS-232 Interface

This is the default setting of the AccuLERT as it is provided from the factory. RS-232 only allows point to point communications, i.e., one communication port from the PC can only be connected to one AccuLERT. RS-232 is a three-wire communication system which consists of Transmit (Tx), Receive (Rx), and Common. The following connections are required: From the PC communications port DB-9 connector, pin 2 is connected to J1 pin 14, DB-9 pin 3 is connected to J1 pin 15, and DB-9 pin 5 is connected to J1 pin 16.

Installation Using RS-485 Interface

This section of the manual is designed to provide detailed instructions for the installation of multiple AccuLERTs using the RS-485 Interface and a daisy chain wiring scheme.

Note: The AccuLERT utilizes the two-wire half-duplex scheme for RS-485 communication which allows for up to 32 units on a single communications the line. Available Unit IDs (addresses) are 1 to 247.

RS-485 Conversion Instructions

The following instructions cover the converting of the AccuLERT from the factory default RS-232 setting to the two-wire half-duplex RS-485 interface.

The AccuLERTs are shipped from the factory ready for operation using the RS-232 interface. To convert to RS-485 please refer to the following tables depending on your AccuLERT hardware switches and jumpers. The AccuLERT's microprocessor reads the settings on power up only; any changes to the settings while the unit is powered will result in a malfunction.

Note: *These setting changes should be made prior to field installation. If the changes must be made in the field while the AccuLERT is mounted on a turbine meter, be sure to remove power from the AccuLERT and get the proper work permits before attempting any of these changes.*

Note: *The RS-485 Termination Resistor is only used if the application requires it on one AccuLERT, the last one in the daisy chain.*

Communication Switch Settings
(Board assemblies with switches)

Switch 6 Positions (On)	Switch 6 Positions (Off)	Communications Type
2, 4	1, 3, 5, 6	RS-232 Communication
1, 3, 5	2, 4, 6	RS-485 Communication
1, 3, 5, 6	2, 4	RS-485 communications with termination resistor enabled on last unit in communications loop

Communication Jumper Table Settings
(Board assemblies with jumpers)

Jumper Position	RS-485 Communication	RS-232 Communication
JP1	Installed	Removed
JP8	RS-485 termination resistor to be installed on last unit in communications loop	Removed
JP9	Pos 1 to 2 RS-485 Communications	Pos 2 to 3 RS-232 Communications
JP10	Pos 1 to 2 RS-485 Communications	Pos 2 to 3 RS-232 Communications

Programming an Individual Identification Number to AccuLERT

If more than one AccuLERT is going to be placed on the RS-485 communications line, each unit will need to be programmed individually with a unique identification number. *(Only one unit can be placed on the communication line at a time until a specific ID number is programmed.)* It would be better to perform this operation on the bench prior to field installation.

Note: *RS-485 communications is performance limited by the PC, i.e., the slower the machine the longer the updates will take to appear on the Present Values screen. A typical screen update rate for RS-232 communications is around two seconds. For RS-485 communications the Present Values screen updates range from three seconds to over ten seconds depending on the amount of memory, the video card and the processor speed of the PC.*

The following will be needed to program the individual identification number.

a) A DC power supply, which can be either 12 Vdc or 24 Vdc.
b) A personal computer loaded with the Modbus Explorer Windows program. This software is shipped with every AccuLERT.
c) An asynchronous RS-485 to RS-232 interface converter is required for connecting the RS-485 communications cable into the personal computer's serial port, which is RS-232.

Note: *Recommended RS-485 converters are available from B&B Electronics, www.bb-elec.com, (815) 433-5100.*

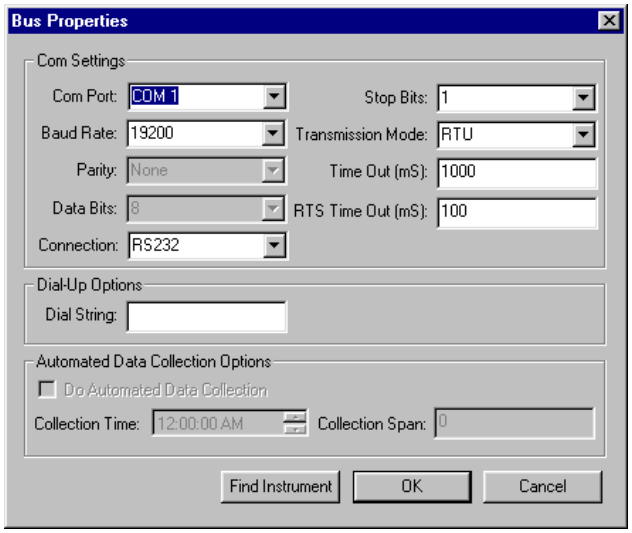
Once all these requirements are satisfied, take the following steps:

1. Connect the RS-232 interface cable into the RS-485 to RS-232 converter. Wire the RS-485 from the converter to the AccuLERT.

2. Start the Modbus Explorer Windows program. Use the mouse to right click on "Bus: Default Bus" near the top of the menu list. Select "Properties" to display the screen shown at the top of the following page.

3. Using the dropdown menu to the right of "Connections," select RS485.

4. Using the dropdown menu to the right of "Com Port," select the communications port on the computer that will be used to connect to the AccuLERT. Selections are COM 1 to COM 4. For most computers, COM 1 is the best choice.


Bus Properties
Com Settings
Com Port: COM 1
Stop Bits: 1
Baud Rate: 19200
Transmission Mode: RTU
Parity: None
Time Out (mS): 1000
Data Bits: 8
RTS Time Out (mS): 100
Connection: RS232
Dial-Up Options
Dial String:
Automated Data Collection Options
Do Automated Data Collection
Collection Time: 12:00:00 AM
Collection Span: 0
Find Instrument
OK
Cancel

5. Using the dropdown menu to the right of "Baud Rate," select the baud rate for communications between the PC and the AccuLERT. Selections are as follows: 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200. (The AccuLERT hardware at this time does not support baud rates of 57600 or 115200.) For most systems, 19200 is the best choice. The computer and the AccuLERT must be set at the same baud rate for communications to occur. Select "Find Instrument" to determine the baud rate at which the AccuLERT is set. The PC will search for the AccuLERT at the lowest baud rate first, and work its way up until it finds the proper baud rate for the AccuLERT. The AccuLERT address will be reported, and the Windows program will auto-select that baud rate on the "Properties" screen.

6. Click "OK" to close the "Properties" box and store all changes.

7. Select "Configuration" from the "Live" menu, then choose the "Serial" tab to configure serial communications. Refer to the following table for options.

Item	Description
Unit ID Number	Enter a unique ID number from 1 to 247
Modbus Type	Choose "RTU" or "ASCII"
Baud Rate	Choose 1200, 2400, 4800, 9600, or 19200
Parity	Choose "None" or "Odd"
RTS Delay	Choose a delay from 0 to 500. The factory default is 50

8. Select "Write All Pages to Instrument" at the upper right-hand corner of the display. This will save all changes to the AccuLERT.

9. Remove power from the AccuLERT. Disconnect the AccuLERT and repeat the above steps for the next AccuLERT to be programmed.

10. Once all AccuLERTs have been programmed with individual identification numbers, connect them in a daisy chain.

Note: *All parameters must be identical for each AccuLERT on the daisy chain, except for unique identification numbers.*

Note: *The maximum number of AccuLERTs on one daisy chain is 32.*

Note: *To communicate with a specific AccuLERT on the daisy chain, the unique identification number of the AccuLERT must be entered in the Serial Communication menu.*

Section V – Modbus Explorer Program Menus and Displays

Introduction to Modbus Explorer

Product Description

Modbus Explorer is a Windows application that facilitates configuration of the AccuLERT. Modbus Explorer allows the user to configure existing parameters, create reports, and monitor the operation of the AccuLERT.

Modbus Explorer is an MDI (Multiple Document Interface) standard application, enabling the user to work with several files simultaneously. In the context of the Modbus Explorer, a "file" is the data associated with one AccuLERT. When multiple files are open, the currently active window is the one that will be affected by menu choices and toolbar options.

Modes of Operation

Archive Mode

In the Archive mode of operation, the Modbus Explorer can be used to completely set up a data file or edit an existing file. This file can then be saved for future use. By switching to Live mode, the file can be downloaded to the AccuLERT.

Live Mode

The Live mode of operation requires that the Modbus Explorer and the AccuLERT's communications port are configured with the same baud rate, parity, protocol, and address. In addition, a file must be created for each AccuLERT with which the Modbus Explorer is to communicate. A file is created by selecting "File" in the upper left-hand corner of the Modbus Explorer's toolbar, then selecting "New."

Once the setup is complete, communications can be used to configure the AccuLERT, read information from the AccuLERT, and dump directories or entire files to the AccuLERT.

System Requirements

The Modbus Explorer will operate on an IBM-PC compatible (486 or better) computer operating in a Windows environment (Windows 95 or later) with at least 4M of memory and one CD-ROM drive. The hard drive should have at least 2M of free disk space.

Installing Modbus Explorer

To install the Modbus Explorer program, do the following:

1. Insert the Modbus Explorer CD-ROM into the CD-ROM drive (typically the D:\ drive).

2. Click on the "Start" button at the lower left-hand side of the screen.

3. Select "Run" from the popup menu.

4. Type "D:\setup" (without the quotation marks) in the dialog box.

5. Click OK. The installation program will display a series of prompts that guide the user through the installation process. A message will appear on the screen during the installation process, prompting the user to select a location for the program. A default destination will be suggested. If the default is acceptable, click "Next." Otherwise, specify another destination and folder for the program.

6. The program will automatically continue to install and will prompt the user to select "Finish" when installation is complete.

7. Click on the “Start” button and then select “Programs” from the menu. Select “Windows Explorer,” then locate the directory in which the Modbus Explorer was installed. Select “Modbus Explorer,” then double-click on “Modbus Explorer” to launch the program. A shortcut to MBExplorer.exe can be established on the Windows desktop, using standard Windows procedures. The shortcut will greatly facilitate program launching.

Program Files

During the installation process, the following files will have been copied to the PC’s hard drive. These files may be viewed by opening Windows Explorer and selecting the Modbus Explorer directory.

- EMPTY_DATA_DO-NOT-EDIT.mdb
- EMPTY_DEVICE_DO-NOT-EDIT.mdb
- EMPTY_MODBUS_DO-NOT-EDIT.mdb
- MBExplorer.exe
- mBEXPL_Data.mdb
- mBEXPL_Device.mdb
- mBEXPL_Modbus.mdb
- Modbus.log
- OptScriptHost.dll
- OptSerialDriver.exe
- OptSerialProxy.dll
- Regsvr32.exe
- Uninst.isu

Contact a Smith distributor if any of these files are missing, or if there are any other problems with the Modbus Explorer installation.

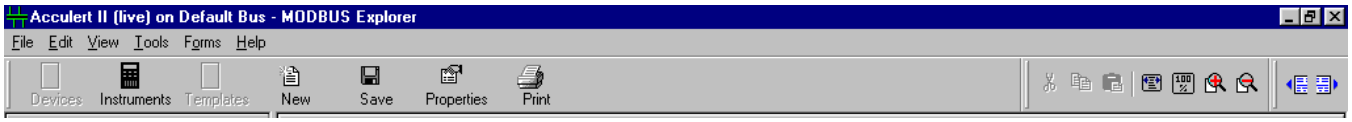
File Extensions

Modbus Explorer file names are typically followed by a three-letter extension (e.g., mdb. The extension indicates the nature of the file.

Establishing Communications

In order for communications to function, the AccuLoad III and Modbus Explorer setups must be compatible and the communications cable correctly wired. Several AccuLoad III parameters (including communications port, baud rate, data bits, and parity) must be properly set to enable communications. The Modbus Explorer setup must then be configured to match the AccuLoad III parameters.

File Management Menu Functions

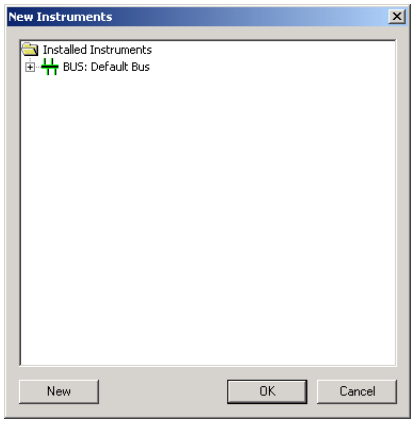


At the top of the Modbus Explorer display is a menu bar similar to that shown above. These menu options are used to manage and view all AccuLERT files. Not all options are available on every display. If an option is unavailable, it will be grayed out; if it is available, the option or icon will be clearly visible.

File

Click on "File" at the upper left-hand corner of the display to obtain a drop-down menu of options. These options and a brief description of each are shown below. (These are standard Windows commands; if you are new to Windows, you may want to refer to the PC's Windows handbook before working with the AccuLERT's Windows interface.)

New — Creates a new Instrument window with a default configuration



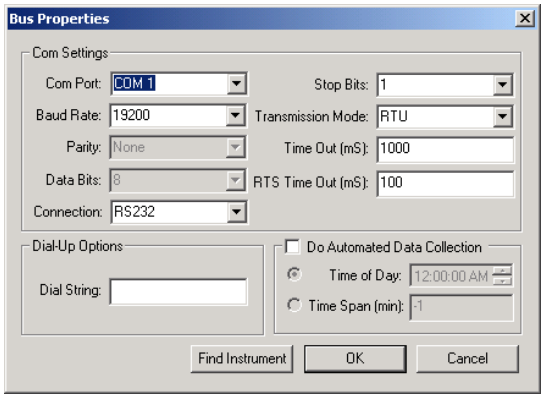
Open — Presents a dialog allowing the user to select an AccuLERT file to open. If only one AccuLERT is configured, that AccuLERT's file will open automatically

Close — Closes an open AccuLERT file

Save — Stores all changes to the open database

Properties

Valid only when the Bus or Instrument Icons are highlighted. Selecting this option will display the Bus or Instrument properties



This menu allows changes to the communications properties of the computer communication with the AccuLERT. It also allows an automatic “find instrument” if the parameters and ID numbers are unknown for a particular AccuLERT connected on the communications line.

After the instrument is found the information window will pop up displaying the instrument address number.

Note: Only one instrument can be on the communications line at a time during the find operation.

If a modem will be used for automated data collection, check the box labeled “Do Automated Data Collection”, then set either the “Time of Day” for a particular time that the data collection will occur or set the “Time Span” field for interval data collections. The Time span number is in minutes; -1 disables the function.

Example: If it is desired to read the instrument every hour, set the Time Span number to “60.” The Modbus explorer will dial the modem once an hour to establish communications with the AccuLERT, read the data, and then hang up.

If the data collection is to be once a day, set the “Time of Day” field for the desired hour that the AccuLERT should be read.

Rename

Allows the operator to change the name of an existing AccuLERT file

Export

Valid only when one of the form views is open. Export creates a Comma Separated Variable (.csv) file of the displayed form for importing into programs such as Microsoft Excel

Import	Not offered in standard program, requires software key. This function is used to customize the screens in the Modbus Explorer
Print	Print the active window
Print Setup	Allows the operator to indicate a printer and select appropriate options, such as paper size and page orientation
Recent File	Allows the operator to select a recently opened file. This command is used when more than one AccuLERT has been configured
Exit	Closes the Modbus Explorer program

Edit

Click on "Edit" near the upper left-hand corner of the display to obtain a drop-down menu of options. These options and a brief description of each are shown below.

Select All	Selects all data in a text file
Cut	Copies selected text and/or graphics from a text file to the Windows clipboard and deletes it from a document
Copy	Copies selected text and/or graphics from a text file to the Windows clipboard
Paste	Pastes text and/or graphics from the Windows clipboard to a file
Delete	Deletes all highlighted text

View

Click on "View" at the top of the display to obtain a drop-down menu of options. These options and a brief description of each are shown below.

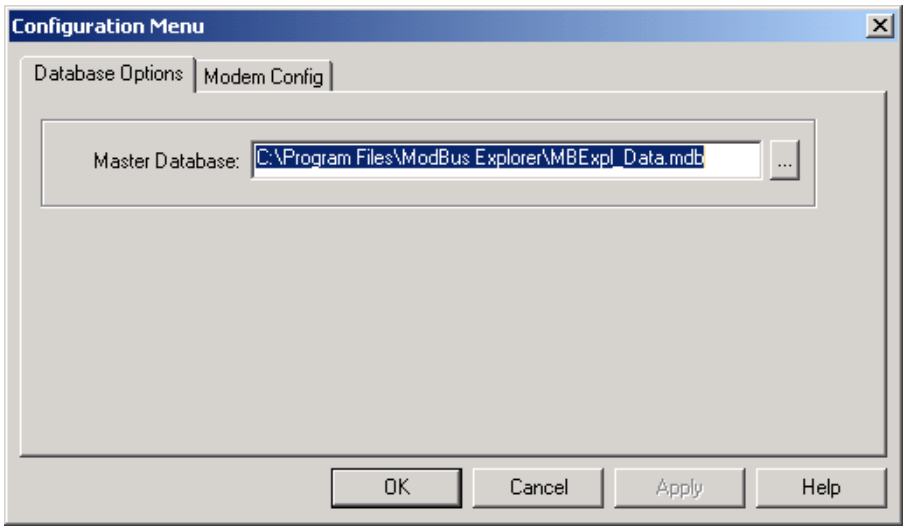
Devices	Not available; for future use
Instruments	Shows the configured instruments on the menu tree
Template	Not offered in standard program, requires software key This function is used to customize the screens in the Modbus Explorer
Toolbar	Click on this option to toggle between hiding and displaying the Windows toolbar at the top of the screen
Status	Click on this option to toggle between hiding and displaying the AccuLERT's communications status bar in the lower left corner of the screen

Tools

Click on "Tools" near the upper left-hand corner of the display to obtain a drop-down menu of options. These options and a brief description of each are shown below.

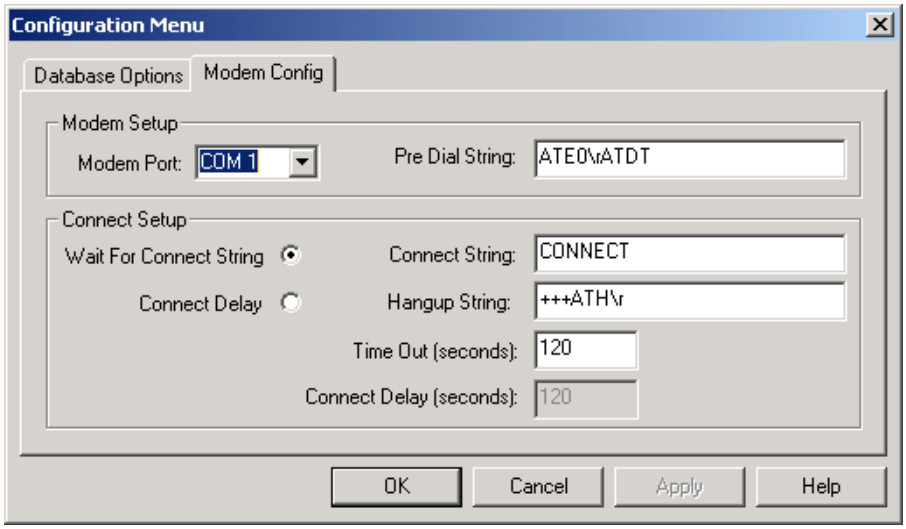
Administration	This menu is used to control where the database files are stored. It is also used to configure the modem commands
Global Functions	Not offered in standard program, requires software key This function is used to customize the screens in the Modbus Explorer
Archive Current View	Copies the current file to the AccuLERT archives; identifies the file by the date and time of archiving
Database Utilities	Subset – Creates a database file subset based on the time frame entered Active – Creates a database file based on the time frame entered Merge – Merges a database file with the current database file based on the time frame entered

Tools / Administration / Database Options



This menu is used to define where the instrument database files are stored.

Tools / Administration / Modem Configuration



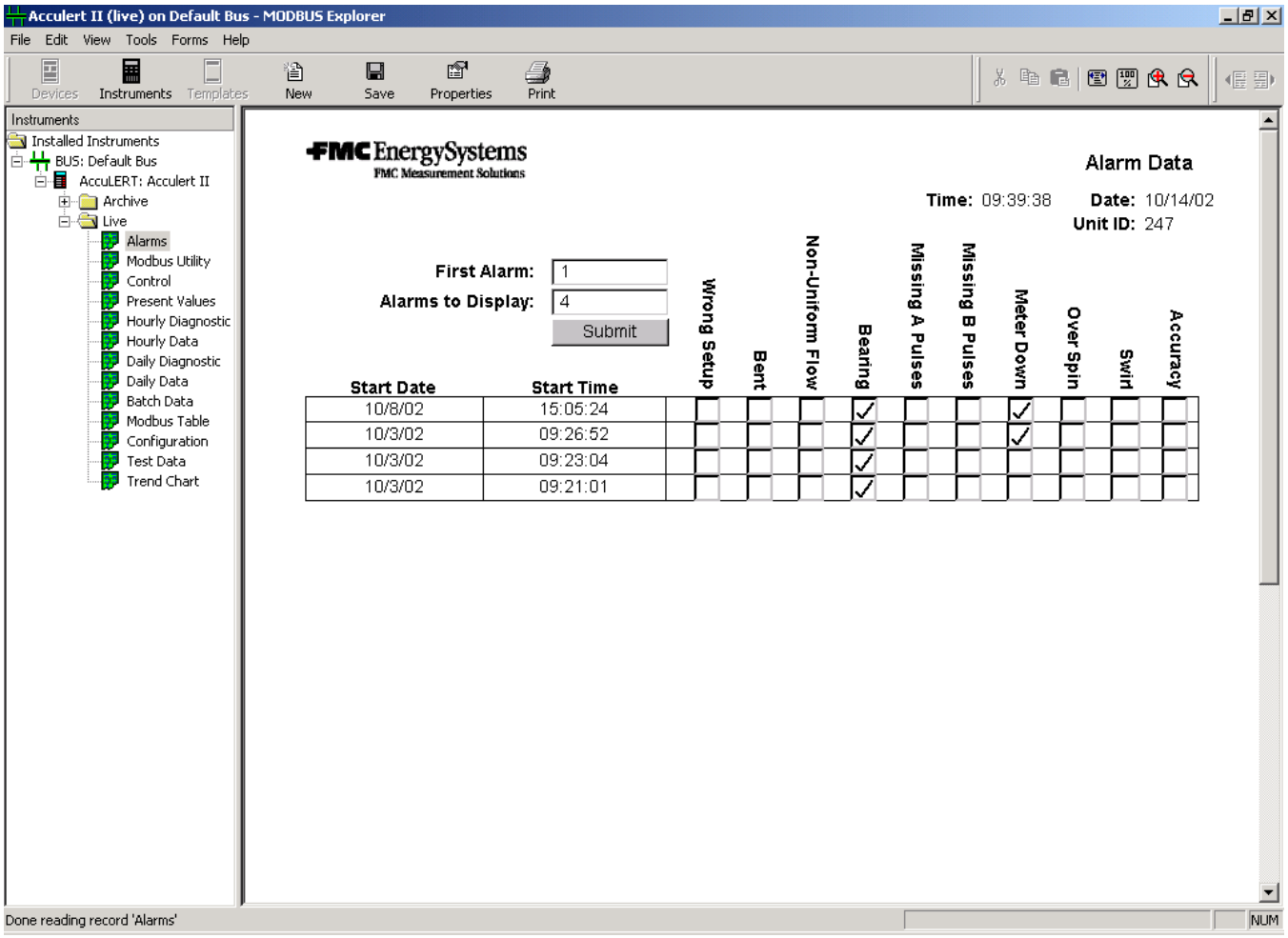
This menu is used to program the modem parameters if a modem will be used for automatic data collection.

Forms

Click on "Forms" on the menu bar at the top of the display to obtain a drop-down menu of options for controlling the appearance of on-line forms. These options and a brief description of each are shown below.

Zoom In	Increases the size of the data being displayed
Zoom Out	Decreases the size of the data being displayed
Fit to Width	Adjusts the size of the data to fill the PC monitor's screen
Zoom 100%	Maximize the size of the data being displayed
Device Editor	Check Warnings – Not offered in standard program; requires software key
	View Control Script – Not offered in standard program; requires software key
	View Master Script – Not offered in standard program; requires software key
Enter New Data	Not offered in standard program; requires software key

Alarms Menu



The Alarm Data screen is used to specify historical alarms to be displayed.

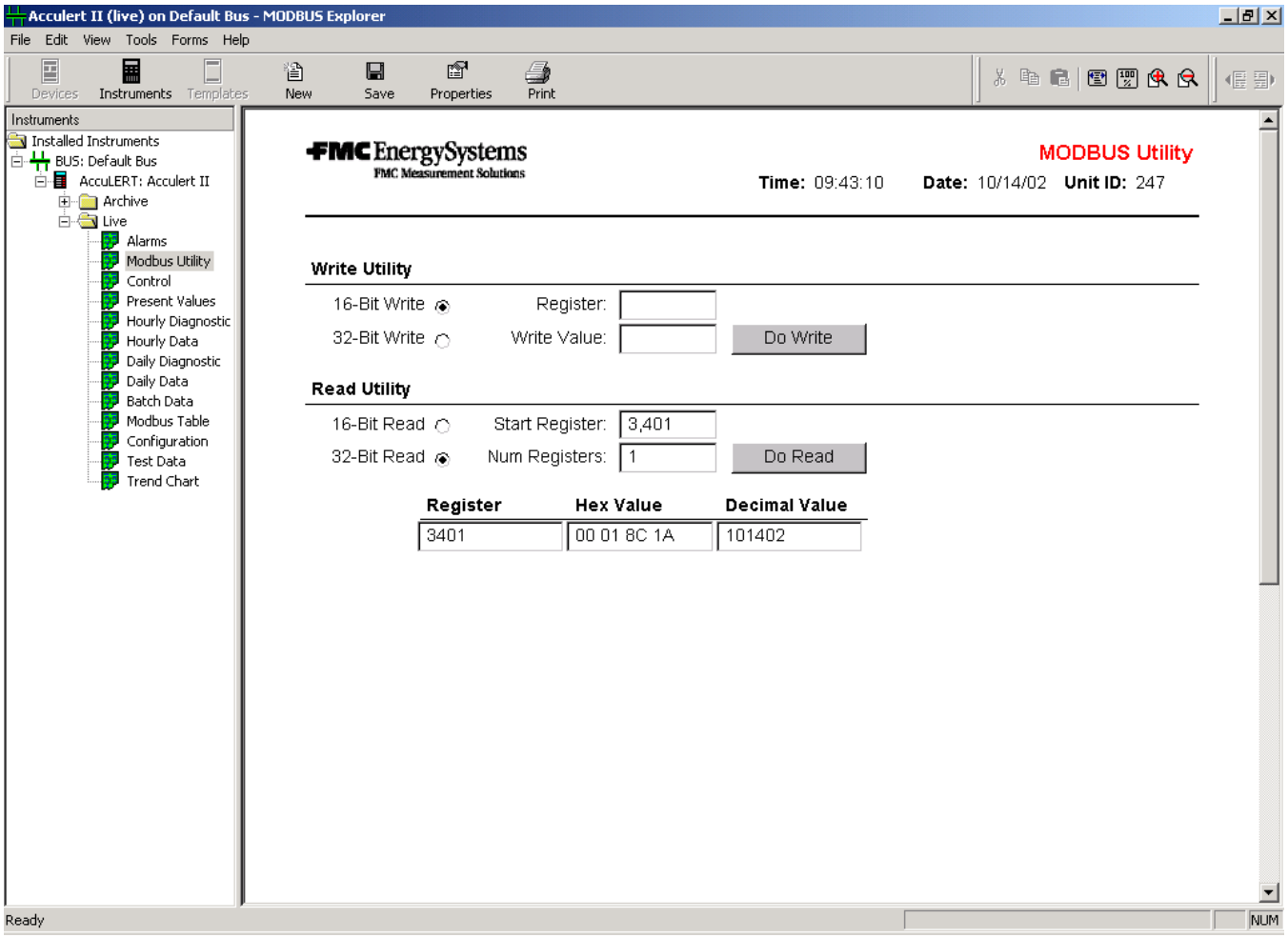
To access the current Alarms screen, select "Alarms" from the Live menu. The AccuLERT stores up to one hundred historical alarms. Alarms are displayed in order of occurrence, with the most recent alarm displayed first. If fewer than 100 alarms have been recorded, the AccuLERT will display all alarms in memory.

To display alarms, type the number of the first alarm to be viewed and the total number of alarms to be viewed, and then press the "Submit" button. The AccuLERT will indicate the date, start time, and error condition that caused the alarm. Alarm conditions and their causes are described in the table on the following page.

Alarm	Description
Wrong Setup	occurs if there is no Bent Blade alarm and the calculated consistency integral (Integral Deviation %) is greater than the entered maximum error value for the consistency integral and the calculated blade/linearity average (Blade Average Deviation %) is greater than the entered maximum error value for blade/linearity average and the calculated blade/linearity maximum (Blade Maximum Deviation %) is less than the entered maximum error value for blade/linearity maximum or if the calculated blade/linearity average (Blade Average Deviation %) is less than the entered maximum error value for blade/linearity average and the calculated blade/linearity maximum (Blade Maximum Deviation %) is greater than the entered maximum error value for blade/linearity maximum or if there is no bearing alarm and the calculated consistency integral (Integral Deviation %) is greater than the entered maximum error value for consistency integral and the calculated bearing/repeatability average (Bearing Average Deviation %) is greater than the entered maximum error value for bearing/repeatability average and the calculated bearing/repeatability maximum (Bearing Maximum Deviation %) is less than the entered maximum error value for bearing/repeatability maximum or the calculated bearing/repeatability average (Bearing Average Deviation %) is less than the entered maximum error value for bearing/repeatability average and the calculated bearing/repeatability maximum (Bearing Maximum Deviation %) is greater than the entered maximum error value for bearing/repeatability maximum
Bent Blade	occurs if the calculated blade/linearity average (Blade Average Deviation %) is greater than the entered maximum error value for blade/linearity average and the calculated blade/linearity maximum (Blade Maximum Deviation %) is greater than the entered maximum error value for blade/linearity maximum
Non-Uniform Flow	occurs if the calculated bearing/repeatability average (Bearing Average Deviation %) is greater than the entered maximum error value for bearing/repeatability average and the calculated bearing/repeatability maximum (Bearing Maximum Deviation %) is greater than the entered maximum error value for bearing/repeatability maximum or the calculated consistency integral (Integral Deviation %) is greater than the entered maximum error value for consistency integral
Bearing	occurs if the calculated consistency ratio (Ratio Deviation %) is greater than the entered maximum error value for consistency ratio
Missing A Pulses	occurs if there are missing pulses on the “A” channel as compared to the “B” channel when the dual pickup function has been enabled (in other words, if “A” does not follow ”B” or a “B” - “B” pulse sequence occurs)
Missing B Pulses	occurs if there are missing pulses on the “B” channel as compared to the “A” channel when the dual pickup function has been enabled (in other words, if “B” does not follow “A” or a “A” - “A” pulse sequence occurs)
Meter Down	occurs if the meter frequency is equal to zero
Meter Over Spin	occurs if the batch instantaneous flow rate is greater than the turbine maximum flow rate established on the Parameter Entry Menu

Swirl	occurs as a result of turbulence in the flow. The AccuLERT will signal a Swirl Alarm when the calculated Ratio Percent Deviation value increases and all other Percent Deviation values decrease within the user selectable Swirl Count limits. The Swirl Count Limit is used to count the number of data table calculations that must occur, and the number of times the Ratio Percent must be increasing with the other percentages decreasing during these occurrences, before the algorithm decides that a valid swirl condition exists. For example, a Swirl Count Limit of 3 out of 10 occurrences means that the Ratio Percent must be increasing (and others decreasing) for 3 consecutive times out of the last ten data table calculations before it can be considered valid. Additionally, the Swirl Percent Change condition must be met. If the Swirl Percent Change is set to 3, then the Ratio Percent must increase by 3% for this condition to be met.
Accuracy	occurs if the calculated “A” or “B” blade average deviation (consisting of the combined average of the Blade Average Deviation “high” pulse data and the Blade Average Deviation “low” pulse data) is greater than the entered maximum error value for blade/linearity average (Blade Average Deviation Percent) or the calculated “A” or “B” blade maximum deviation (consisting of the combined average of the Blade Maximum Deviation “high” pulse data and the Blade Maximum Deviation “low” pulse data) is greater than the entered maximum error value for blade/linearity maximum (Blade Maximum Deviation Percent).

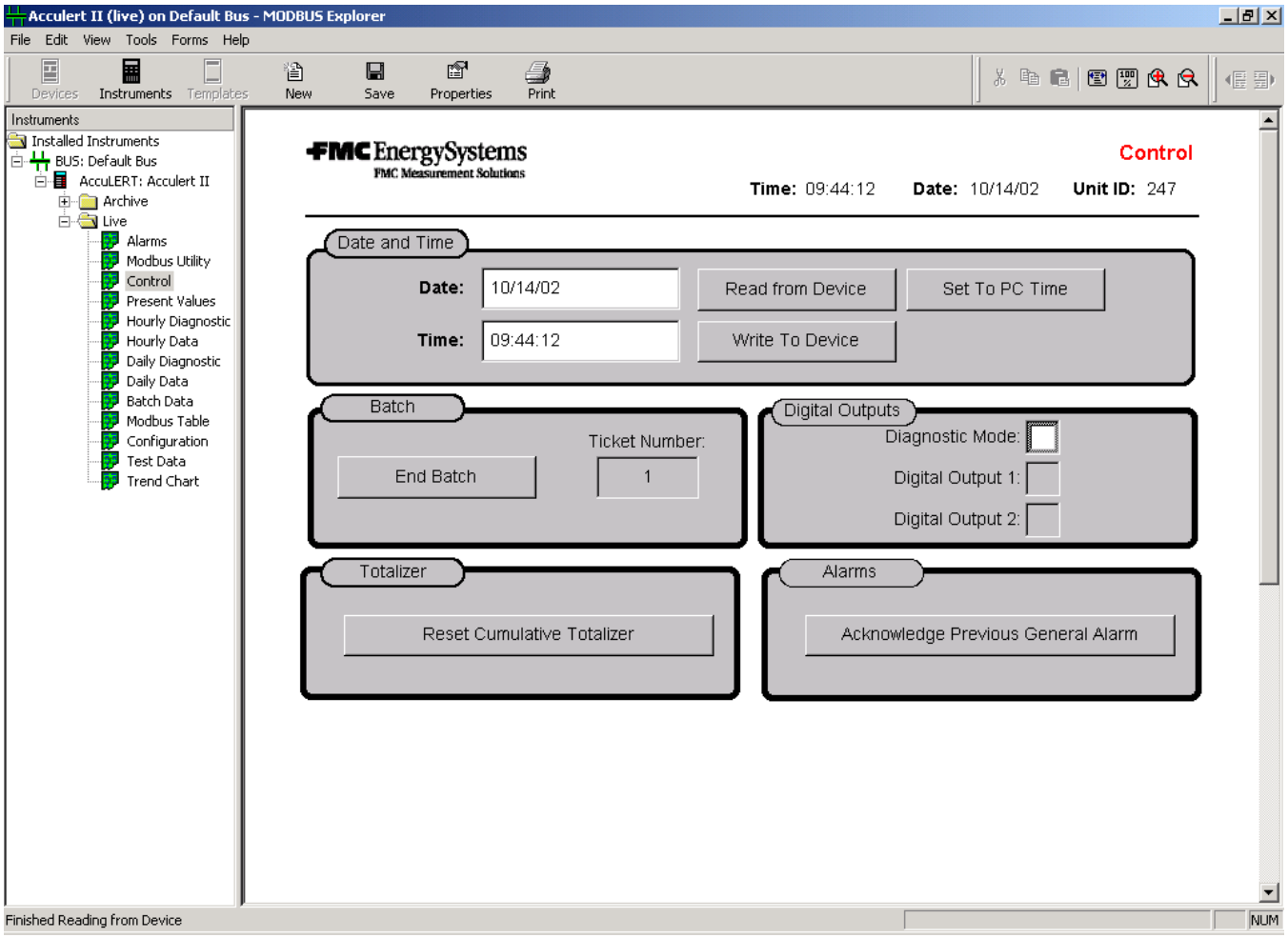
Modbus Utility



The Modbus utility screen is used to directly access the Modbus registers in the AccuLERT. Access includes the ability to read or write to any of the valid registers. A complete listing of the Modbus registers is available through the program by selecting the Modbus Table screen.

To access the current Modbus Utility screen, select “Modbus Utility” from the Live menu. This display allows the operator to specify a read or write Modbus register. The operator must also specify the type of read/write based on the information from the Modbus Table, i.e., 16-bit or 32-bit. The AccuLERT then returns the 16- or 32-bit hex and decimal values for that register.

Control



To access the Control screen, select "Control" from the Live menu. The Control menu is used to set the Date and Time of the AccuLERT's internal clock. This menu allows the user to reset Batch and Cumulative Totalizer data; also the two digital outputs can be turned on manually for diagnostic purposes.

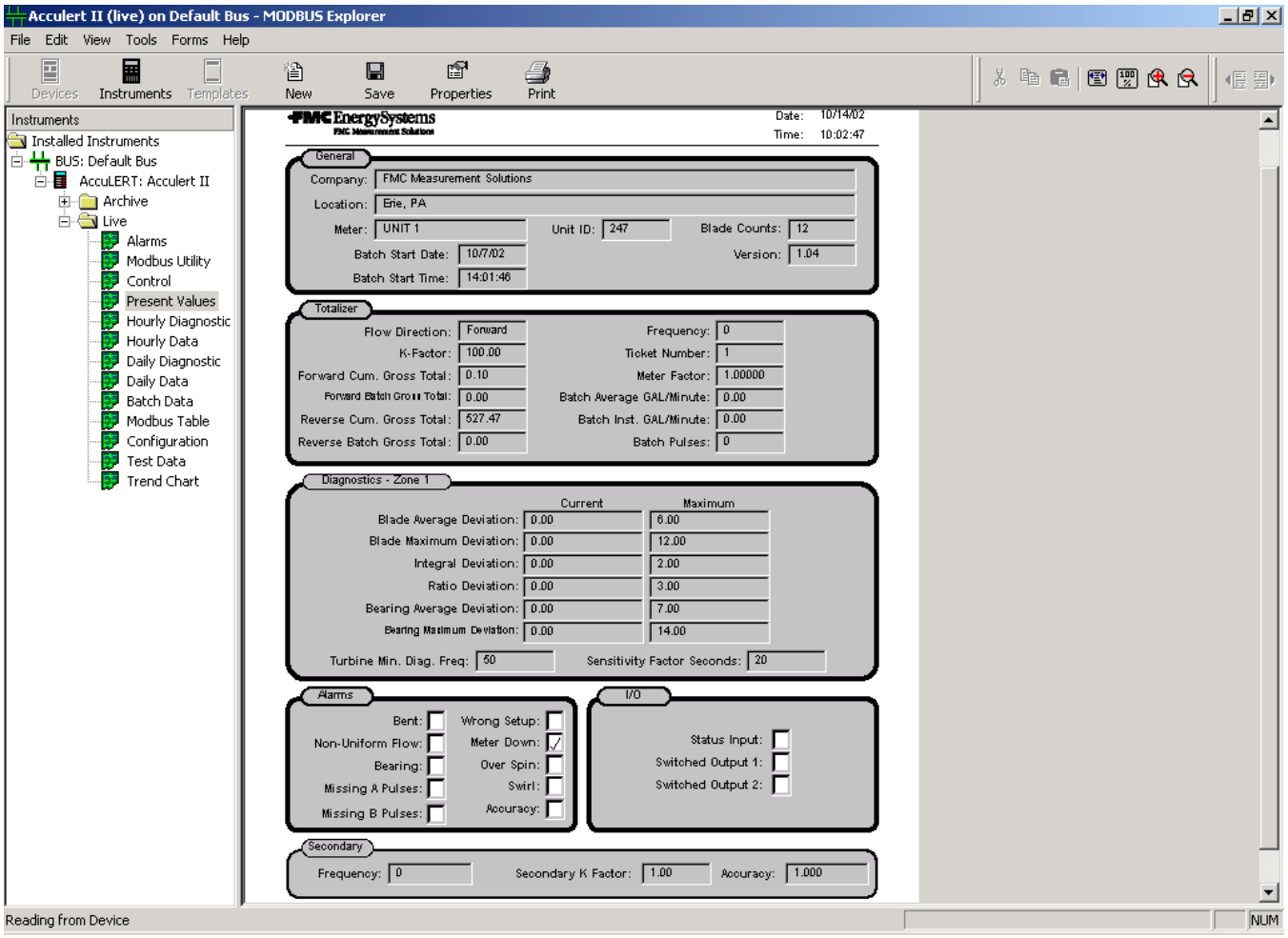
Date and Time. From this display, the operator can read the current date and time from the AccuLERT by clicking on "Read from Device." The operator can set the time for the AccuLERT by entering the correct date and time in the appropriate fields and clicking on "Write to Device." The operator can allow the PC to set the time for the AccuLERT by clicking on "Set to PC Time." The PC date and time will appear automatically in the appropriate fields. The operator can then click on "Write to Device" to download the PC time to the AccuLERT.
Note: *The time is entered as military time (i.e., 15:30:36).*

End Batch. Click on the "End Batch" button to end the current batch. The batch totalizer will be cleared to zero and a new batch will be started.
Note: *The non-resettable totalizer continues to count.*

Digital Outputs. The Digital Outputs can be controlled by the user by placing a check mark in the Diagnostic box and then placing a check block in the Digital Output box. This action will activate the appropriate Digital Output. This function can be used during the installation process or for troubleshooting the system.

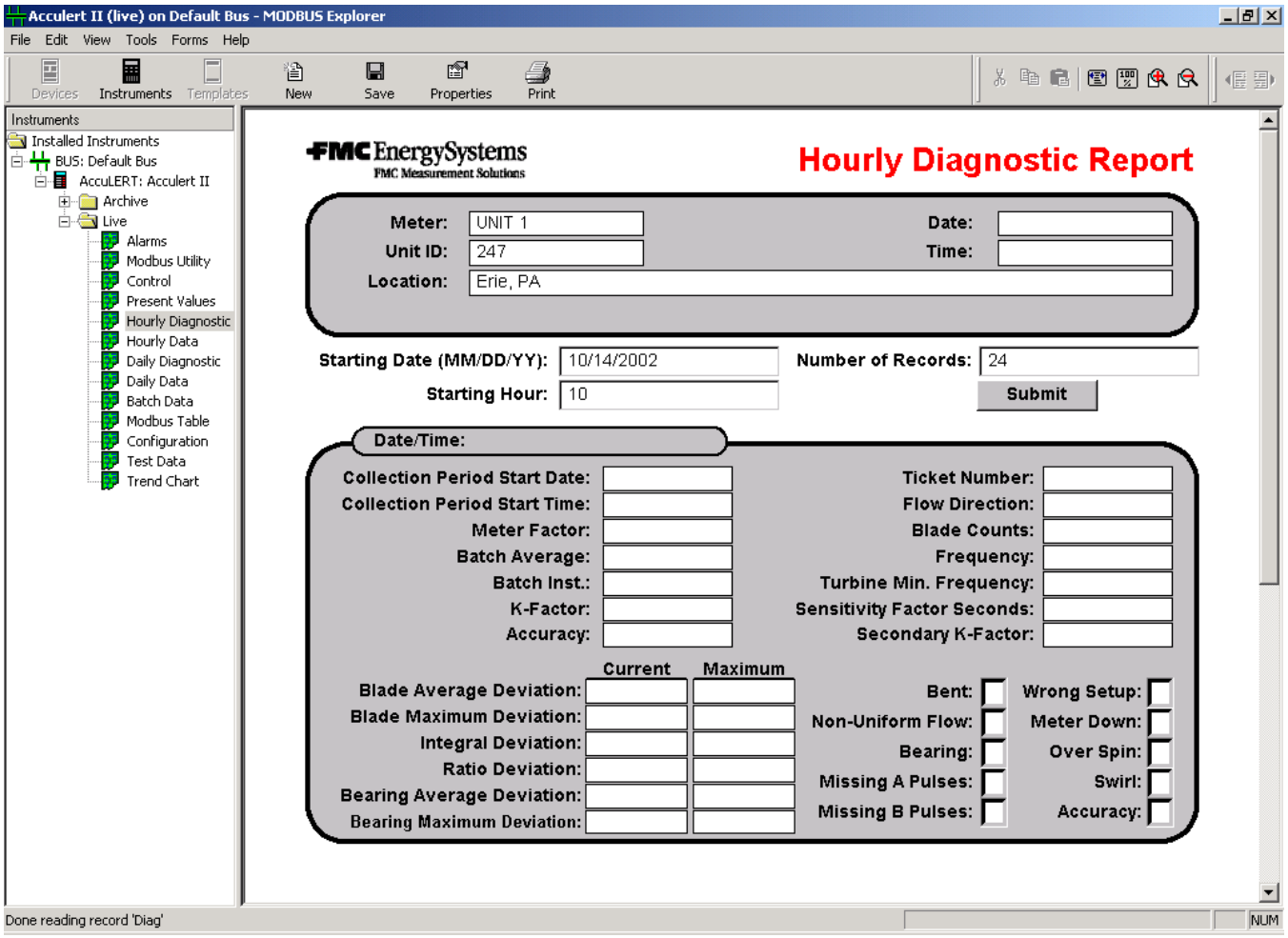
Reset Cumulative Totalizer. To reset cumulative Totalizers, click on the Reset Cumulative Totalizer button at the bottom of the display.

Present Values



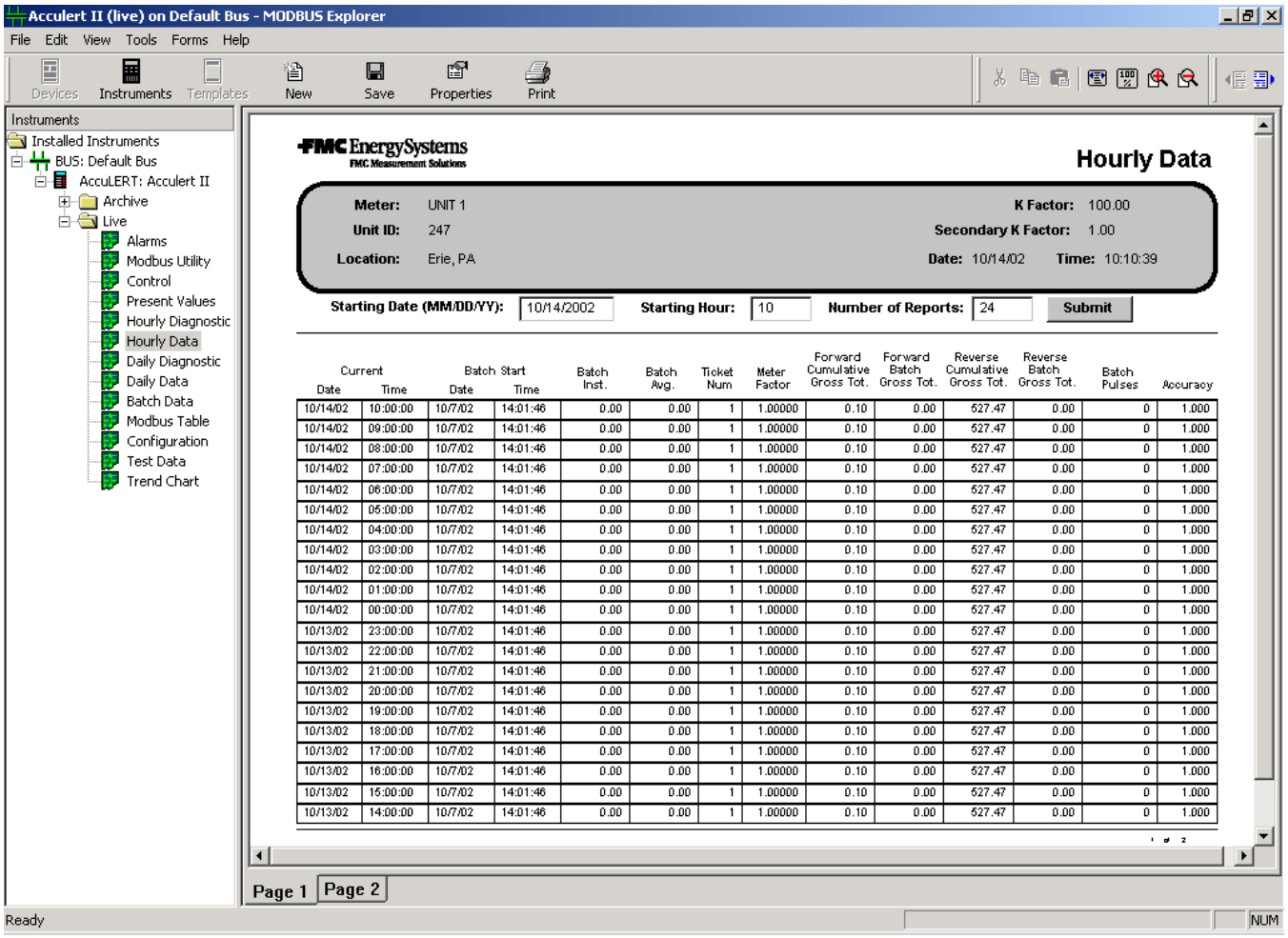
To view the current status of the AccuLERT, choose "Present Values" from the Live menu. This display indicates the current condition of the AccuLERT, and is constantly being monitored and revised.

Hourly Diagnostic Report



To access the current Hourly Diagnostic Report screen, select "Hourly Diagnostic" from the Live menu. Up to 24 hourly diagnostic reports are available. Enter the number of reports to be displayed, and the number of the first report to be displayed. Press "Submit." If the number of reports to be viewed is 24, all current (non-archived) hourly diagnostic data reports stored in the AccuLERT will be displayed and can be viewed, printed, and/or saved. Reports are displayed in order, with the most recent report displayed first.

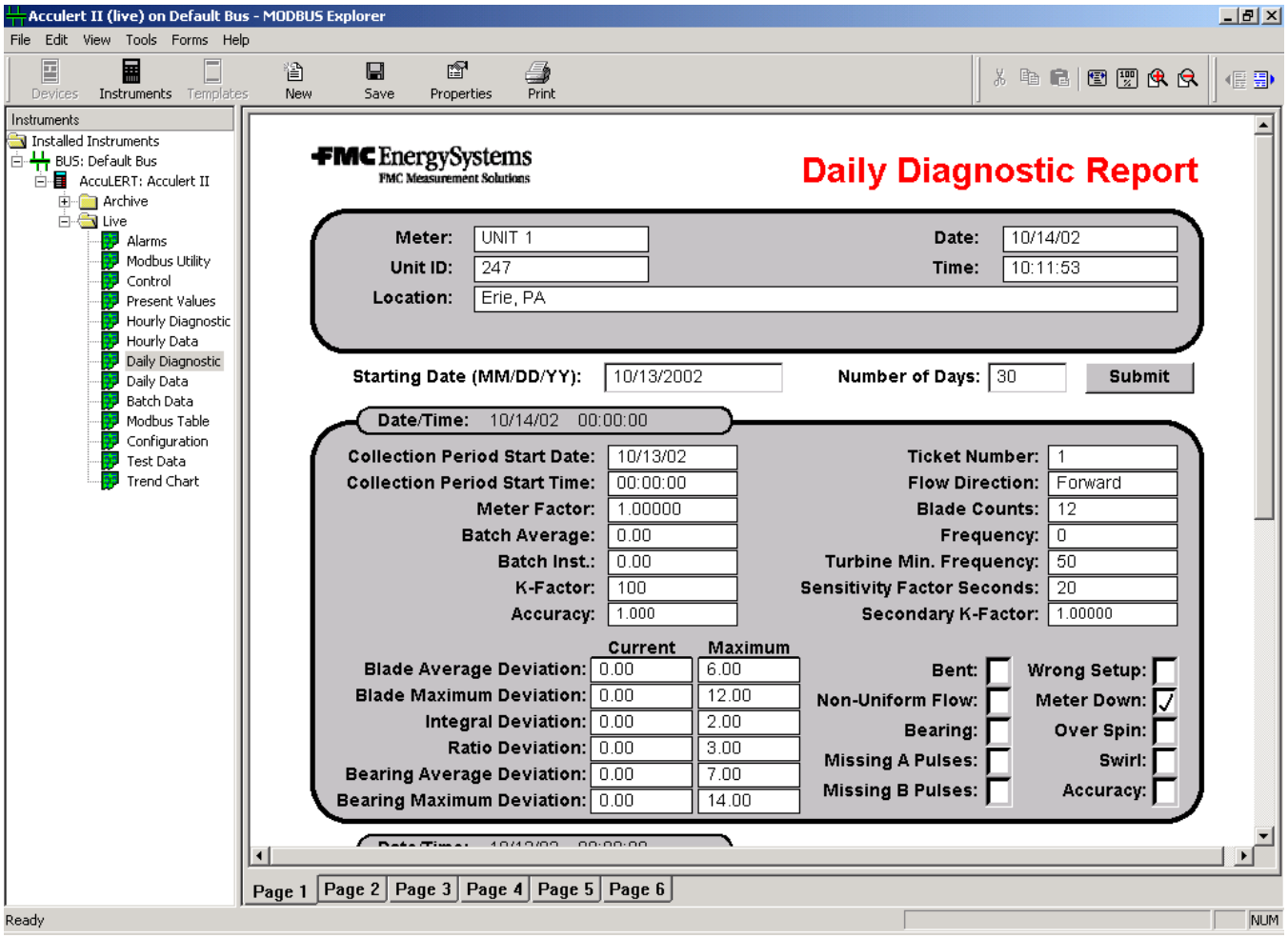
Hourly Data Report



Current Date	Current Time	Batch Start Date	Batch Start Time	Batch Inst.	Batch Avg.	Ticket Num	Meter Factor	Forward Cumulative Gross Tot.	Forward Batch Gross Tot.	Reverse Cumulative Gross Tot.	Reverse Batch Gross Tot.	Batch Pulses	Accuracy
10/14/02	10:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	09:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	08:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	07:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	06:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	05:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	04:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	03:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	02:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	01:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/14/02	00:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	23:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	22:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	21:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	20:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	19:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	18:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	17:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	16:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	15:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	14:00:00	10/7/02	14:01:46	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000

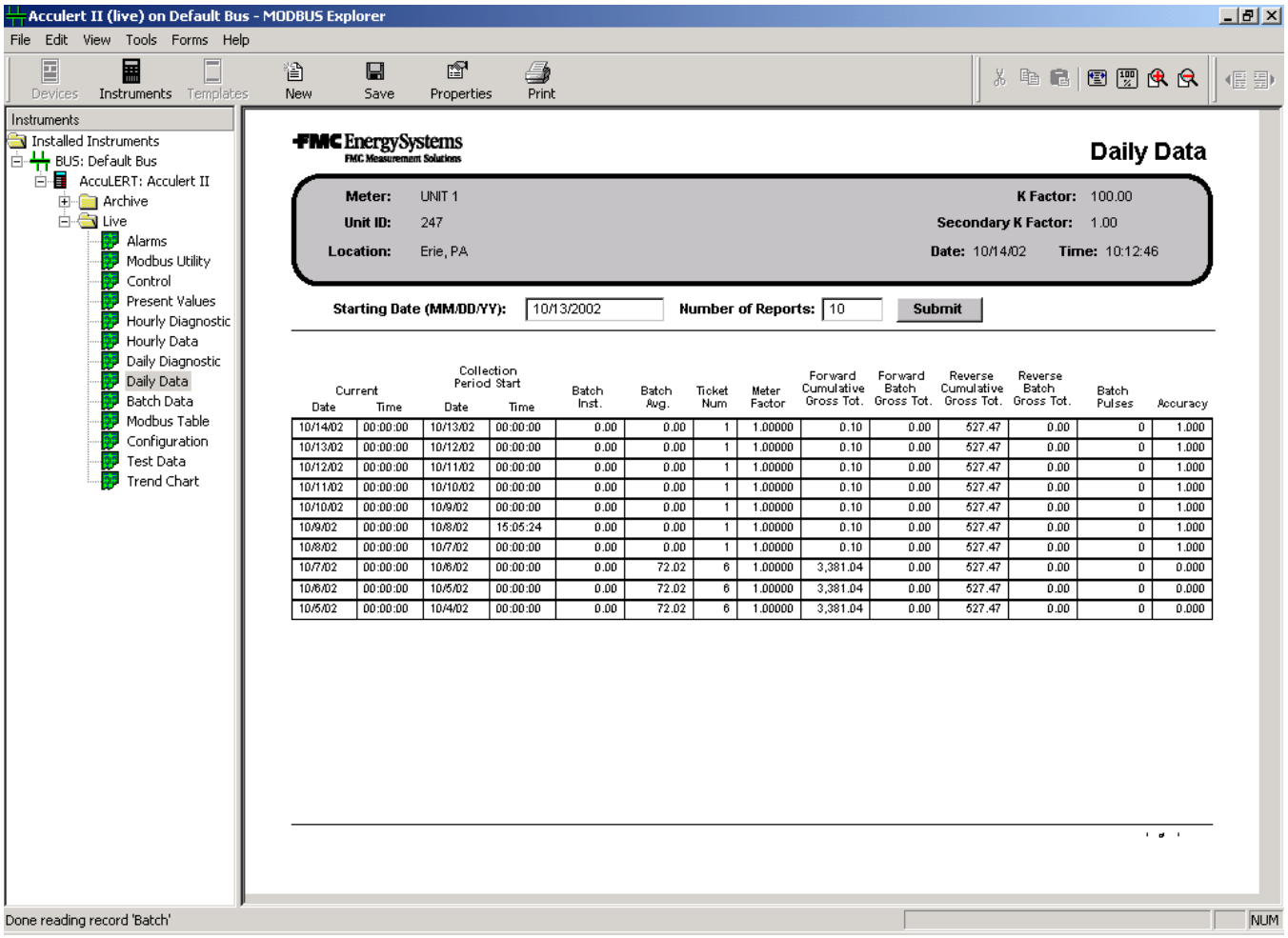
To access the current Hourly Data Report screen, select "Hourly Data" from the Live menu. Up to 24 hourly data reports are available. Enter the number of reports to be displayed, and the number of the first report to be displayed. Press "Submit." If the number of reports to be viewed is 24, all current (non-archived) daily data reports stored in the AccuLERT will be displayed and can be viewed, printed, and/or saved. Reports are displayed in order, with the most recent report displayed first.

Daily Diagnostic Report



To access the current Daily Diagnostic Report screen, select "Daily Diagnostic" from the Live menu. Up to thirty daily diagnostic reports are available. Enter the number of reports to be displayed, and the number of the first report to be displayed. Press "Submit." If the number of reports to be viewed is 30, all current (non-archived) daily diagnostic reports stored in the AccuLERT will be displayed and can be viewed, printed, and/or saved. Reports are displayed in order, with the most recent report displayed first.

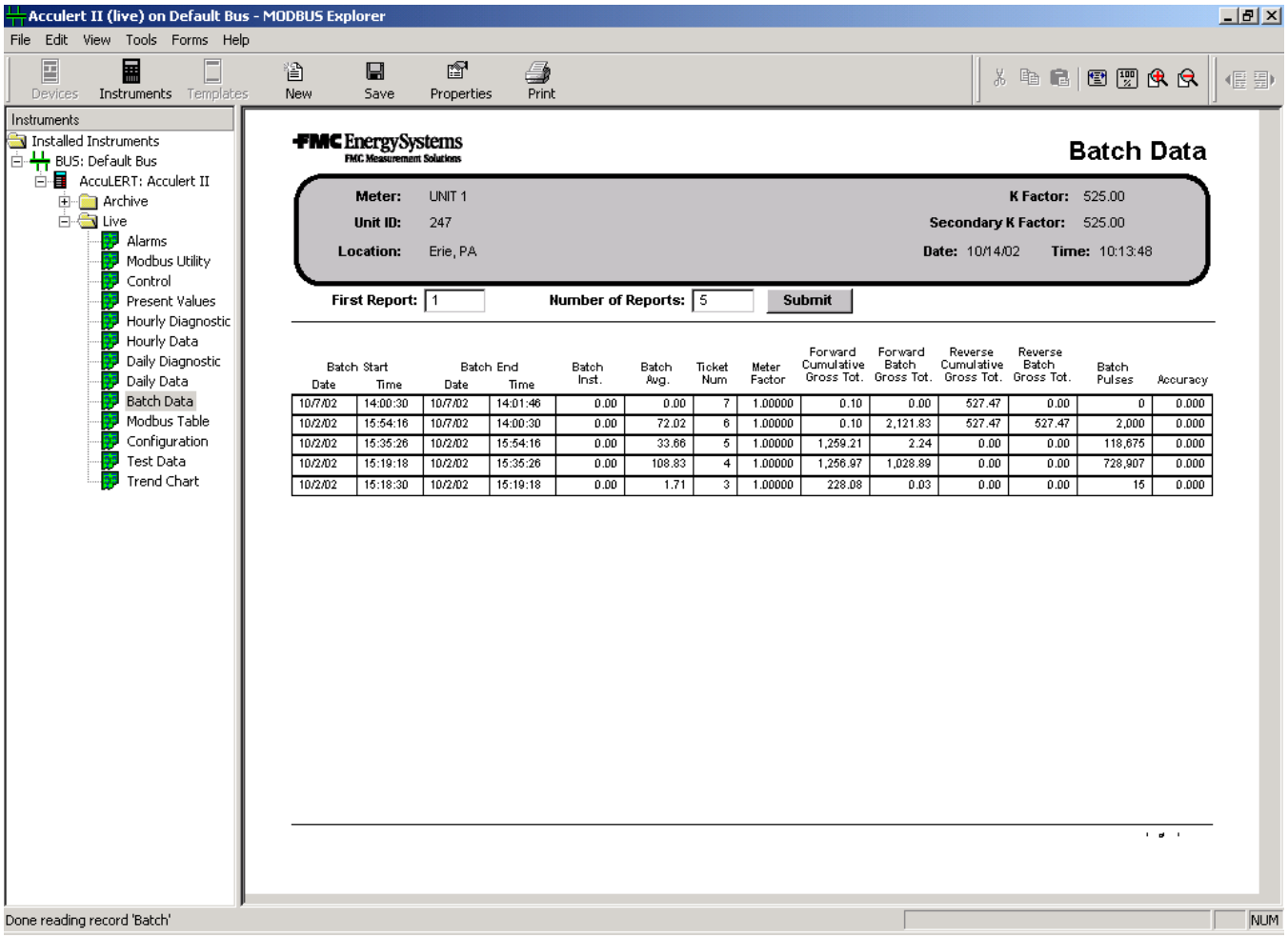
Daily Data Report



Current Date	Current Time	Collection Period Start Date	Collection Period Start Time	Batch Inst.	Batch Avg.	Ticket Num	Meter Factor	Forward Cumulative Gross Tot.	Forward Batch Gross Tot.	Reverse Cumulative Gross Tot.	Reverse Batch Gross Tot.	Batch Pulses	Accuracy
10/14/02	00:00:00	10/13/02	00:00:00	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/13/02	00:00:00	10/12/02	00:00:00	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/12/02	00:00:00	10/11/02	00:00:00	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/11/02	00:00:00	10/10/02	00:00:00	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/10/02	00:00:00	10/9/02	00:00:00	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/9/02	00:00:00	10/8/02	15:05:24	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/8/02	00:00:00	10/7/02	00:00:00	0.00	0.00	1	1.00000	0.10	0.00	527.47	0.00	0	1.000
10/7/02	00:00:00	10/6/02	00:00:00	0.00	72.02	6	1.00000	3,381.04	0.00	527.47	0.00	0	0.000
10/6/02	00:00:00	10/5/02	00:00:00	0.00	72.02	6	1.00000	3,381.04	0.00	527.47	0.00	0	0.000
10/5/02	00:00:00	10/4/02	00:00:00	0.00	72.02	6	1.00000	3,381.04	0.00	527.47	0.00	0	0.000

To access the current Daily Data Report screen, select "Daily Data" from the Live menu. Up to ten daily data reports are available. Enter the number of reports to be displayed, and the number of the first report to be displayed. Press "Submit." If the number of reports to be viewed is 10, all current (non-archived) daily data reports stored in the AccuLERT will be displayed and can be viewed, printed, and/or saved. Reports are displayed in order, with the most recent report displayed first.

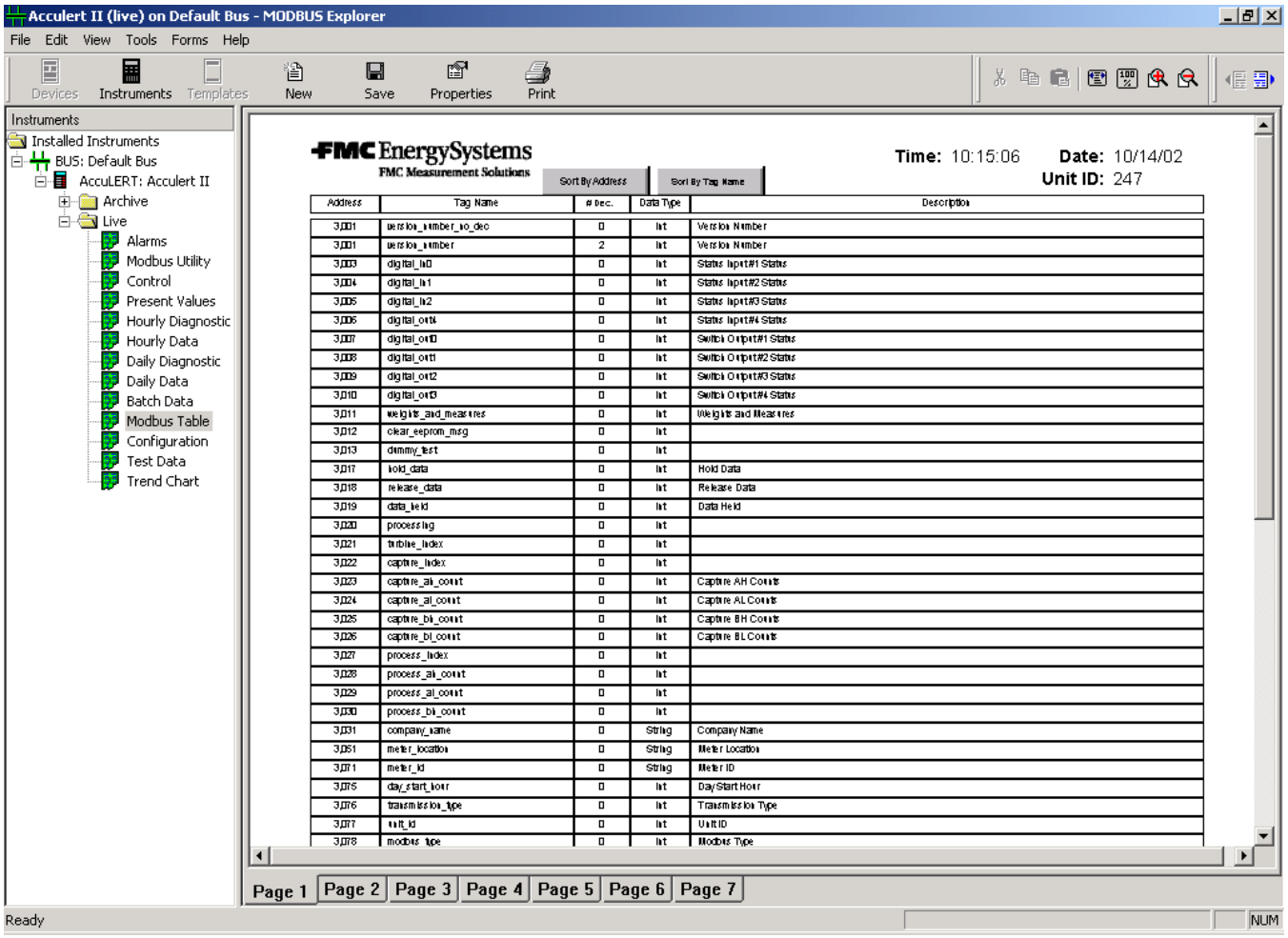
Batch Data Report



Batch Start Date	Batch Start Time	Batch End Date	Batch End Time	Batch Inst.	Batch Avg.	Ticket Num	Meter Factor	Forward Cumulative Gross Tot.	Forward Batch Gross Tot.	Reverse Cumulative Gross Tot.	Reverse Batch Gross Tot.	Batch Pulses	Accuracy
10/7/02	14:00:30	10/7/02	14:01:46	0.00	0.00	7	1.00000	0.10	0.00	527.47	0.00	0	0.000
10/2/02	15:54:16	10/7/02	14:00:30	0.00	72.02	6	1.00000	0.10	2,121.83	527.47	527.47	2,000	0.000
10/2/02	15:35:26	10/2/02	15:54:16	0.00	33.66	5	1.00000	1,259.21	2.24	0.00	0.00	118,675	0.000
10/2/02	15:19:18	10/2/02	15:35:26	0.00	108.83	4	1.00000	1,256.97	1,028.89	0.00	0.00	728,907	0.000
10/2/02	15:18:30	10/2/02	15:19:18	0.00	1.71	3	1.00000	228.08	0.03	0.00	0.00	16	0.000

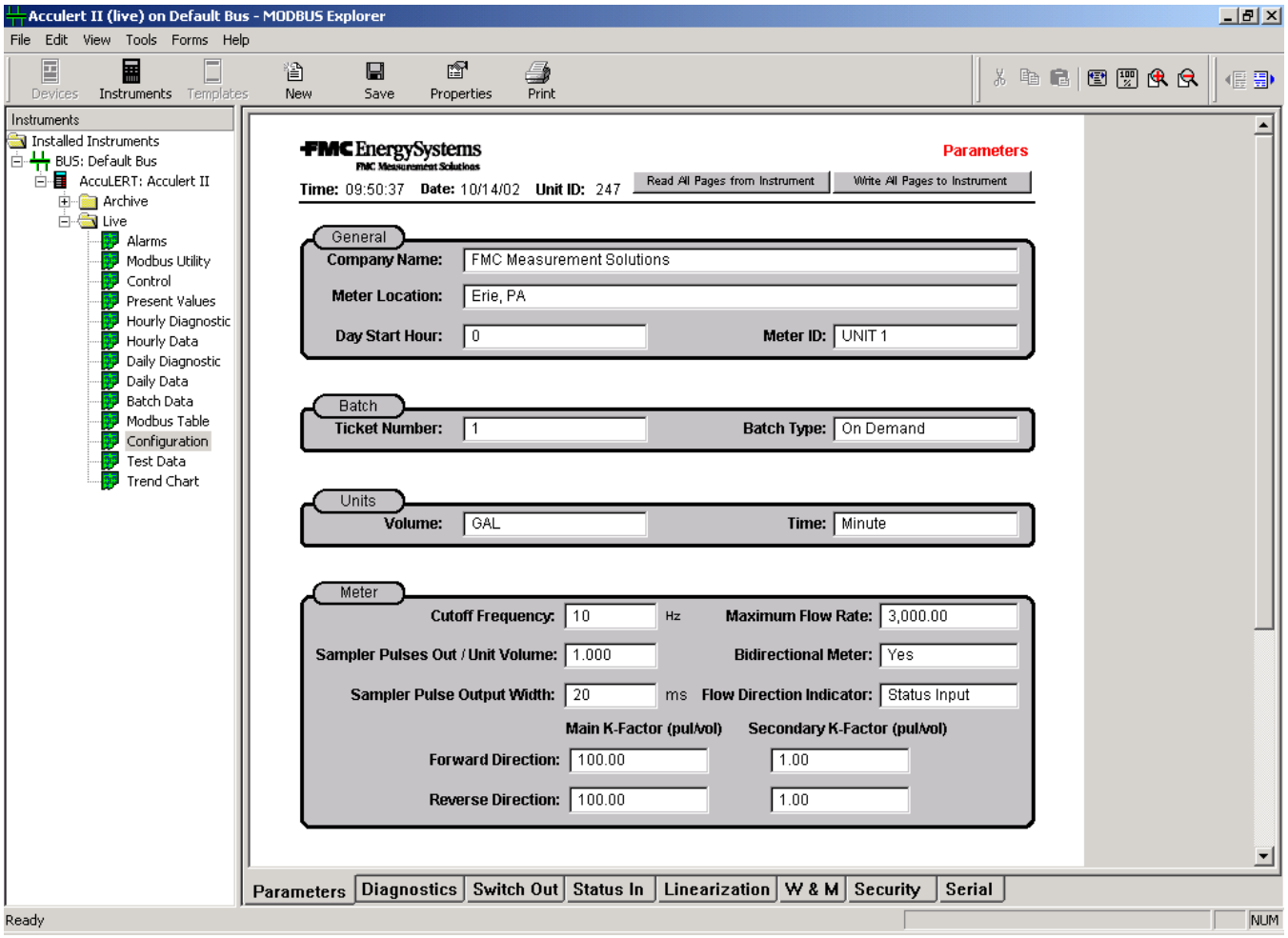
To access the current Batch Data Report screen, select "Batch Data" from the Live menu. Up to ten batch reports are available. Enter the number of reports to be displayed, and the number of the first report to be displayed. Press "Submit." If the number of reports to be viewed is 10, all current (non-archived) batch reports stored in the AccuLERT will be displayed and can be viewed, printed, and/or saved. Reports are displayed in order, with the most recent report displayed first.

Modbus Table



To access the Modbus table screen, select "Modbus Table" from the Live menu. All Modbus registers will be displayed, with data sorted either by address or by tag name. Use the tabs at the top of the screen to select the format for the data display.

Configuration – Parameters



The Configuration menu is used to enter various parameters into the AccuLERT.

Note: When all selections are complete on any of the following configuration menu pages the data must be transferred to the AccuLERT memory. This is accomplished by clicking on "Write All Pages to Instrument" to download parameters to the AccuLERT.

To use these saved settings select “Archive” on the menu tree; this will expand the tree. Select “Configuration”. The tree will expand to show “This Week”, “This Month”, “This Year”, or “All”. Open the desired file from the appropriate menu. After the form is displayed on the screen, a right click of the mouse will display “Copy Form Values.” This selection will take all of the Configuration settings and place them on the clipboard.

To paste the values into the AccuLERT, select “Live” from the menu tree, then select “Configuration” and open the form. Right click the mouse on the configuration menu and select “Paste Form Values.” The data will be transferred to the displayed configuration form. Select “Write All Pages to Instrument.” This action will write all of the configuration pages to the AccuLERT’s internal memory. This same procedure can be used for any of the other archived form values.

Note: It is recommended that after the “Write All Pages to Instrument” command has been completed, the user should issue the “Read All Pages from Instrument” command. This is done to verify that the stored data is correct. In some cases, such as the W&M Mode protection, a parameter has the appearance of being transferred to the AccuLERT; however, upon reading the data back from memory it is apparent that the data was not changed because it was under the W&M mode protection. See Weights and Measures Mode for more details.

General

To configure AccuLERT parameters, choose the Parameters tab on the Live Configuration menu. Type the company name, meter location, and unit identification number in the boxes provided in the "General" area at the top of the screen. "Company Name" and "Meter Location" are alphanumeric entries of up to 40 characters each; "Meter ID" is limited to eight alphanumeric characters.

Day Start Hour

Enter the hour using military time (i.e., 1, 2, 15, etc.) in whole hours for the start of a new day. If daily batch operation is selected in the "Batch" area of the display, the totalizer will be reset at the end of the day at that hour.

Ticket Number

The operator can manually enter a ticket number. If a Ticket Number is not entered, the AccuLERT will use the last available ticket number and increment it by one at the end of the batch. The Ticket Number appears on the Batch Report.

Batch Type

Click on the pull-down menu directly to the right of "Batch Type" in the "Batch" area to select either "Daily" or "On Demand." Selecting “Daily” will result in the AccuLERT resetting the batch data on the Day Start Hour selected above. Selecting “On Demand” will only allow the Batch Data to be reset with an operator command, either through communications, or through the activation of a contact input if programmed.

Meter Volume Units

Click on the pull-down menu directly to the right of "Volume" in the "Units" area to indicate the units in which the volume is to be reported. Options are as follows: Gallons (GAL), Barrels (BBL), Cubic Feet (FT3), Cubic Meters (M3), and Liters (LIT).
Note: *Units must correspond to the K-Factor that is entered (pulses/unit volume).*

Time Unit

Click on the pull-down menu directly to the right of "Time" in the "Units" area to indicate the time basis for the flow rate entry. Options are as follows: Hour and Minute.

Turbine Cutoff Frequency

This parameter defines the minimum frequency that will be used for totalizing; below this frequency, internal totalization will cease. The purpose of the threshold is to ignore erroneous pulses that may occur when product is not flowing through the meter. The cutoff frequency only affects the internal batch totalizer registers in the Accu-LERT. The range of this entry is from 0 to 99 Hz. An initial setting of 5 Hz is recommended; this value may vary depending on the applications.
Note: *Pulse output of the AccuLERT is not related to the threshold level. The pre-amplification circuitry will continue amplification below threshold level.*

Turbine Maximum Flow Rate Volume/Unit of Time

This value is used to set the upper flow rate alarm limit. Enter the maximum flow rate in volume/hour (or minutes) that will be allowed without generating an alarm condition. The range of this entry is from 10 to 99999.00 volume units per unit time.

Pulse Output/Unit Volume

The pulse output can be used for driving equipment such as samplers or injection pumps. The period width is user programmable. Maximum output is 250 pulses per second. The range of this entry is from 0.001 to 100 pulses per unit volume. This entry is only used if either of the two available contact outputs is programmed for “Pulse Output to Samplers.”

Pulse Output Width

This value is used to set the pulse output pulse width. Enter the pulse output width in milliseconds that is required for the receiving equipment. The range of this entry is from 0.004 to 250 milliseconds. This entry is only used if either of the two available contact outputs is programmed for “Pulse Output to Samplers.”

Bi-Directional Meter

Indicate the type of meter to be monitored. Select "No" for a unidirectional meter or "Yes" for a bi-directional meter. Only the forward totalizer is activated if a unidirectional meter is selected. If a bi-directional meter is selected, both the forward and reverse totalizers are activated and the flow is monitored in both directions by either the phase method or the contact input switch.

Flow Direction Indicator

Flow direction detection can either be automatic or manual. Automatic detection is enabled by selecting Phase. This requires the Dual pick-up coil selection on the Turbine Meter Diagnostic Menu. The AccuLERT uses the phase angle to determine flow direction. (“A” input leading “B” input is defined as the forward direction.) The flow direction detection can also be set for manual detection; this is accomplished by selecting Status Input. If Status Input is selected, the direction of flow is dependent on the status of the contact input. A logic low signal on the status input activates the forward batch counter; a logic high input activates the reverse batch counter.

Note: *When using the Status Input for the control of the Flow Direction indicator, the contact input must be programmed for Flow Direction. This is found under the Status Input submenu of the Configuration Menu.*

Main K-Factor (Forward Direction)

This entry represents the number of pulses from the meter per unit volume when flowing in the forward direction. The K-Factor is only used for internal calculation of the flow rates, volume accumulations, and sampler output; it does not affect the pre-amplified output. The K-Factor (pulses/unit) must match the units programmed in the meter volume units. The range of this entry is 00000.01 to 999999.99.

Main K-Factor (Reverse Direction)

This entry is only active if the Bi-Directional meter entry is set for Yes. The entry represents the number of pulses from the meter per unit volume when flowing in the reverse direction. The K-Factor is only used for internal calculation of the flow rates, volume accumulations, and sampler output; it does not affect the pre-amplified output. The K-Factor (pulses/unit) must match the units programmed in the meter volume units. The range of this entry is 00000.01 to 999999.99.

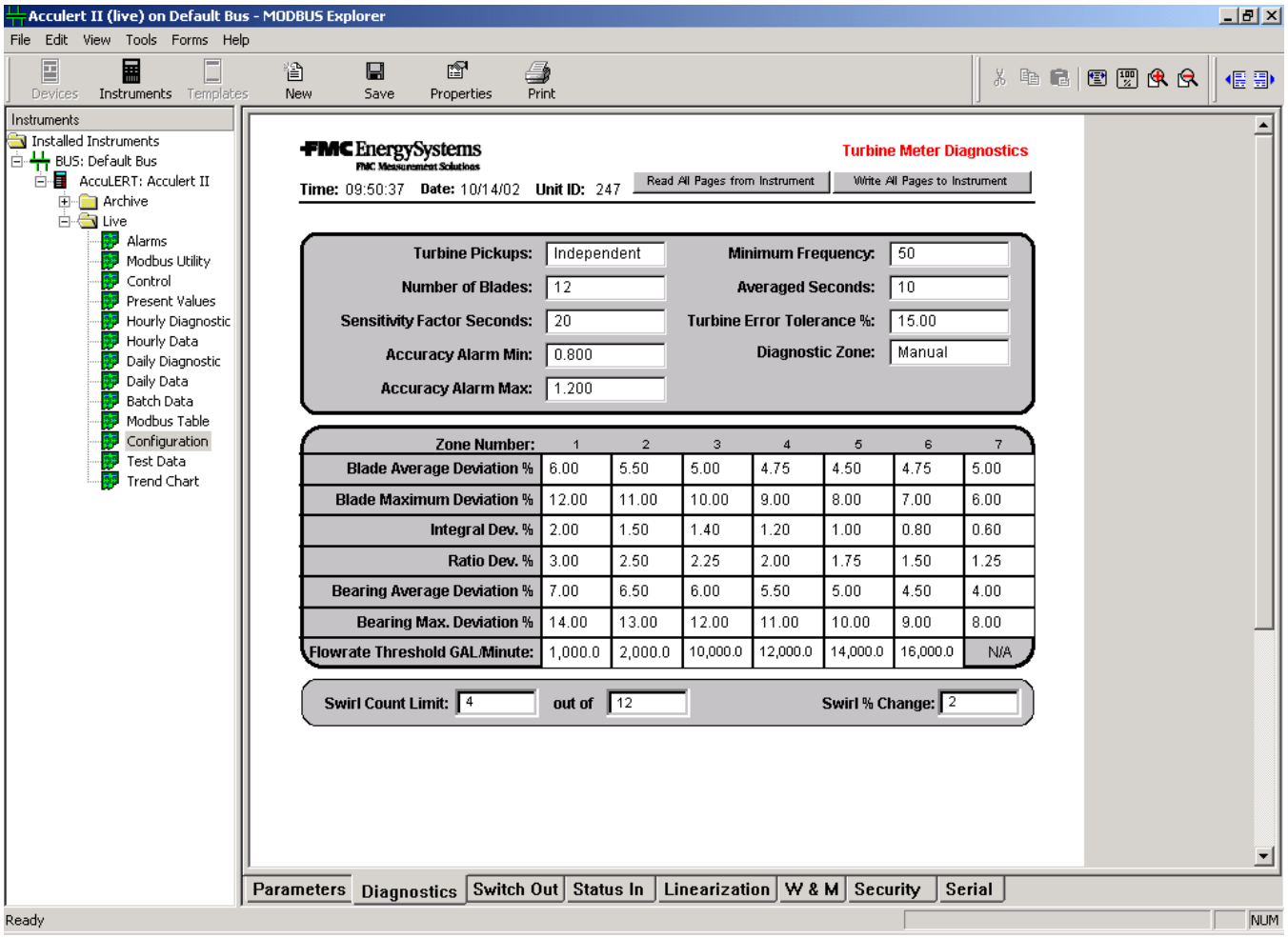
Secondary K-Factor (Forward Direction)

This entry is only active if the Turbine Meter Pick-up selection is set for Independent in the Turbine Meter Diagnostic submenu of the Configuration menu. This entry represents the number of pulses from the meter per unit volume when flowing in the forward direction. The K-Factor is only used for the determination of the Accuracy Alarm; it does not affect the pre-amplified output. The K-Factor (pulses/unit) must match the units programmed in the meter volume units. The range of this entry is 00000.01 to 999999.99.

Secondary K-Factor (Reverse Direction)

This entry is only active if the Bi-Directional meter entry is set for Yes and the Turbine Meter Pick-up selection is set for Independent in the Turbine Meter Diagnostic submenu of the Configuration menu. This entry represents the number of pulses from the meter per unit volume when flowing in the reverse direction. The K-Factor is only used for the determination of the Accuracy Alarm; it does not affect the pre-amplified output. The K-Factor (pulses/unit) must match the units programmed in the meter volume units. The range of this entry is 00000.01 to 999999.99.

Configuration – Diagnostics



To view the current Turbine Meter Diagnostics data, select the "Diagnostics" tab from the Live "Configuration" sub-menu. To download configuration changes to the AccuLERT, click on "Write All Pages to Instrument" at the upper right of the display.

Turbine Pickups

This selection is used to indicate the number of pickup transducers on the meter. The selection is made by clicking the drop-down menu directly to the right of "Turbine Pickups" at the top of the display. Options are as follows: Single, Dual, and Independent. Select Single if only one pickup is available. Select Dual if two pickups are available and bi-direction phase sensing will be utilized. Select Independent for gas meter applications where it is desired to monitor the local mechanical counter via the one pulse per revolution contact switch.

Number of Blades

The number of blades (if a non-rimmed rotor is used) or buttons/slots (if a rimmed rotor is used) is entered in this location to indicate to the microprocessor how to structure the turbine analysis routines, such as bearing consistency and blade (button/slot) repeatability. Blade count can be from 2 minimum to 96 maximum. The user is always required to manually enter the blade count in the diagnostic menu.

Sensitivity Factor Seconds

This entry is particularly useful for avoiding false alarms due to short term changes in operating conditions. The sensitivity factor acts as a filter and masks the issuance of an alarm for the time period set. In the event that alarm conditions continue beyond the sensitivity time, the AccuLERT will signal an alarm both through communications or through any discrete output programmed as an alarm indicator. (For load rack applications this time should be set for the longest time that the turbine meter speed will be fluctuating, usually either the ramp up time from no flow to full flow, or the ramp down time from full flow to no flow.) The range of this entry is from 0 to 3600 seconds.

Accuracy Alarm Minimum

This menu item is only displayed when the Turbine Pickups menu selection is set for "Independent." This value is used to set the lower tolerance value for the accuracy alarm. The recommended Accuracy Alarm Minimum value is 0.995 (99.5%).

Accuracy Alarm Maximum

This menu item is only displayed when the Turbine Pickups menu selection is set for "Independent." This value is used to set the upper tolerance value for the accuracy alarm. The recommended Accuracy Alarm Minimum value is 1.005 (100.5%).

Minimum Frequency

The AccuLERT will initiate turbine diagnostics when the frequency from the turbine meter pickup transducer exceeds the minimum frequency threshold programmed in this location. This entry is used for activating alarms and does not affect the batching totalizers. The range of this entry is from 0 to 7200 Hz. For pipeline applications, the recommended value is 100 Hz. For load rack applications, the recommended value is 20 Hz.

Averaged Seconds

Instantaneous data may be erratic and some filtering may be required. The AccuLERT will average the instantaneous data using the number of seconds entered. The range of this entry is from 0 to 15 seconds. For smoothing, a value of at least 5 seconds is recommended. (Load rack applications may want to use a smaller value, such as 4 or 5 seconds, whereas pipeline applications may want to use higher values of 8 seconds or more.)

Turbine Error Tolerance Percentage

Some flexibility is required in the turbine meter signature. The number (in percentage) should be considered individually for each turbine application. Operational conditions are the key elements in this consideration. The tighter the operation (the more stable the flow conditions), the less flexible this number needs to be. A reasonable entry is 10%. The range of this entry is from 0 to 15%.

Example
Real Number = 2%
Turbine Error Tolerance = 15%
Entry into the zone is $1.15 \times 2\% = 2.3\%$
2.3% is the value used for the zone diagnostics

Flow Rate Threshold

These entries define the flow rates at which the turbine meter signature fields change. Each turbine meter signature zone applies to the flow rate below the entered threshold to the flow rate of the next threshold. Threshold 1 is the point where the turbine meter diagnostics change from Zone 1 to Zone 2. (Zone 1 extends from the minimum turbine meter diagnostic frequency to the Zone 1 entry.) Threshold 2 is the point where the turbine meter diagnostics change from Zone 2 to Zone 3, etc.

Example
Zone #1 could be set from 10 to 1000 units/hour (based on threshold #1 being programmed at 1000 units/hour).

Diagnostic Zone

Turbine meter performance is influenced by several different factors, including rotor / rim machining, bearing performance, sensitivity of the pickup coils, and pressure fluctuations of the metered product at different flow rates. The AccuLERT takes these factors into consideration and allows the user to manually or automatically develop and enter signature limits for individual flow rate zones. Recommended zones would be between the maximum usable flow rate and minimum range for the turbine meter in each specific application.

Seven different zones are available. If automatic selection is used, the AccuLERT will automatically develop the signature for each individual zone after gathering sufficient data points within the zone. If manual selection is used, the operator must enter the signature manually. Manual data can be set by using previously observed hourly or daily data.

Select “Diagnostic Zone” by clicking the drop-down menu directly to the right of "Diagnostic Zone" field on the display.

Options are as follows:

- Manual
- Auto
- Reset All Zones
- Reset Zone 1
- Reset Zone 2
- Reset Zone 3
- Reset Zone 4
- Reset Zone 5
- Reset Zone 6
- Reset Zone 7

For clearing all data within a zone, select “Reset All Zones” and then select “Write All Pages to Instrument” to download to the AccuLERT. Select “Read All Pages from Instrument” and all zone data will be set to zeros. Data can also be cleared within individual zones by selecting the appropriate zone and then selecting “Write All Pages to Instrument” to download to the AccuLERT.

For Automatic Zone data acquisition, select “Auto” and then “Write All Pages to Instrument” to start the acquisition mode. For manual entry of the zone data, select “Manual” and then enter the zone data in the appropriate fields. Once the data has been entered, select “Write All Pages to Instrument” to download the data to the AccuLERT.

Note: *Zones must be zeroed before they can be re-computed in Auto Mode.*

Blade Average Deviation in Percentage

Blade average deviation is exactly what the name implies – an average. This number is influenced by factors such as the machine accuracy of blade pitch or buttons on the shroud. It can also be influenced by other factors such as an out-of-balance rotor or objects hanging on the blades. Recommended error setting for bladed type turbine meters is 2.50%. In the case of shrouded turbine meters, the number can be higher. High average error tolerances are indicative of possible linearity problems with the meter. Other error messages (if applicable) point to possible problems with the flow profile assisting in the evaluation of the problem (meter or system).

Blade Maximum Deviation in Percentage

Referencing the Blade Average Deviation described above, the Blade Maximum Deviation is influenced by the same factors. When bladed type turbine meters are used, the linearity of the turbine meter could be affected by large values in this field. (An object striking the blade changing the pitch angle slightly will produce a large variation in this field, while the average will not indicate a large change in value.) Recommended entry for a bladed turbine meter is 4.00%.

Integral Deviation in Percentage

The integral deviation is a measure of wobble/flow fluctuation within a short measurement period. Because this calculation is done across all data points gathered during the data collection process, the computation of the result eliminates the effect of “position of the blade” and looks only at the velocity, making the displayed result less sensitive to variations than the maximum of the bearing calculations. A large percentage error in this location indicates a shift in meter factor and/or repeatability. A typical number for this value is less than 0.75% in a stable flow profile.

Ratio Deviation in Percentage

The ratio is a function of the consistency of rotation of the turbine meter rotor. Since this value indicates instantaneous changes in the rotational speed of the rotor, large values in this location would indicate problems with the meter bearings. Flow rate plays a minor role in this calculation. A reasonable value for stable flow conditions would be less than 2.00%. Continued high readings in this and the bearing percentage errors could indicate repeatability problems with the meter.

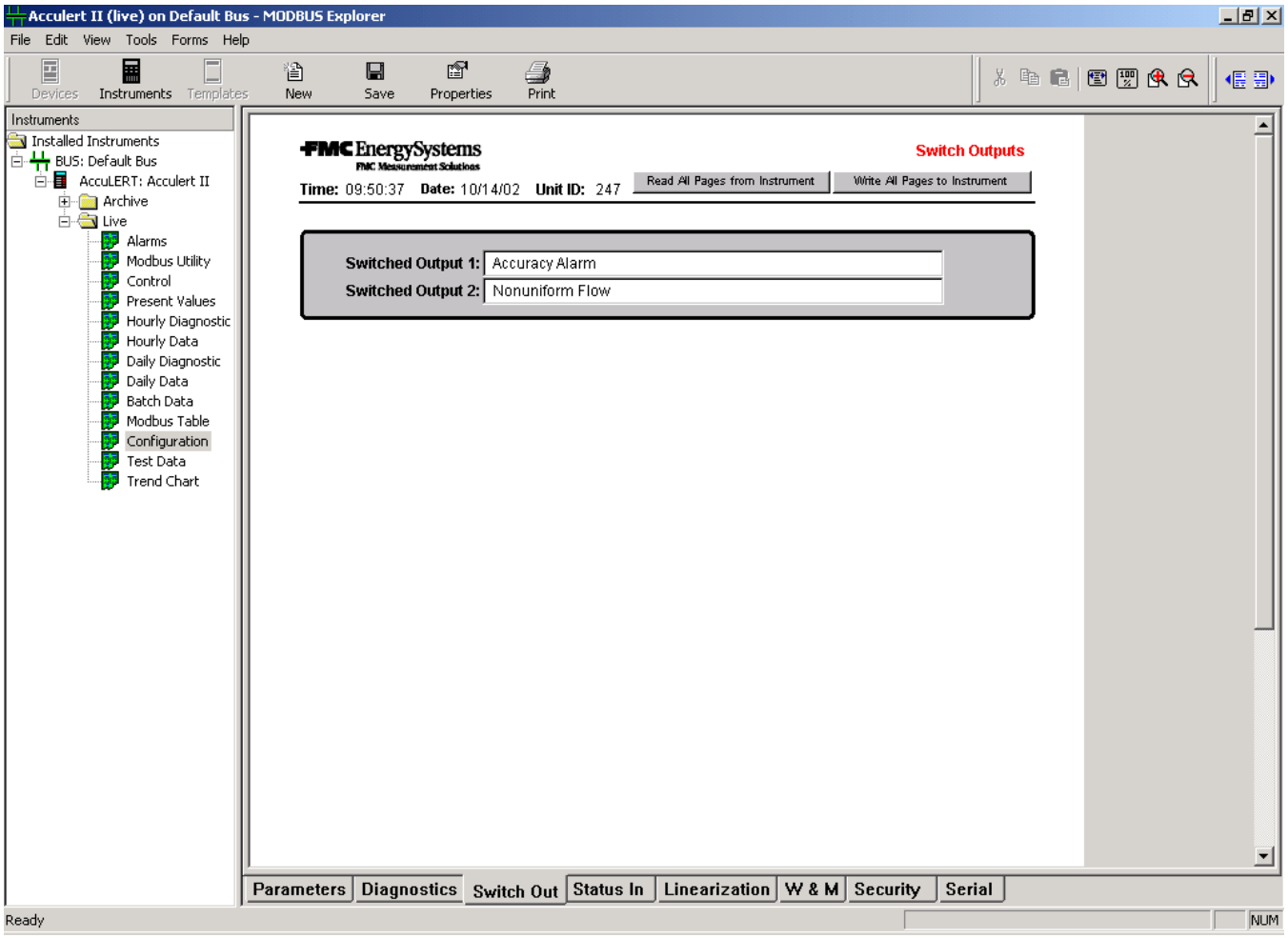
Bearing Average Deviation in Percentage

The average bearing deviation is a function related to the uniformity of the rotation of the turbine meter. The rotation can be influenced by factors such as bad bearings, pulsating flow, and other variables. Large numbers in this position indicate possible repeatability problems with the meter which could also be influenced by factors pertaining to the flow profile. A common number would be less than 3.00%.

Bearing Maximum Deviation in Percentage

The maximum bearing deviation is a function related to the uniformity of the rotation of the turbine meter. The sensitivity factor is much higher than the average bearing deviation which allows the AccuLERT to detect the minimum of errors. A common number would be less than 4.00%.

Configuration – Switch Outputs

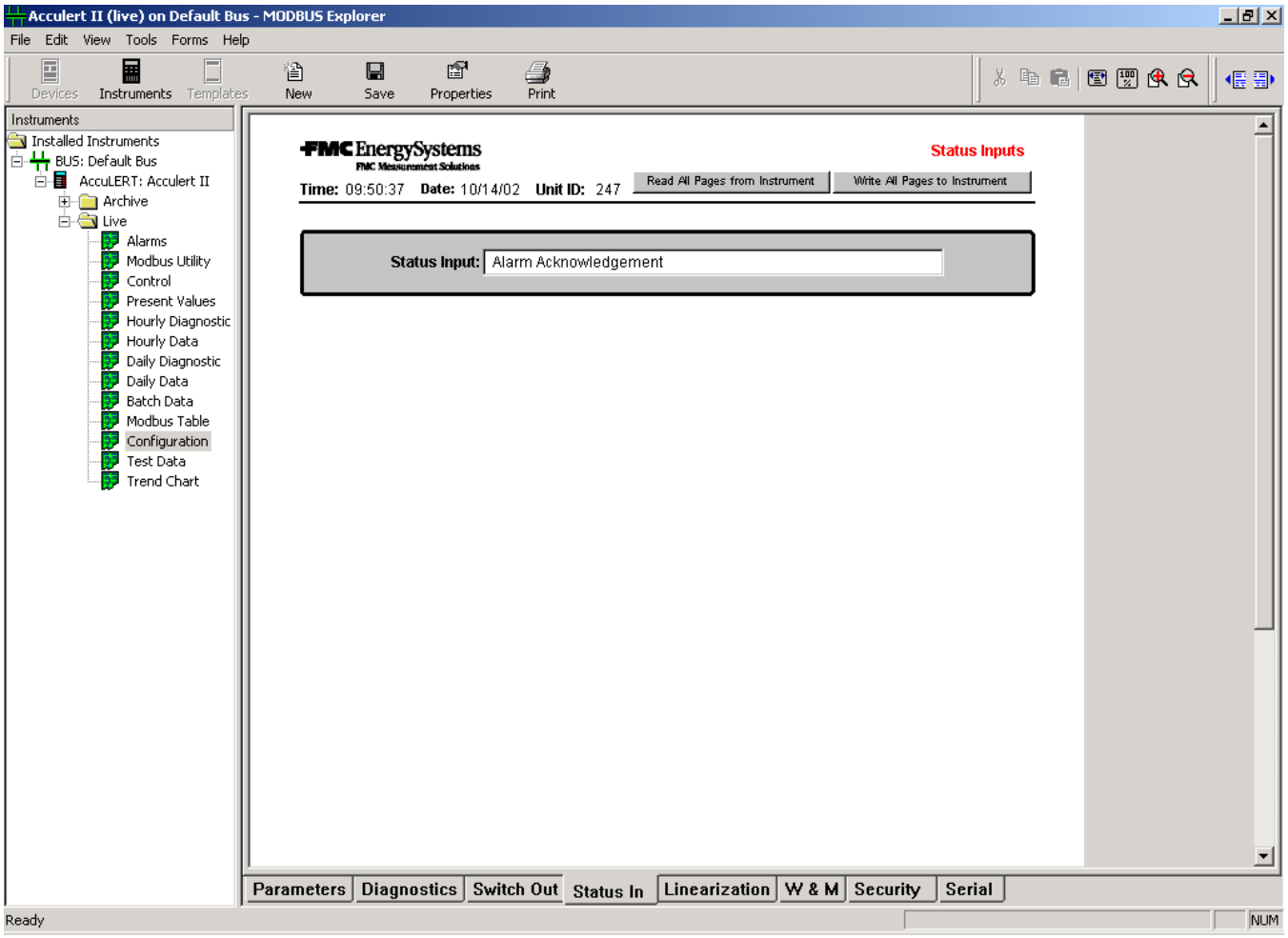


To view or change the current Switch Output settings, select the “Switch Out” tab on the Configuration menu. Click in the box to the right of “Switched Output 1” and “Switched Output 2” to obtain a drop-down pick list of switch output options. The options for both switches are as follows:

- Not Configured
- Alarm for Bent Blades
- Alarm for Bearing
- Alarm for Missing B Pulse
- Meter Down
- Active General Alarm
- Pulse Output to Samplers
- Flow Direction Indication High is Forward
- Day End
- Bad A Coil
- Swirl Alarm
- Alarm for Wrong Setup
- Non-Uniform Flow
- Alarm for Missing A Pulse
- Active Turbine Alarm
- Meter Over Spin
- Previous General Alarm
- Flow Direction Indication High is Reversed
- Batch End
- Bad B Coil
- Accuracy Alarm

Two “contact closure” type switch outputs are available from the AccuLERT and are programmable as to function as indicated above. The outputs are Darlington transistors rated for 50mA continuous current at 24 volts DC. An interposing relay may be required if additional current is required. To assign a switch output to an alarm, use the mouse to select the appropriate option from the pick list. When the switches are assigned, click on the "Write All Pages to Instrument" button found at the upper right-hand corner of the screen.

Configuration – Status Inputs

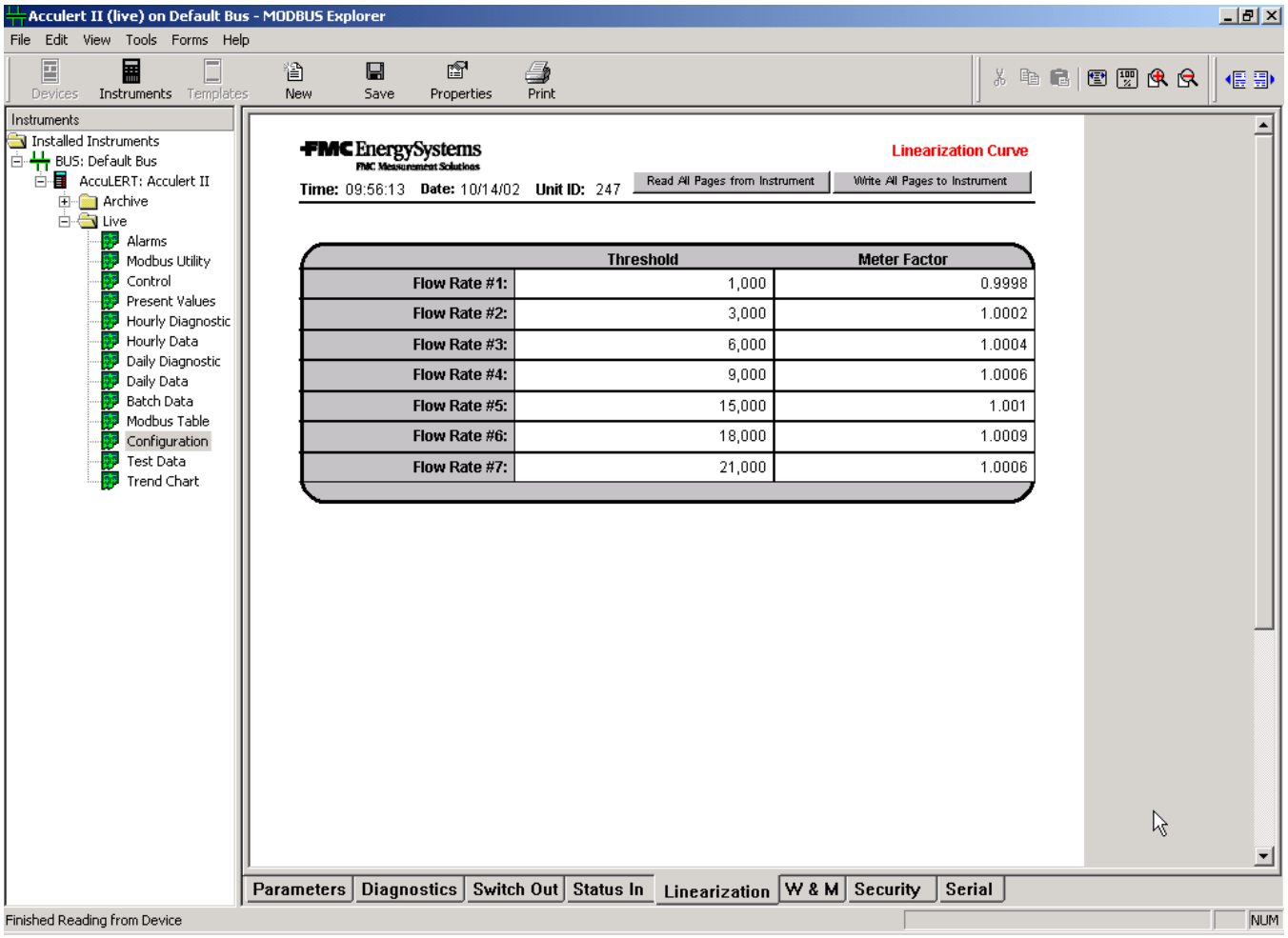


To view or change the current Status Input settings, select the "Status In" tab on the Configuration menu.

One status input is programmable from this screen. To assign the status input, click in the box directly to the right of “Status Inputs” to obtain a drop-down menu. Select the appropriate option, and then click on the “Write All Pages to Instrument” button at the upper right-hand corner of the screen to save the change to the AccuLERT. Status Input options are as follows:

- Batch End
- Alarm Acknowledgement
- Not Configured
- Flow Direction
- Weights and Measures

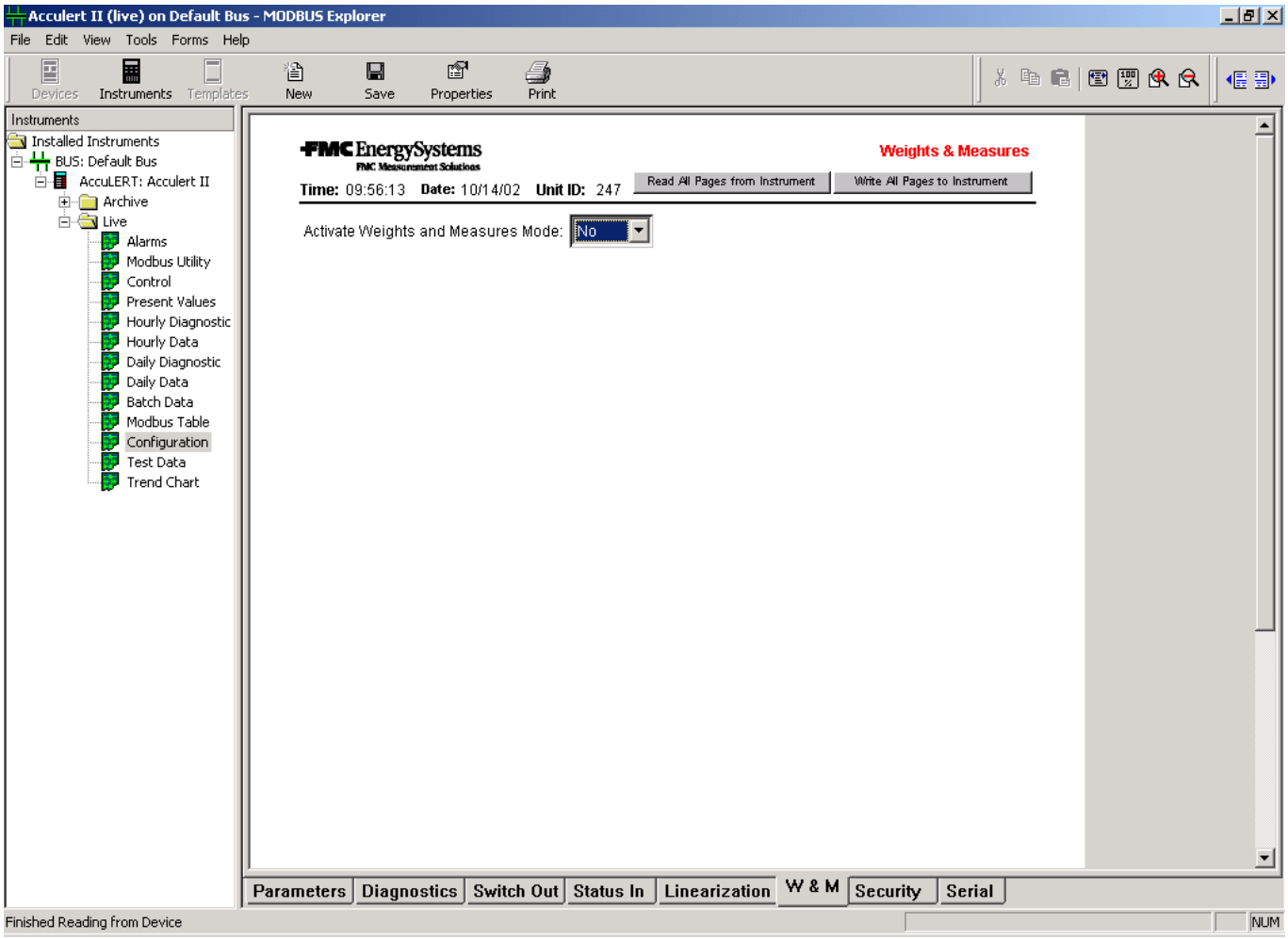
Configuration – Linearization Curve



To access the current linearization curve data, select the Linearization submenu tab from the Live Configuration menu. The meter factor linearization curve is provided for correction of the calculation of a turbine meter's gross reading. Seven meter factors and the associated flow rates can be entered in the program for the linearization curve. When flow is in progress the AccuLERT will use this curve to linearly interpolate the meter factor for any flow rate that is on this curve. The flow rates and associated meter factors have to be entered from the lowest flow rate in Flow Rate #1 to the highest flow rate in Flow Rate #7. If only one flow rate and associated meter factor is used it should be entered in Flow Rate #1. All unused entries must be set to zero. The meter factor linearization curve has no effect on the pulse output or accumulated pulses of the AccuLERT.

To save changes in linearization curve parameters, click on the "Write All Pages to Instrument" to download the data to the AccuLERT.

Configuration – Weights and Measures Mode



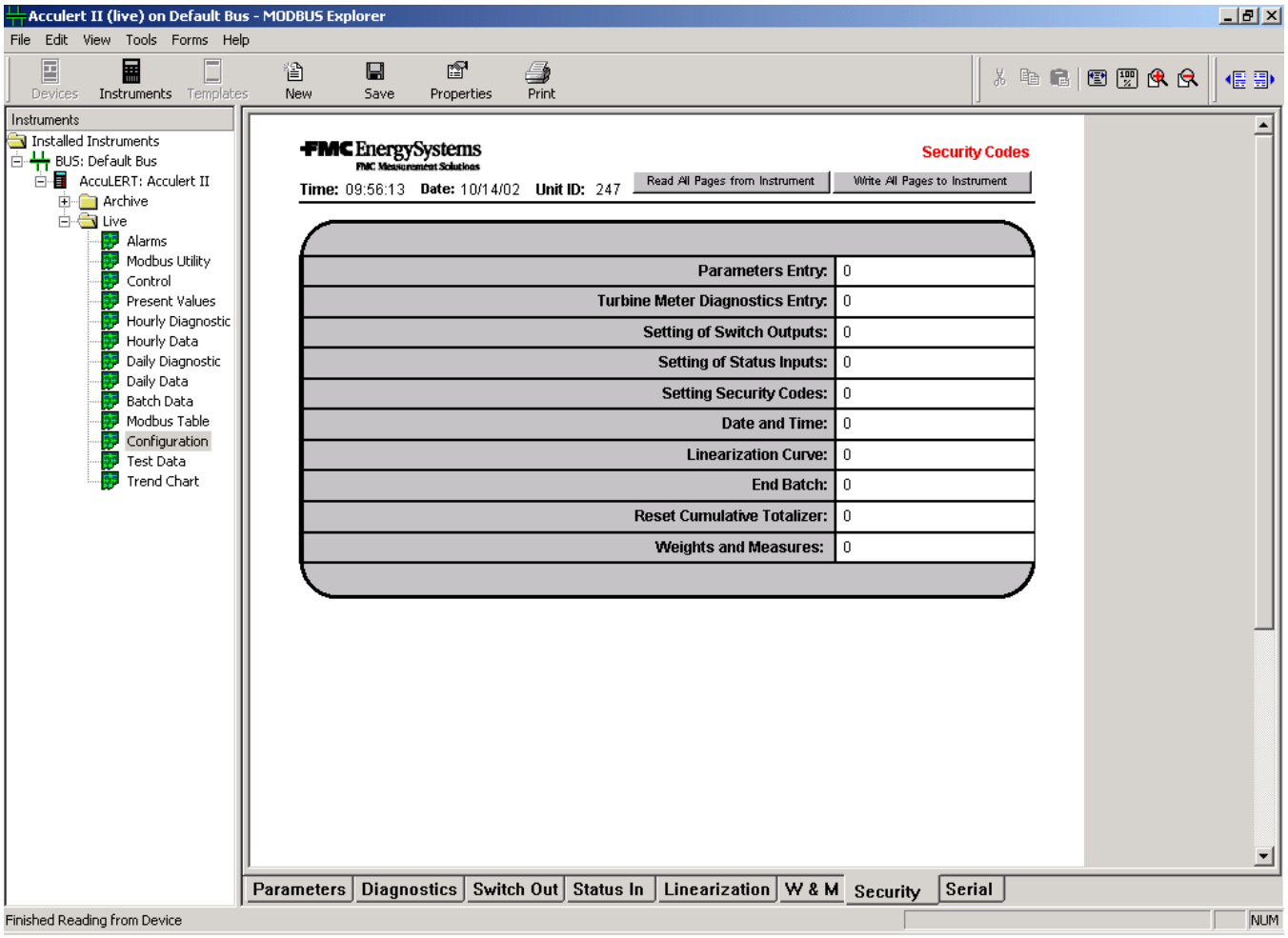
The Weights & Measures Mode is used to protect Weights and Measures significant parameters. ***Note:*** *If the Weights and Measures Mode is selected, then the Status Input must also be set to Weights and Measures Input Mode. Typically a key switch contact closure will be connected to the status input. The contact closure must be closed to allow any changes to the protected data.*

To activate or de-activate the AccuLERT's Weights and Measures feature, select the "W & M" submenu tab from the Live Configuration menu. Click on the drop-down box beside "Activate Weights and Measures Mode." Choose "Yes" or "No," as appropriate, then click on "Write All Pages to Instrument" to download the selection to the AccuLERT.

Weights and Measures Mode provides protection for the following parameters:

- Main K-Factor (Forward)
- Main K-Factor (Reverse)
- Linearization curve factors
- Volume units
- Time units
- Pulse output volume factor
- Reset cumulative totalizer command

Configuration – Security Codes

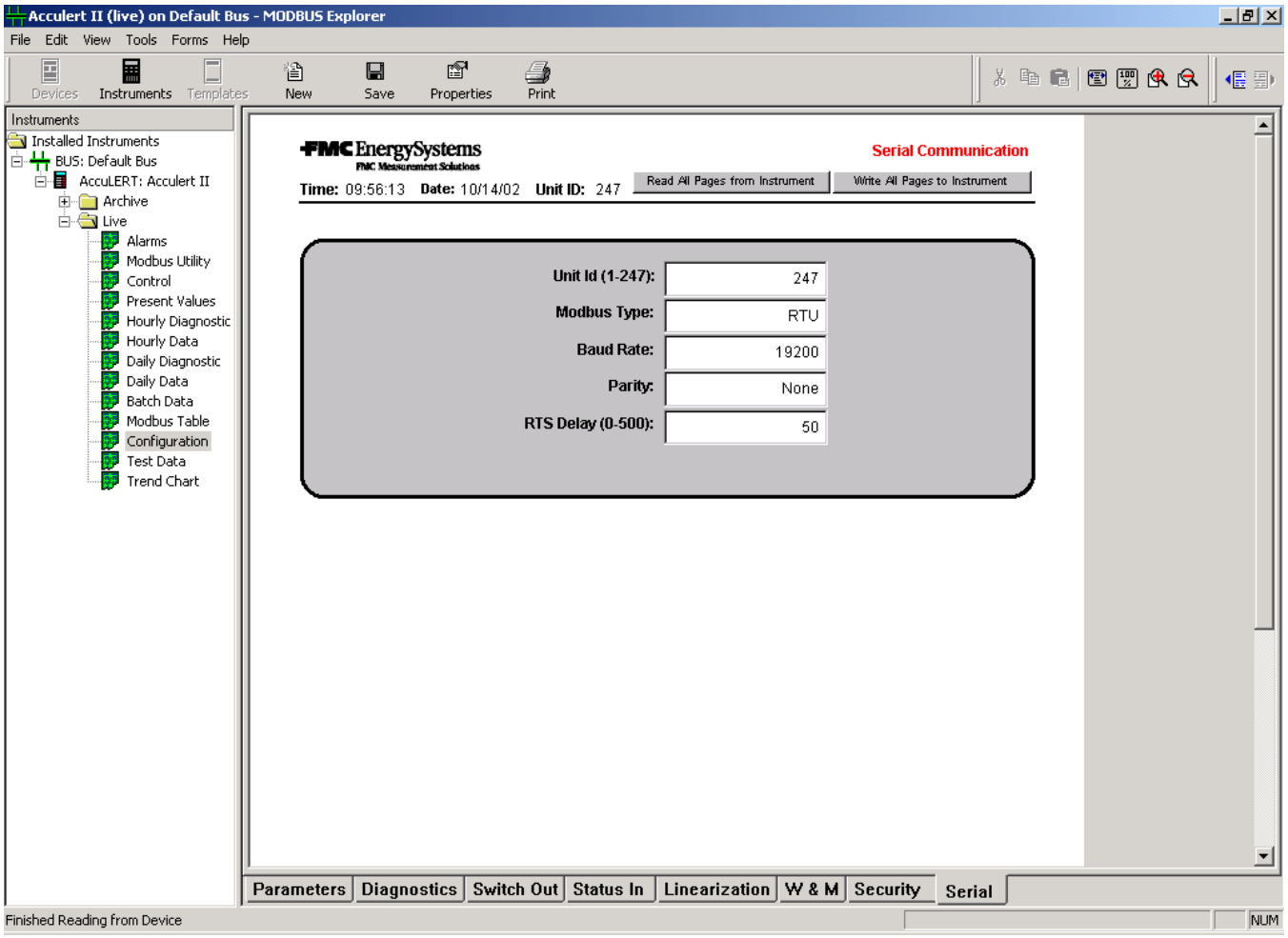


To access current security code data, select the Security submenu tab from the Live Configuration menu. There are ten different program menu access areas of security codes available to the user, as shown in the figure above. The purpose is to allow multi-level security for the AccuLERT. The range of each entry is 0 to 999999. Specify a security code of zero to six digits for a specific function (e.g., Linearization, Weights and Measures), then select the "Write All Pages to Instrument" button at the upper right-hand corner of the screen. The next time the corresponding menu is selected, the program will prompt the operator to enter the security code. If the wrong security code is entered for a function, the message "Invalid Security Code" will appear on the screen and the screen data will not be displayed.

When all changes are complete, click on "Write All Pages to Instrument" to download selections to the AccuLERT.

Note: *The factory default security code is 0. If no other code is specified for a function, the AccuLERT is unprotected from unauthorized access and parameter changes.*

Configuration – Serial Communication



To access the Serial Communication submenu, click on “Configuration” from the Live menu, then click on the “Serial” tab at the bottom of the display. To download changes to the AccuLERT, click on the “Write All Pages to Instrument” button at the upper right-hand corner of the screen. Because this function uses Modbus address 0 (reserved for broadcast messages), it only works if one AccuLERT is connected to the computer communication line. All Modbus devices perform the function sent by a broadcast message. In this case, all AccuLERTs would try to respond simultaneously causing data contention on the communication bus. Therefore, this option is not available if more than one AccuLERT is active on the communication line.

Failure to establish communication could be a result of bad connections, a faulty unit, or a unit set up for the wrong interface (RS-485 or RS-232).

Unit ID

Type an identification number from 1 to 247 for this AccuLERT. Note that every AccuLERT on a communication line must have its own unique number.

Modbus Type

Select the Modbus type for the PC. This entry must match the AccuLERT Modbus type, unless communications have already been established and the intent is to change parameters in the AccuLERT. Click on the drop-down menu directly to the right of “Modbus Type:” to select either “RTU” or “ASCII.”

Baud Rate

Five baud rates are available for the transmission of data to and from the AccuLERT. This entry must match the AccuLERT's baud rate, unless communications have already been established and the intent is to change parameters in the AccuLERT. Click on the drop-down menu directly to the right of "Baud Rate:" to select the appropriate option. The available options are as follows: 1200, 2400, 4800, 9600, or 19200. The factory default is 19200, which is appropriate for most applications.

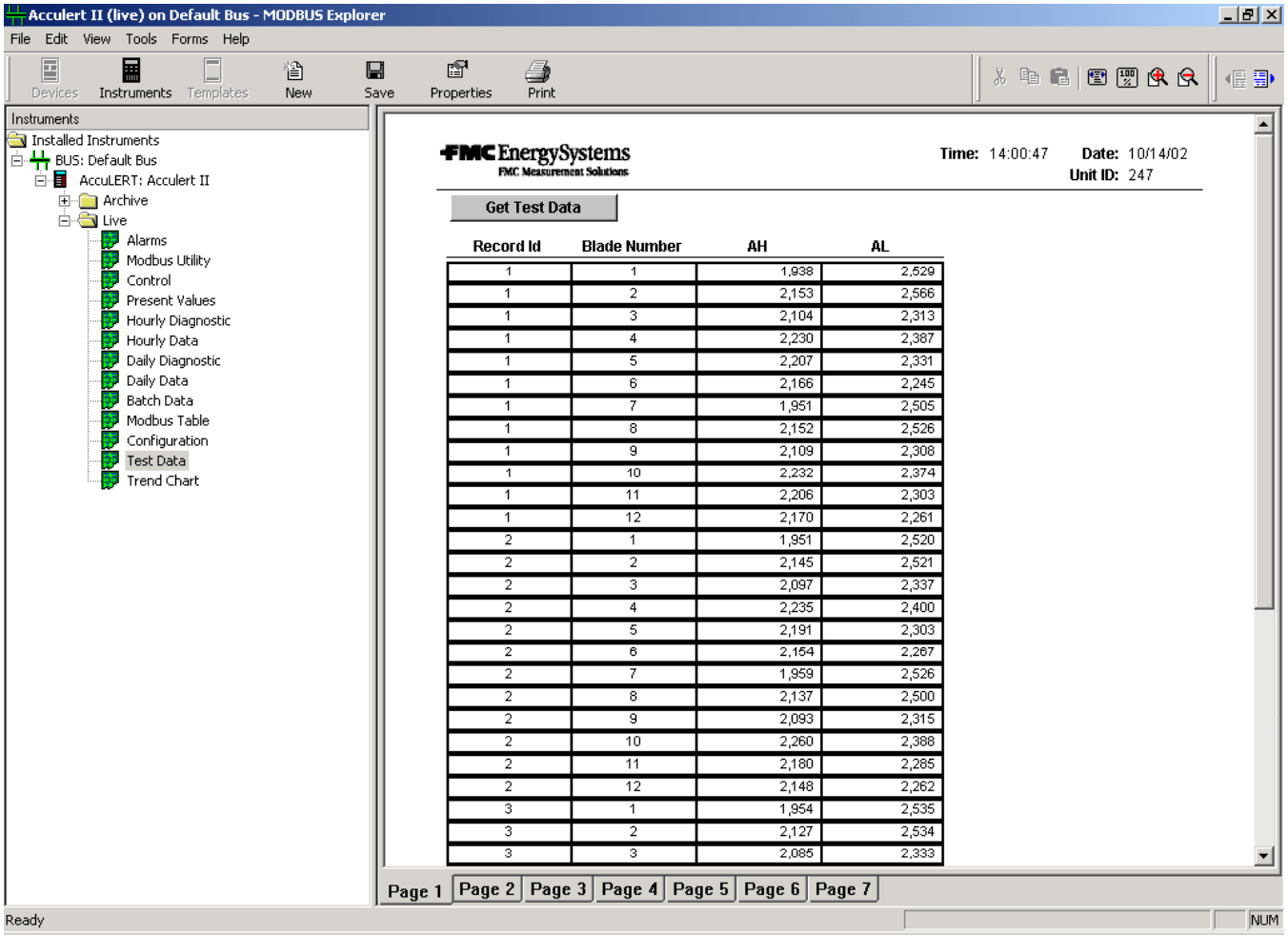
Parity

This entry indicates the parity for the protocol selected in the AccuLERT. This entry must match the AccuLERT's parity setting, unless communications have already been established and the intent is to change parameters in the AccuLERT. Click on the drop-down menu directly to the right of "Parity:" to select the appropriate option. The available options are as follows: "None" or "Odd." As a general rule, select "None" for RTU and "Odd" for ASCII.

RTS Delay

This function allows the user to set the modem delay time before the transmission of data. Type a number from 1 to 500 in the field directly to the right of "RTS Delay." The factory default is 50, but a longer delay time may be required when a modem is used. When using a two-wire link for communications, this value should be set up for a minimal value of 500 milliseconds to allow for compatible data transmission.

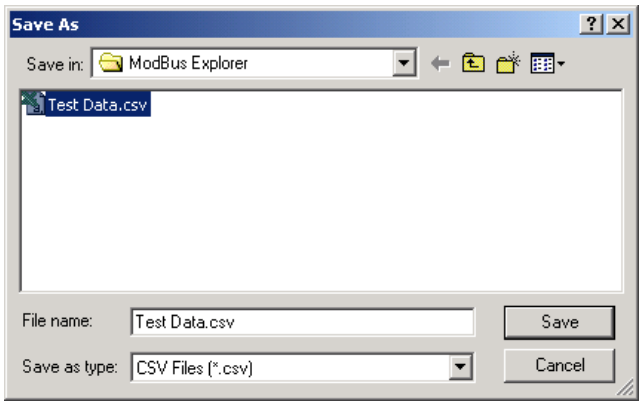
Test Data – Generating and Saving into CSV File



Record Id	Blade Number	AH	AL
1	1	1,938	2,529
1	2	2,153	2,566
1	3	2,104	2,313
1	4	2,230	2,387
1	5	2,207	2,331
1	6	2,166	2,245
1	7	1,951	2,505
1	8	2,152	2,526
1	9	2,109	2,308
1	10	2,232	2,374
1	11	2,206	2,303
1	12	2,170	2,261
2	1	1,951	2,520
2	2	2,145	2,521
2	3	2,097	2,337
2	4	2,235	2,400
2	5	2,191	2,303
2	6	2,154	2,267
2	7	1,959	2,526
2	8	2,137	2,500
2	9	2,093	2,315
2	10	2,260	2,388
2	11	2,180	2,285
2	12	2,148	2,262
3	1	1,954	2,535
3	2	2,127	2,534
3	3	2,085	2,333

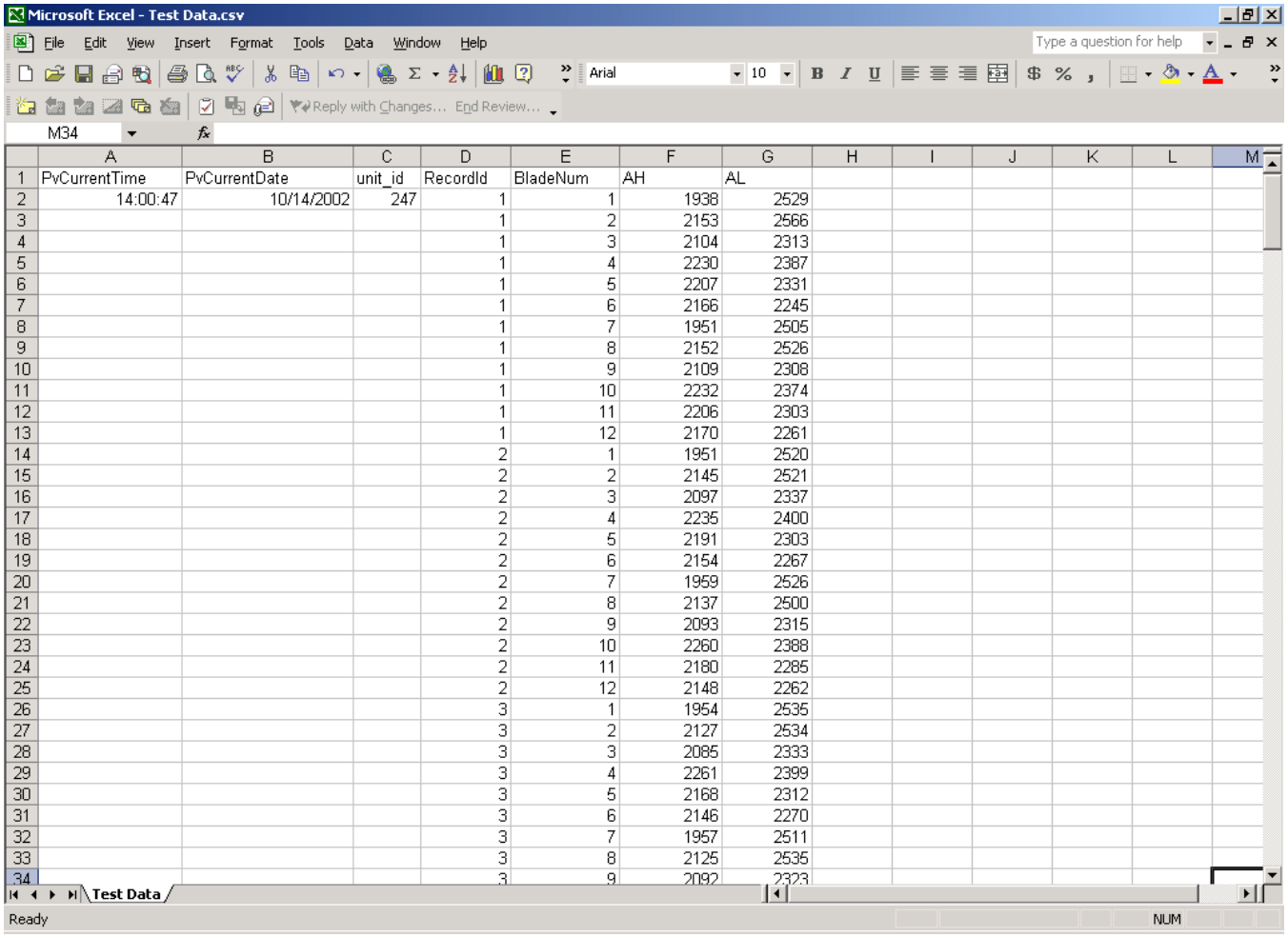
To access the current Test Data screen, select “Test Data” from the Live menu. Click on the “Get Test Data” button to automatically generate up to seven pages of reports. Reports are displayed in order, with the most recent report displayed first.

To Export the test data into a Comma Separated Variable (.csv) file, select File / Export / Report to CSV. The following menu box will appear. Select “Save” after naming the file.



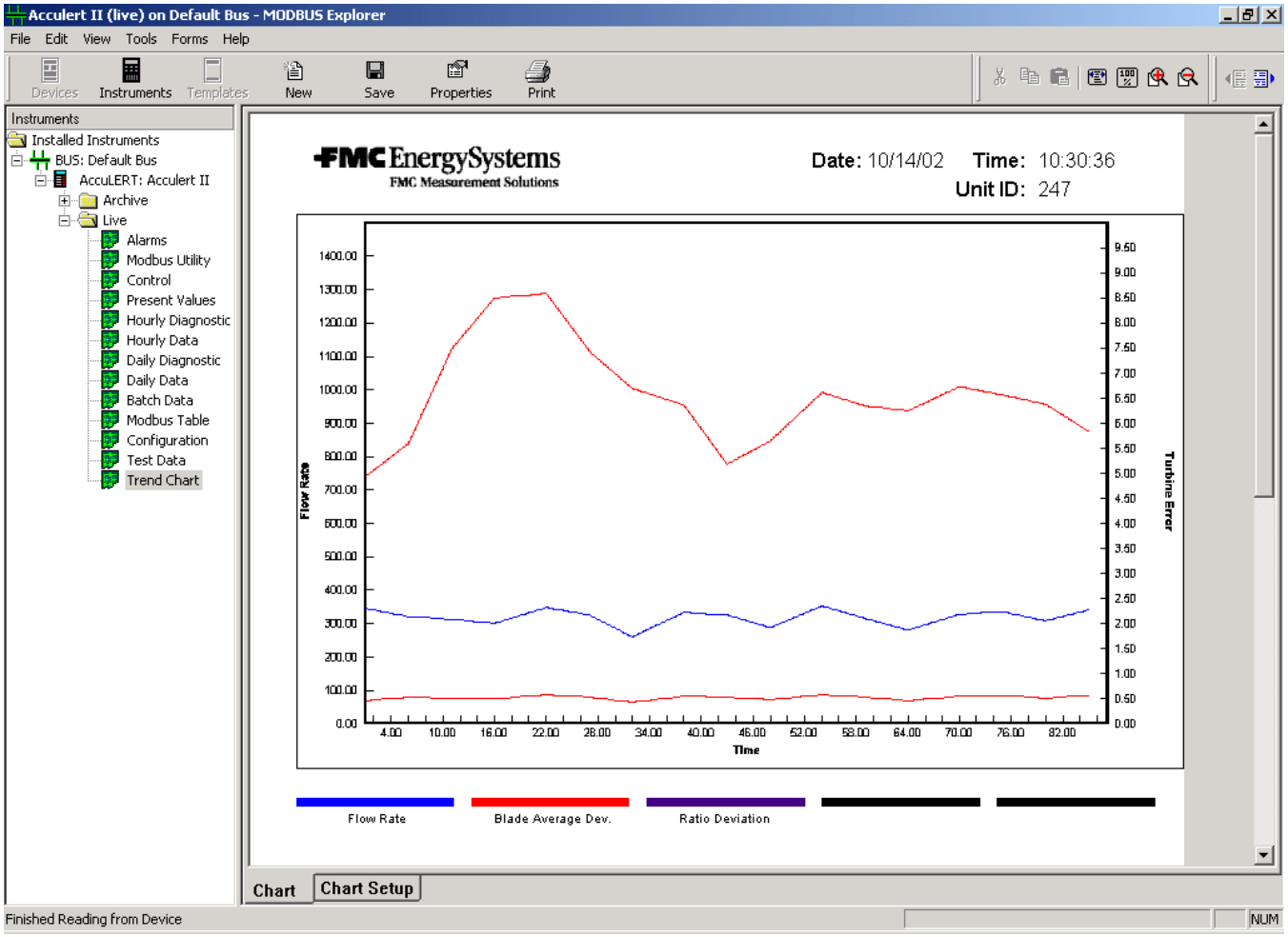
Test Data – Importing into Other Windows-Based Programs

The saved CSV file can then be imported into a spread sheet program such as Microsoft Excel for external data analysis.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	PvCurrentTime	PvCurrentDate	unit_id	RecordId	BladeNum	AH	AL						
2	14:00:47	10/14/2002	247	1	1	1938	2529						
3				1	2	2153	2566						
4				1	3	2104	2313						
5				1	4	2230	2387						
6				1	5	2207	2331						
7				1	6	2166	2245						
8				1	7	1951	2505						
9				1	8	2152	2526						
10				1	9	2109	2308						
11				1	10	2232	2374						
12				1	11	2206	2303						
13				1	12	2170	2261						
14				2	1	1951	2520						
15				2	2	2145	2521						
16				2	3	2097	2337						
17				2	4	2235	2400						
18				2	5	2191	2303						
19				2	6	2154	2267						
20				2	7	1959	2526						
21				2	8	2137	2500						
22				2	9	2093	2315						
23				2	10	2260	2388						
24				2	11	2180	2285						
25				2	12	2148	2262						
26				3	1	1954	2535						
27				3	2	2127	2534						
28				3	3	2085	2333						
29				3	4	2261	2399						
30				3	5	2168	2312						
31				3	6	2146	2270						
32				3	7	1957	2511						
33				3	8	2125	2535						
34				3	9	2092	2323						

Trend Chart



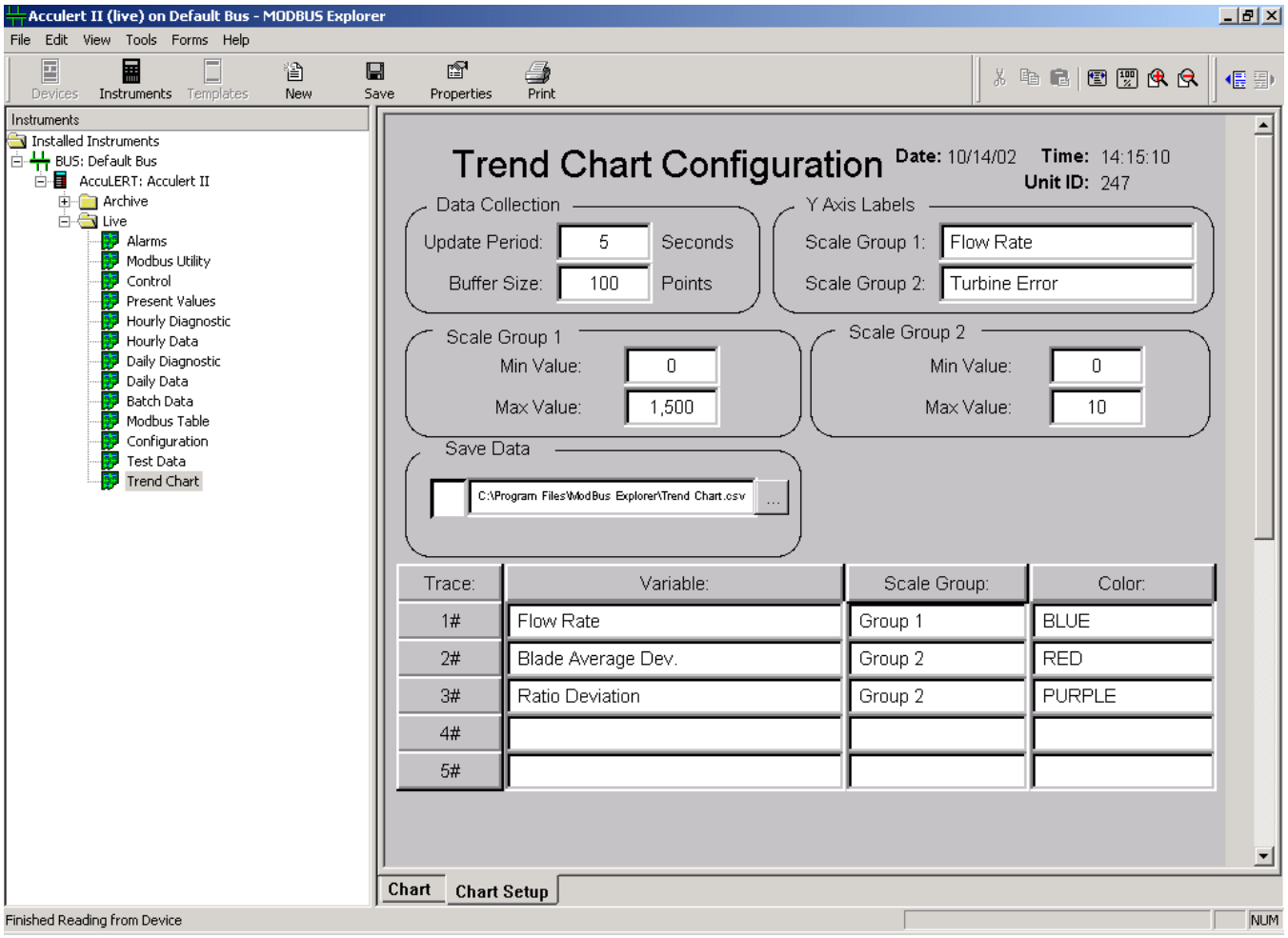
The Trend Chart is used to provide a graphical real time view of the performance of the Turbine Meter.

Variables that can be displayed are as follows:

- Meter Factor
- Flow Rate
- Frequency
- Blade Average Deviation
- Blade Maximum Deviation
- Ratio Deviation
- Integral Deviation
- Bearing Average Deviation
- Bearing Maximum Deviation.

The Trend Chart is configured under the Trend Chart Setup menu.

Trend Chart Setup



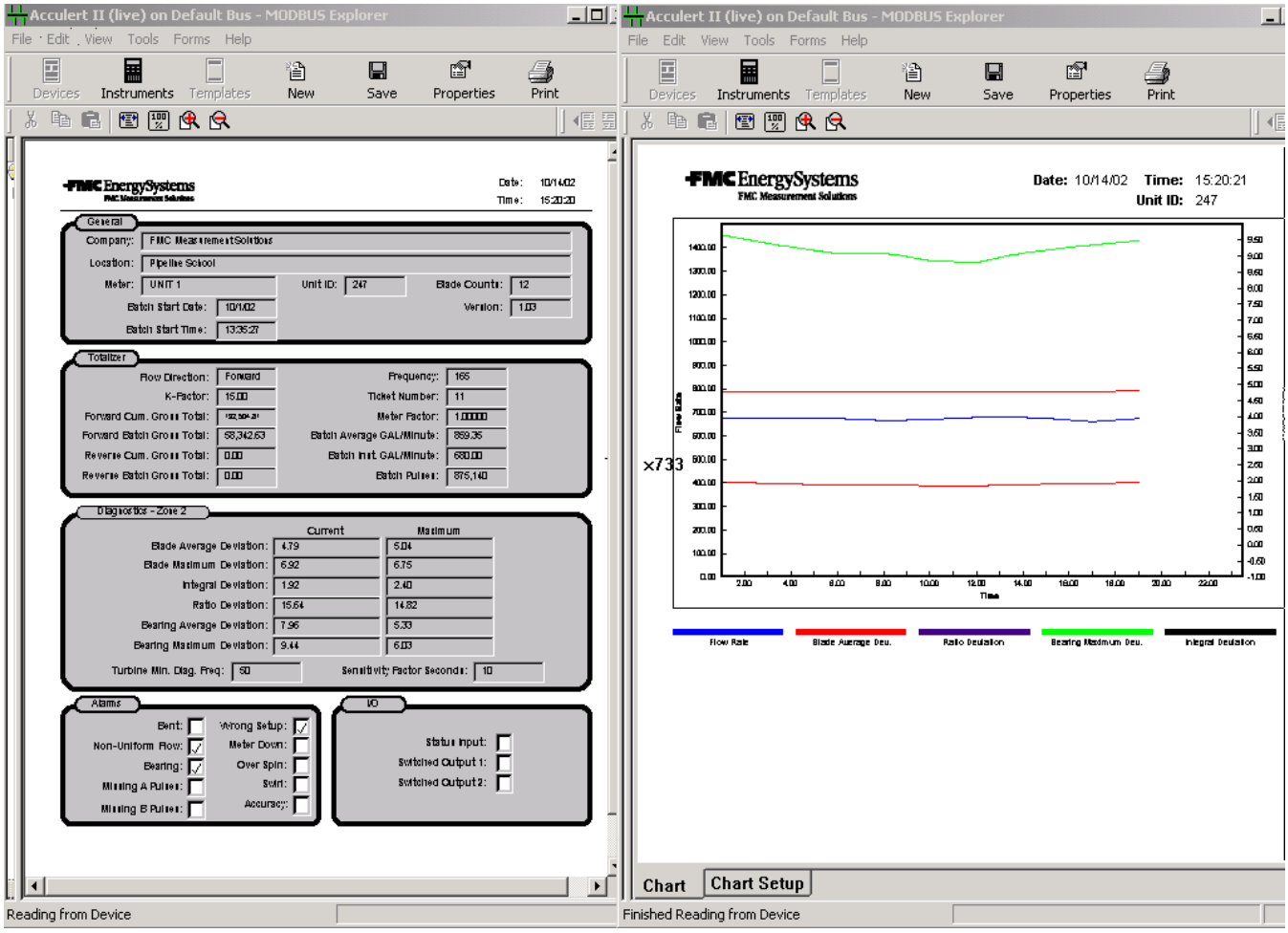
The Trend Chart Setup screen is used to define which variables will be displayed on the trend chart. It is also used to define the colors of the traces, scale group names, scale group association, and minimum and maximum scale group values.

The Trend Chart displays one minute's worth of data at a time on a graphical strip chart. If it is desired to save the Trend Chart Data so it can be imported into other Windows programs such as Microsoft Excel, select the "Save Data" check box and name the file and the storage location. The Trend Chart will automatically be saved in a .csv file.

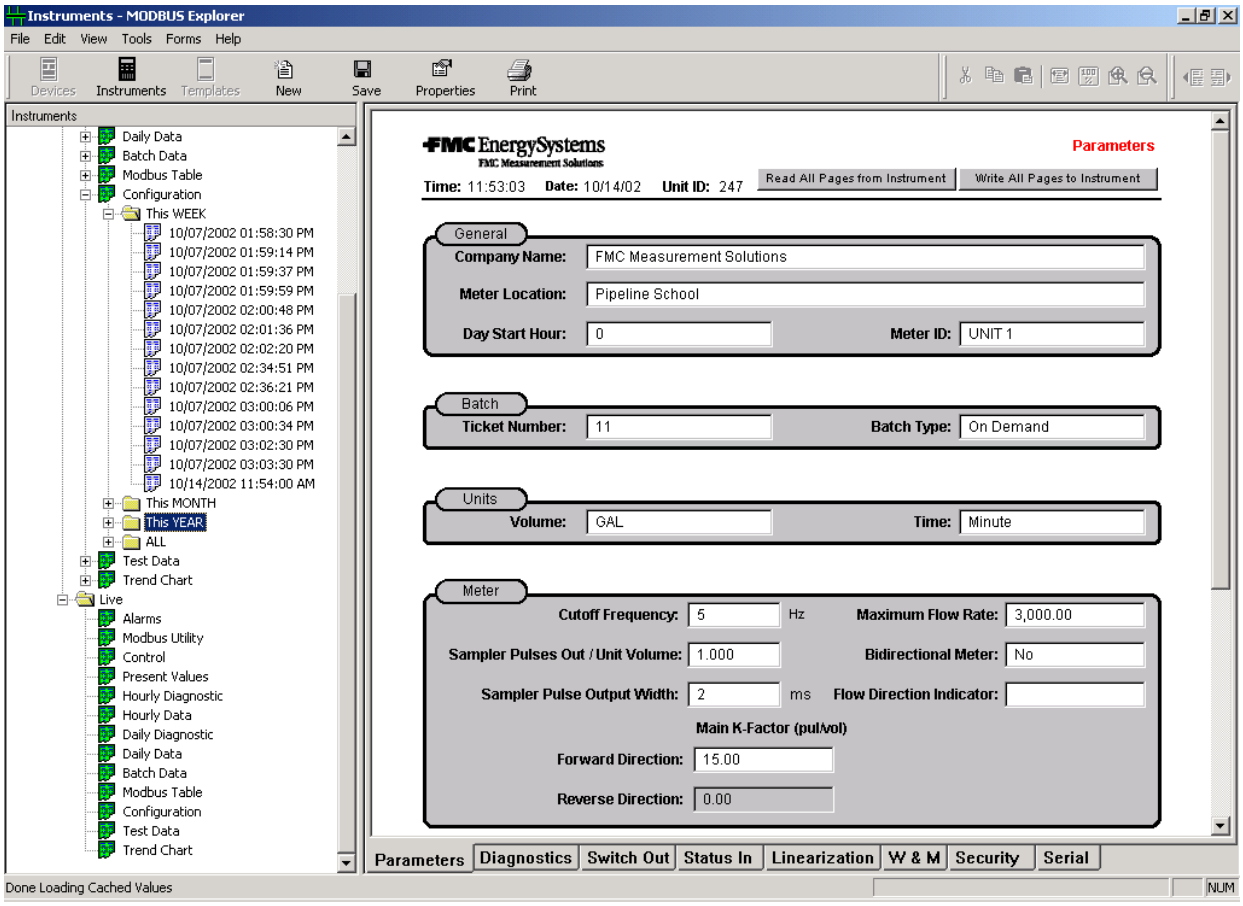
Note: *The Trend Chart Function only operates when the Trend Chart menu is active. If the window is closed, the trend chart will be reset and will not log data. To perform other Modbus Explorer functions or other Window functions, minimize the Trend Chart menu but do not close it. The user then can open another Windows application or another instance of Modbus Explorer.*

Section V – Modbus Explorer Program Menus and Displays

The following is an example of multiple Modbus Explorer windows open in one session. One instance is the Trend Chart and the other instance is the Present Value Screen. By keeping the Trend Chart screen active, the Trend Chart function will continue to plot and save data.

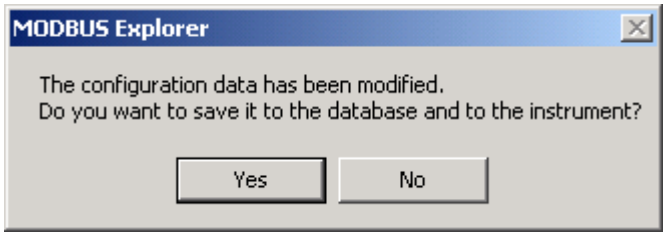


Archived Data



All menu items can be archived into the computer's storage for retrieval at later data. In the example above, the Configuration Data was archived on different dates as shown.

The Archive is initiated when the user exits a particular menu function from the "Live Menu." As shown below, the program prompts the user to indicate if the data should be archived.



If the user selects "Yes," the data (Configuration Settings in this example) will be archived for future use.

This is particularly helpful when referring to a previously stored configuration file. To do so, select the archived "Configuration" settings by double clicking the left mouse button. After the menu opens, right click on the mouse so that the "Copy Form Values" dialog appears, then left click to perform the copy operation. Open the Live "Configuration" menu, then right click the mouse so that the "Paste the Form Values" dialog appears. Left click the mouse to perform the paste operation. This action will paste the data into all Configuration screens; however, to

write the data into the AccuLERT memory, select “Write All Pages to Instrument.” This will download the new settings into the AccuLERT memory, completing the operation.

***Note**: It is recommended that after the “Write All Pages to Instrument” command has been completed, the operator issue the “Read All Pages from Instrument” command. This is done to verify that the stored data is correct.*

Modbus Protocol Information for User-Developed Communications Interface

The AccuLERT implements a variation of the Modbus protocol. The maximum baud rate is 19200. The Modbus protocol specifies one master and up to 247 slaves on a common communication line. Each slave is assigned a unique address from 1 to 247.

Transmission Mode

Two modes of transmission are available (ASCII or RTU).

	ASCII	RTU
Data Bits	7	8
Start Bits	1	1
Parity	Even, Odd	None
Stop Bits	1	1
Error Checking	Checksum	CRC
Baud Rate	1200-19200	1200-19200

ASCII Framing

Framing is accomplished by using a colon character (:) indicating the beginning of frame and a carriage return (CR) or line feed (LF) for the end of frame.

ASCII Message Format

	ADDR	FUNC	DATA	ERR/CHECK		
	2 CHAR	2 CHAR	N*2CHAR	2 CHAR	CR	LF
8 BITS	16 BITS	16 BITS	N*16BIT	16 BITS	8 BITS	8BITS

RTU Framing

Frame synchronization is done by time basis only. The AccuLERT allows 3.5 characters time without new characters coming in before proceeding to process the message and resetting the buffer.

RTU Message

ADDRESS	FUNCTION	DATA	CRC
8 BITS	8 BITS	N*8 BITS	16 BITS

Function Code

These functions are to inform the slave device of what function to perform.

FUNCTION CODE	ACTION
03	READ STRINGS OR MULTIPLE 16-BIT
16	WRITE MULTIPLE 16-BIT VARIABLES

Error Check

LRC Mode

The LRC check is transmitted as two ASCII hexadecimal characters. First, the message has to be stripped of the colon, LF, and CR, and then the Hex ASCII must be converted to binary. Add the binary bits and then twos complement the result.

CRC Mode

The entire message is considered in the CRC mode. The most significant bit is transmitted first. The message is pre-multiplied by 16. The integer quotient digits are ignored and the 16-bit remainder is appended to the message as the two CRC check bytes. The resulting message, including the CRC when divided by the same polynomial (X16 + X15 + X2 + 1) at the receiver, will give a zero remainder if no error has occurred.

Exception Response

An exception response comes from the slave if it finds errors in communication. The slave responds to the master echoing the slave address, function code (with high bit set), exception code and error check. To indicate that the response is notification of an error, the high order bit of the function code is set to 1.

EXCEPTION CODE	DESCRIPTION
01	ILLEGAL FUNCTION
02	ILLEGAL DATA ADDRESS
03	ILLEGAL DATA VALUE
04	DATA CANNOT BE WRITTEN

Modbus Examples

Function Code 03 (Read Single or Multiple Register Points); RTU Read Address 3076

		STARTING POINT		NUMBER OF POINTS		
ADDR	**FUNC CODE**	**HI**	**LO**	**HI**	**LO**	**CRC CHECK**
01	03	0C	04	00	01	C6 9B

RESPONSE

			DATA		
ADDR	**FUNC CODE**	**BYTE COUNT**	**HI**	**LO**	**CRC CHECK**
01	03	02	00	01	79 84

RTU READ ADDRESS 3076-3077

		STARTING POINT		NUM. OF POINTS		
ADDR	**FUNC CODE**	**HI**	**LO**	**HI**	**LO**	**CRC CHECK**
01	03	0C	04	00	02	86 9A

RESPONSE

			DATA		
ADDR	**FUNC CODE**	**BYTE COUNT**	**HI**	**LO**	**CRC CHECK**
01	03	02	00	01	6A 33

Modbus Examples

Function Code 03 (Read Single or Multiple Register Points)

ASCII READ ADDR 3076

		STARTING POINT		NUMBER OF POINTS		
ADDR	**FUNC CODE**	**HI**	**LO**	**HI**	**LO**	**LRC CHECK**
:30 31	30 33	30 43	30 34	30 30	30 31	45 42 CR LF

RESPONSE

			DATA			
ADDR	**FUNC CODE**	**BYTE COUNT**	**HI**	**LO**	**LRC CHECK**	
:30 31	30 33	30 30	30	31	46 39	CRLF

ASCII READ ADDR 3076-3077

		STARTING POINT		NUMBER OF POINTS		
ADDR	**FUNC CODE**	**HI**	**LO**	**HI**	**LO**	**LRC CHECK**
:30 31	30 33	30 43	30 34	30 30	30 32	45 41 CR LF

RESPONSE

			DATA		
ADDR	**FUNC CODE**	**BYTE COUNT**	**HI**	**LO**	**LRC CHECK**
:30 31	30 33	30 34	30 30	30 31	46 36 CRLF

FUNCTION CODE 16 (WRITE SINGLE OR MULTIPLE INTEGERS)
ASCII WRITE ADDR 3097

		STARTING ADDRESS		NUMBER OF POINTS			DATA		
ADDR	FUNC CODE	HI	LO	HI	LO	BYTE COUNT	HI	LO	LRC CHECK
:30 31	31 30	30 43	31 39	30 30	30 31	30 32	30 30	30 43	42 42

RESPONSE

		STARTING ADDRESS		NUMBER OF POINTS		
ADDR	FUNC CODE	HI	LO	HI	LO	LRC CHECK
:30 31	31 30	30 43	31 39	30 30	30 31	43 39

RTU WRITE ADDR 3076

					DATA		
ADDR	FUNC CODE	STARTING ADDRESS	NO. OF POINTS	BYTE COUNT	HI	LO	CRC CHECK
01	10	0C 04	00 01	02	00	01	AA 14

RESPONSE

ADDR	FUNC CODE	STARTING ADDRESS		NO. OF POINTS	CRC CHECK
01	10	0C	04	01	43 58

"Broadcast Command" is supported by the AccuLERT. All units listen to unit ID zero, and none will respond when that write function is broadcast.

Retrieving Alarm History

The Last Alarm Status Request is 3103. This produces a set of 100 alarms, with number 1 being the most recent alarm and number 100 being the oldest alarm. The AccuLERT stores up to fifteen groups of historical alarm data. An alarm is correct only if the alarm ID is a non-zero value. Refer to the table below for Alarm ID and Status codes.

Alarm ID	Status	Alarm ID	Status
Bit 0	0 – Wrong Setup OK 1 – Wrong Setup	Bit 4	0 – Missing A OK 1 – Missing A Pulses
Bit 1	0 – Bent OK 1 – Bent	Bit 5	0 – Missing B OK 1 – Missing B Pulses
Bit 2	0 – Non-Uniform Flow OK 0 – Non-Uniform Flow	Bit 6	0 – Meter Start 1 – Meter Down
Bit 3	0 – Bearing OK 1 – Bearing	Bit 7	0 – Over Spin OK 1 – Over Spin

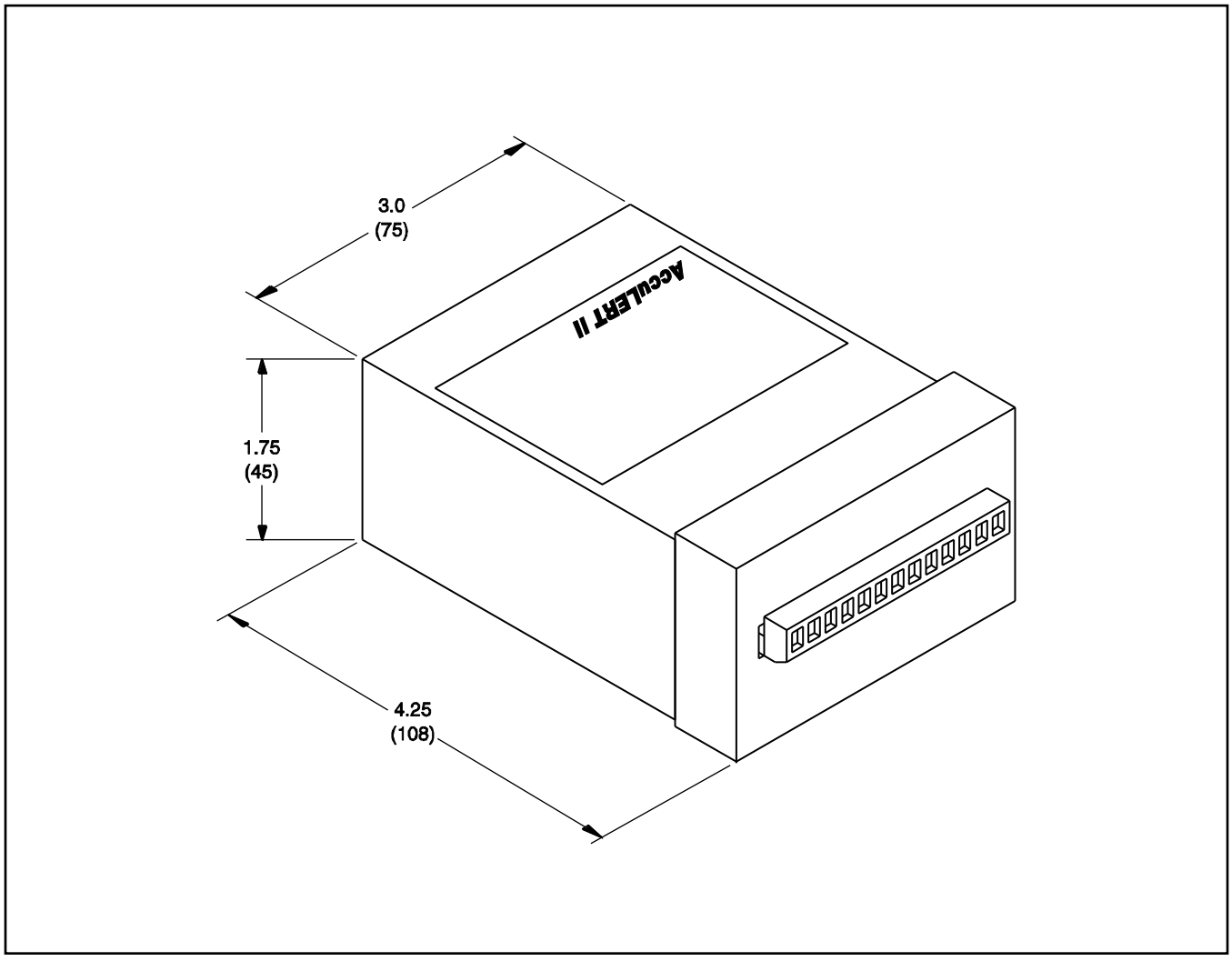


Figure 1. General Purpose Housing Dimensional Outline

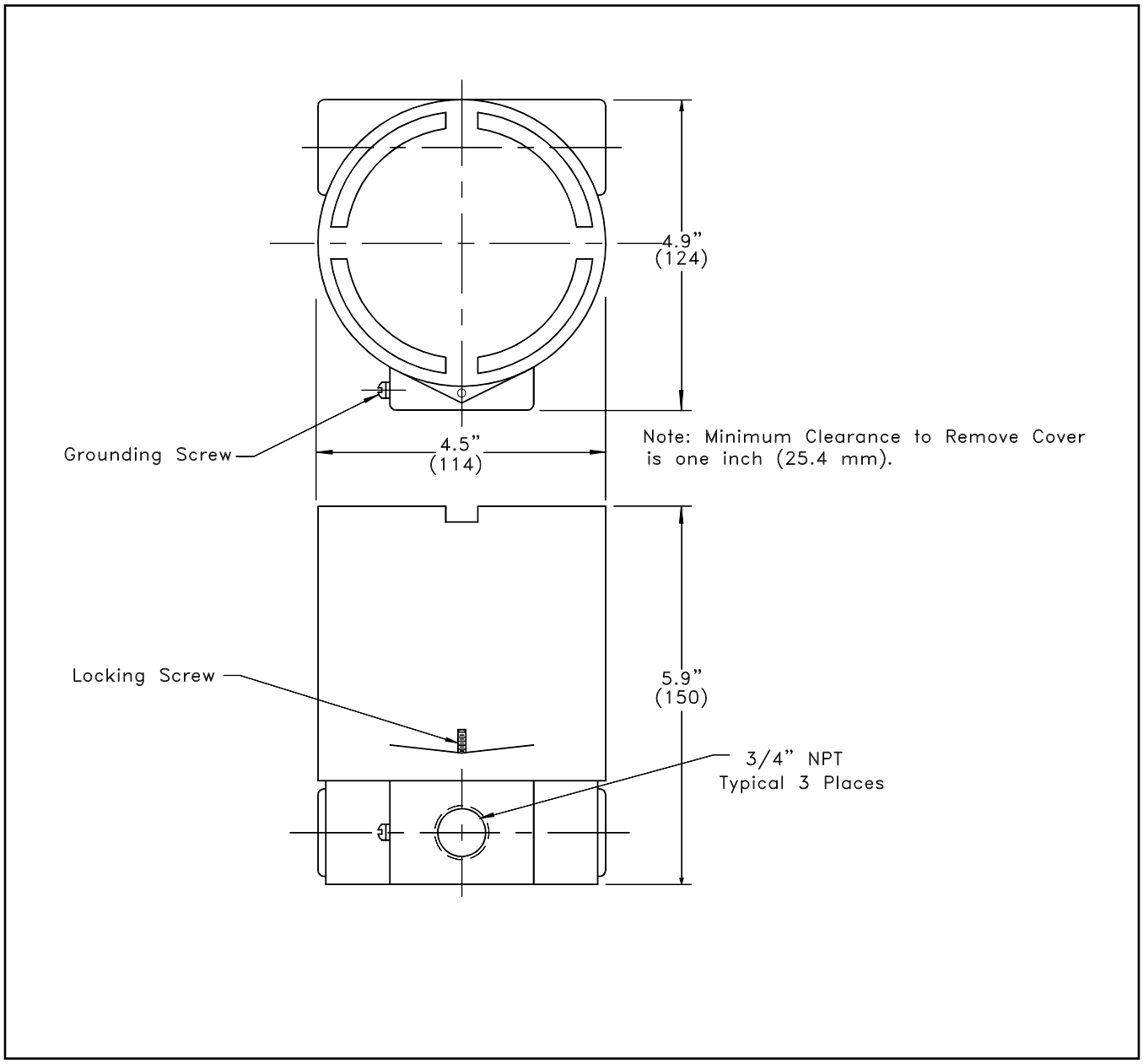
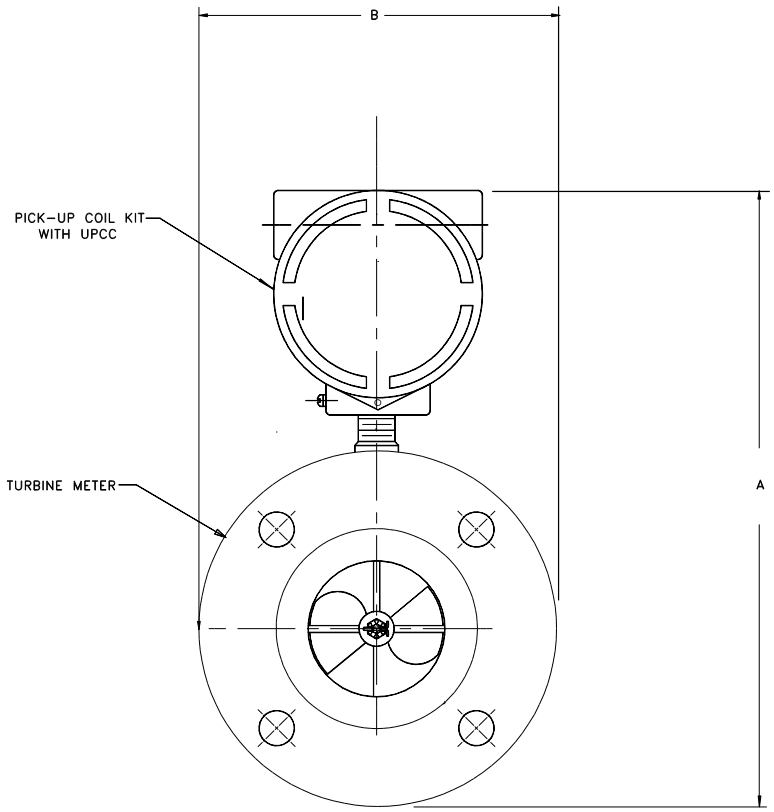


Figure 2. Explosion Proof Housing Dimensions



Size	3”	4”	6”	8”	10”	12”	16”
A	14.4 (366)	15.8 (401)	17.9 (455)	20.2 (513)	22.5 (572)	25.0 (635)	28.9 (734)
B	7.5 (191)	9.0 (228)	11.0 (279)	13.5 (343)	16.0 (406)	19.0 (483)	23.5 (597)

Figure 3. AccuLERT Factory Mounted Envelope Dimensions for 150# Flanged Meters with Dual Pickup Coil

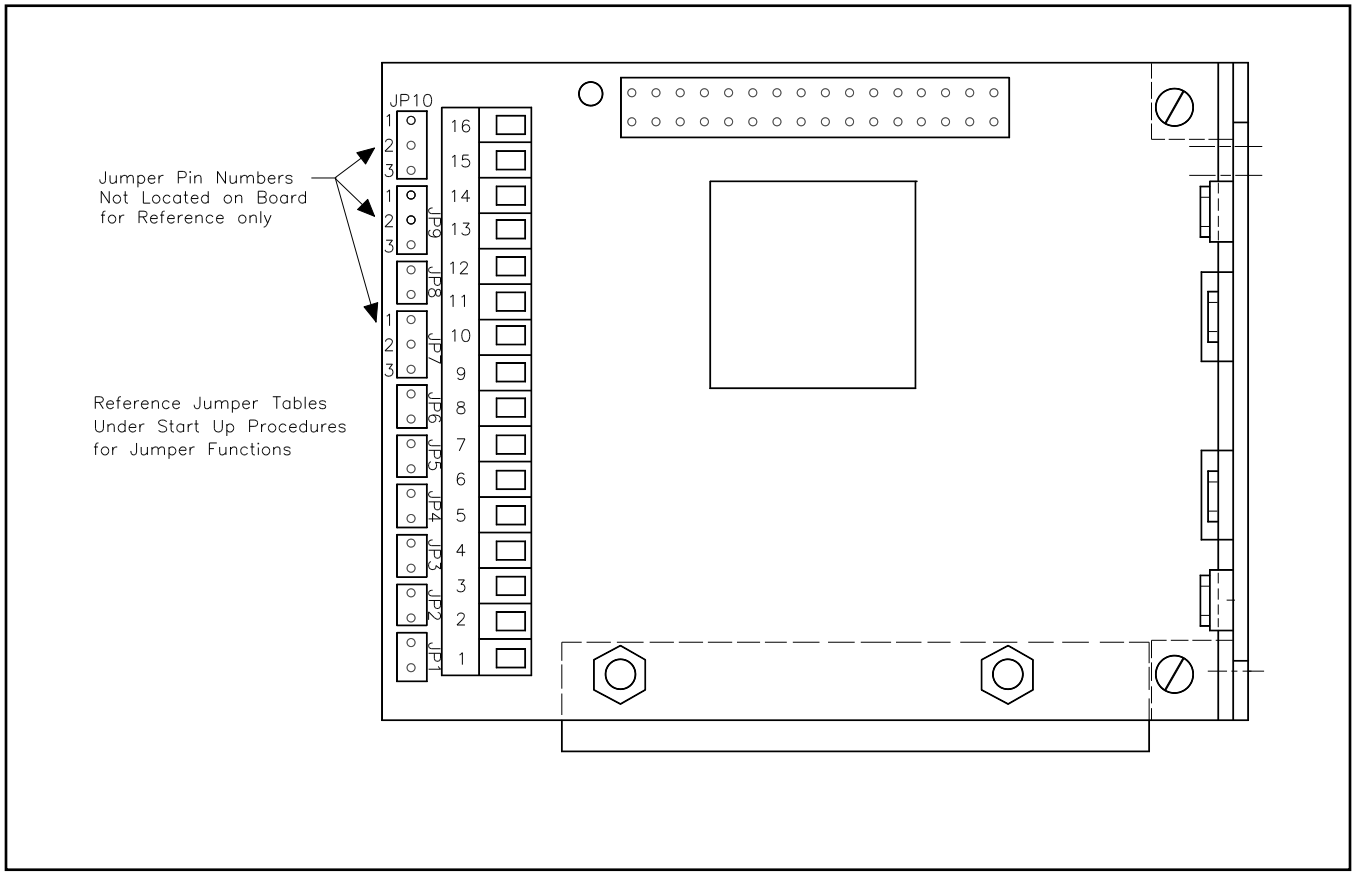


Figure 3. Jumper Locations (Revision 2 Artwork and Lower PC Boards)

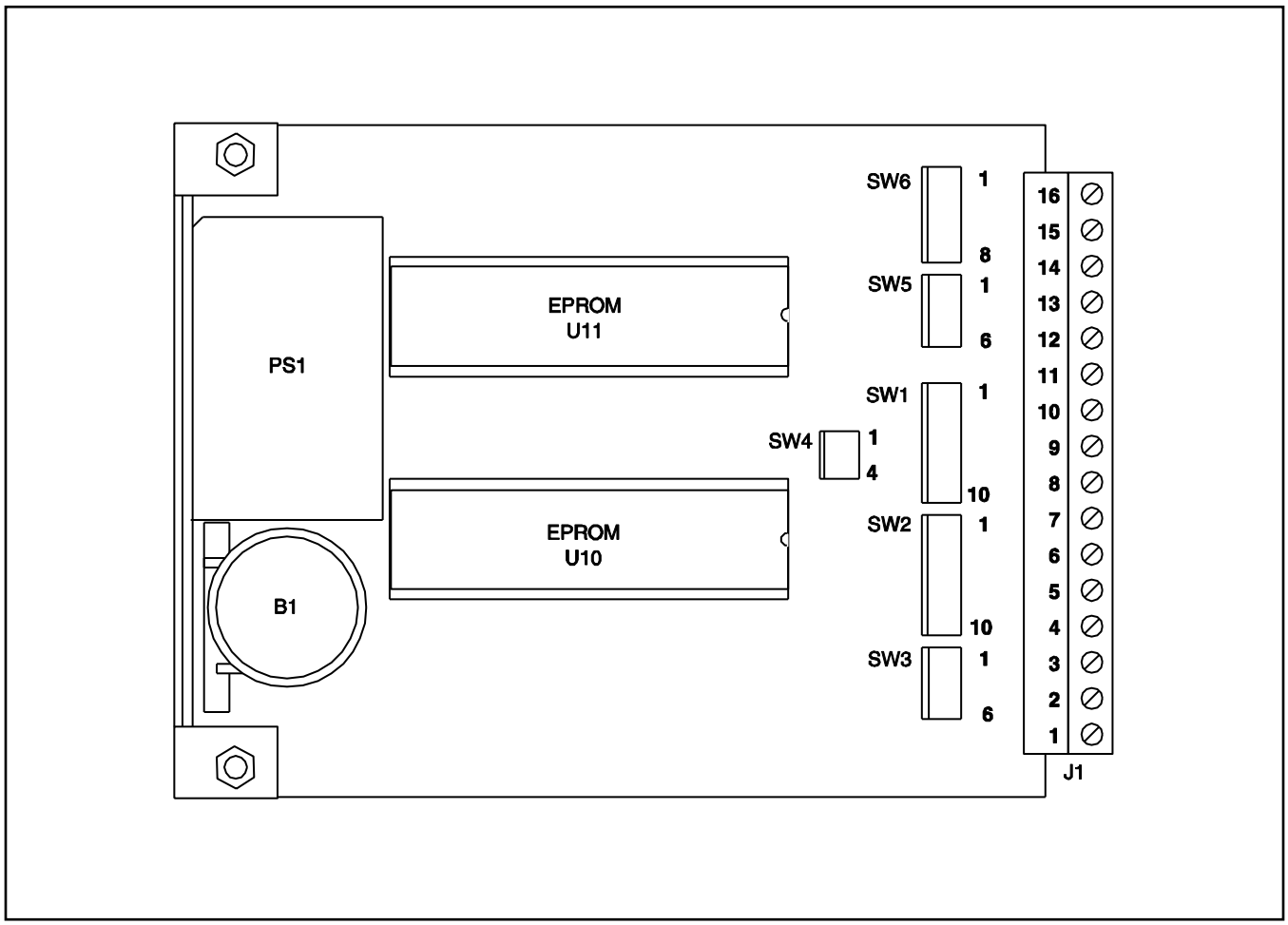


Figure 4. Switch Locations (Revision 3 Artwork)

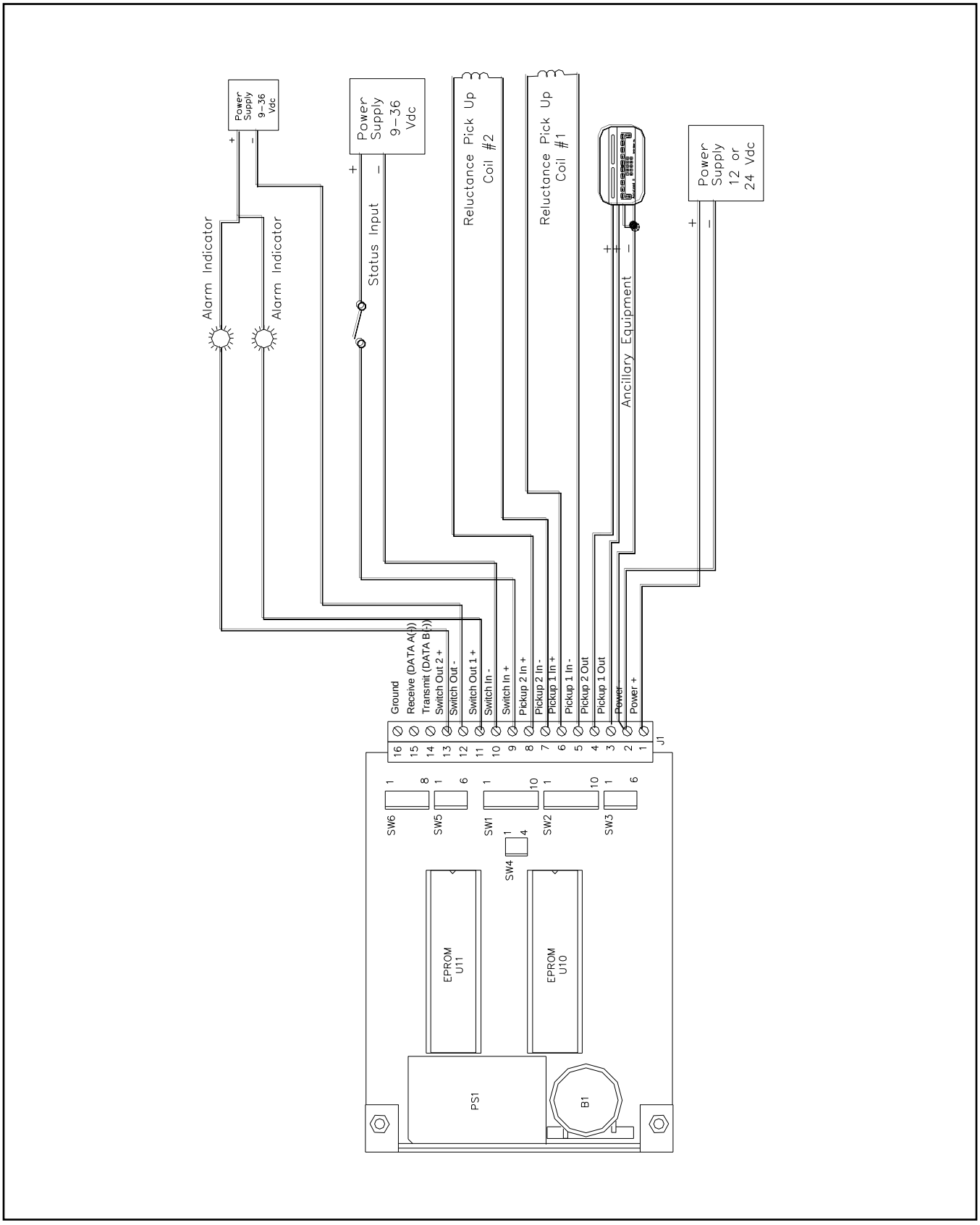


Figure 5. AccuLERT Typical System Wiring

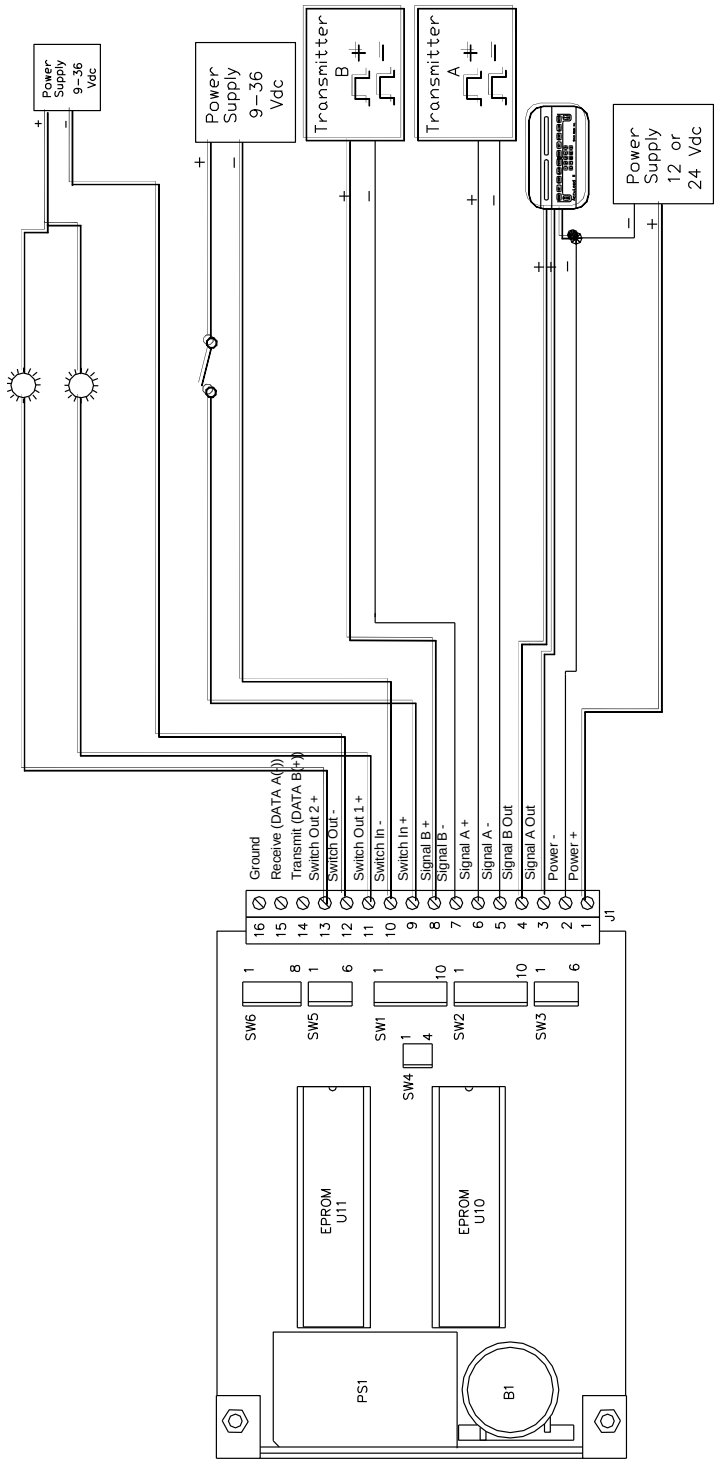


Figure 6. AccuLERT Typical Wiring with Square Wave Input

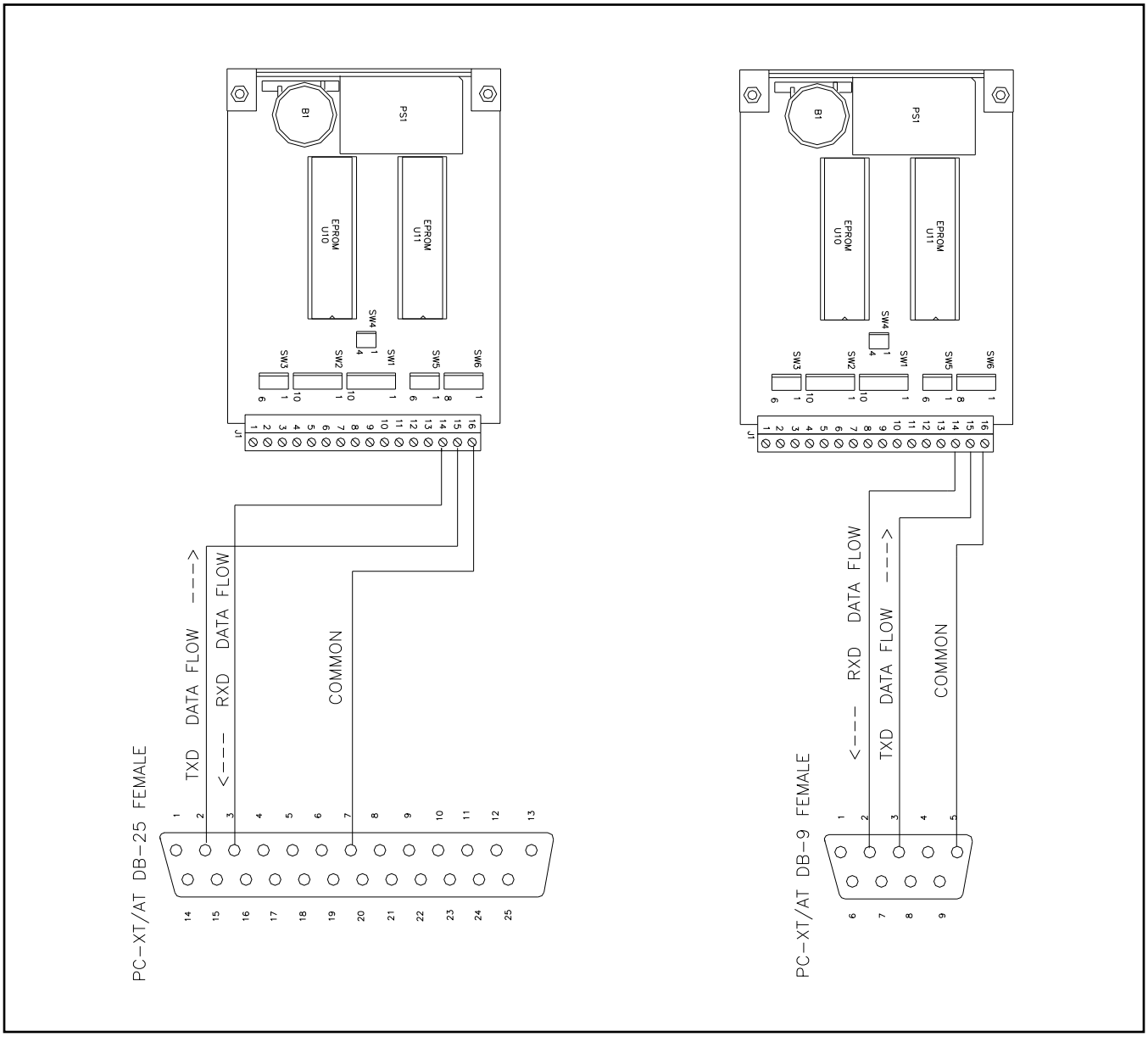


Figure 7. AccuLERT RS-232 Communications Wiring

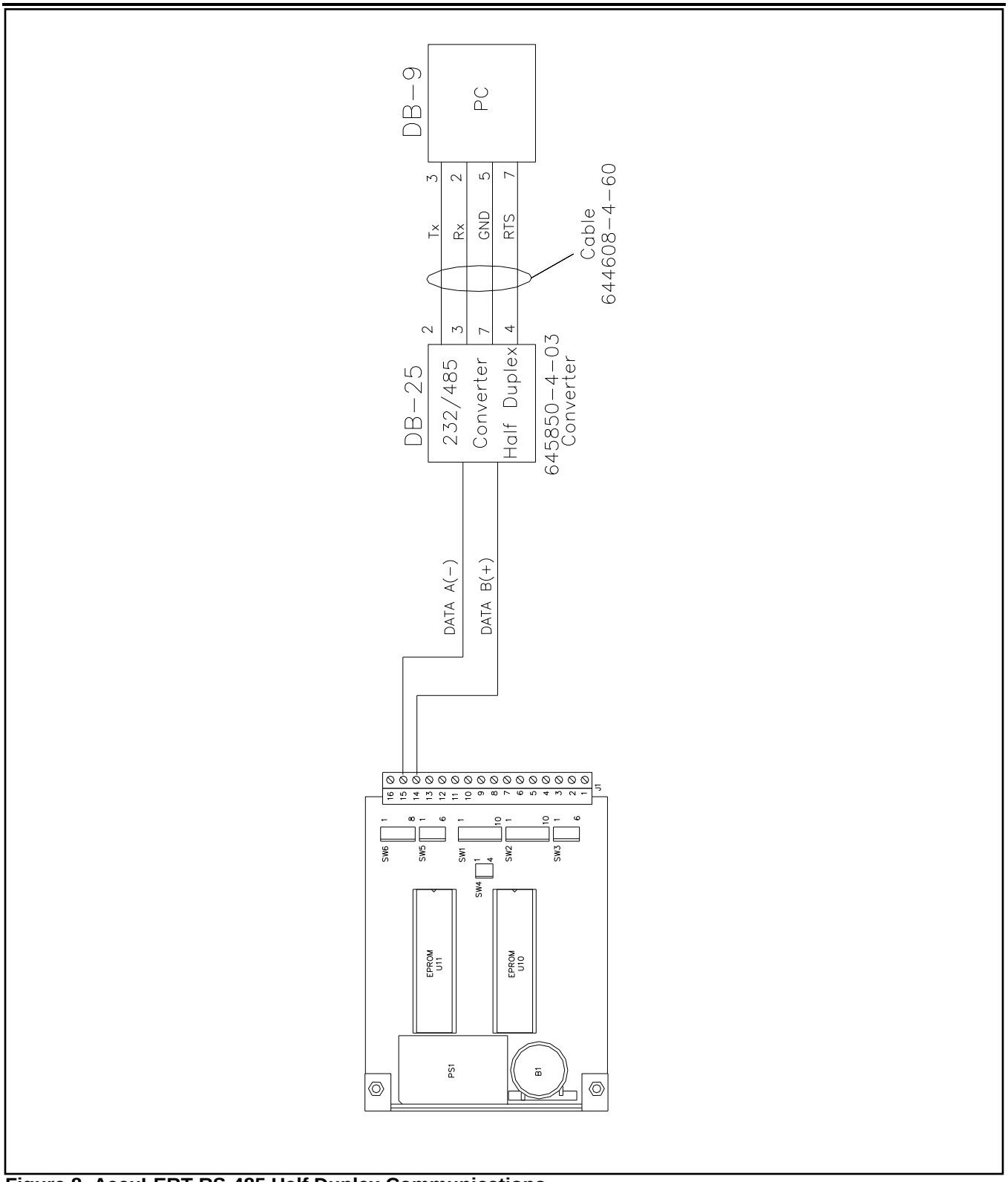


Figure 8. AccuLERT RS-485 Half Duplex Communications

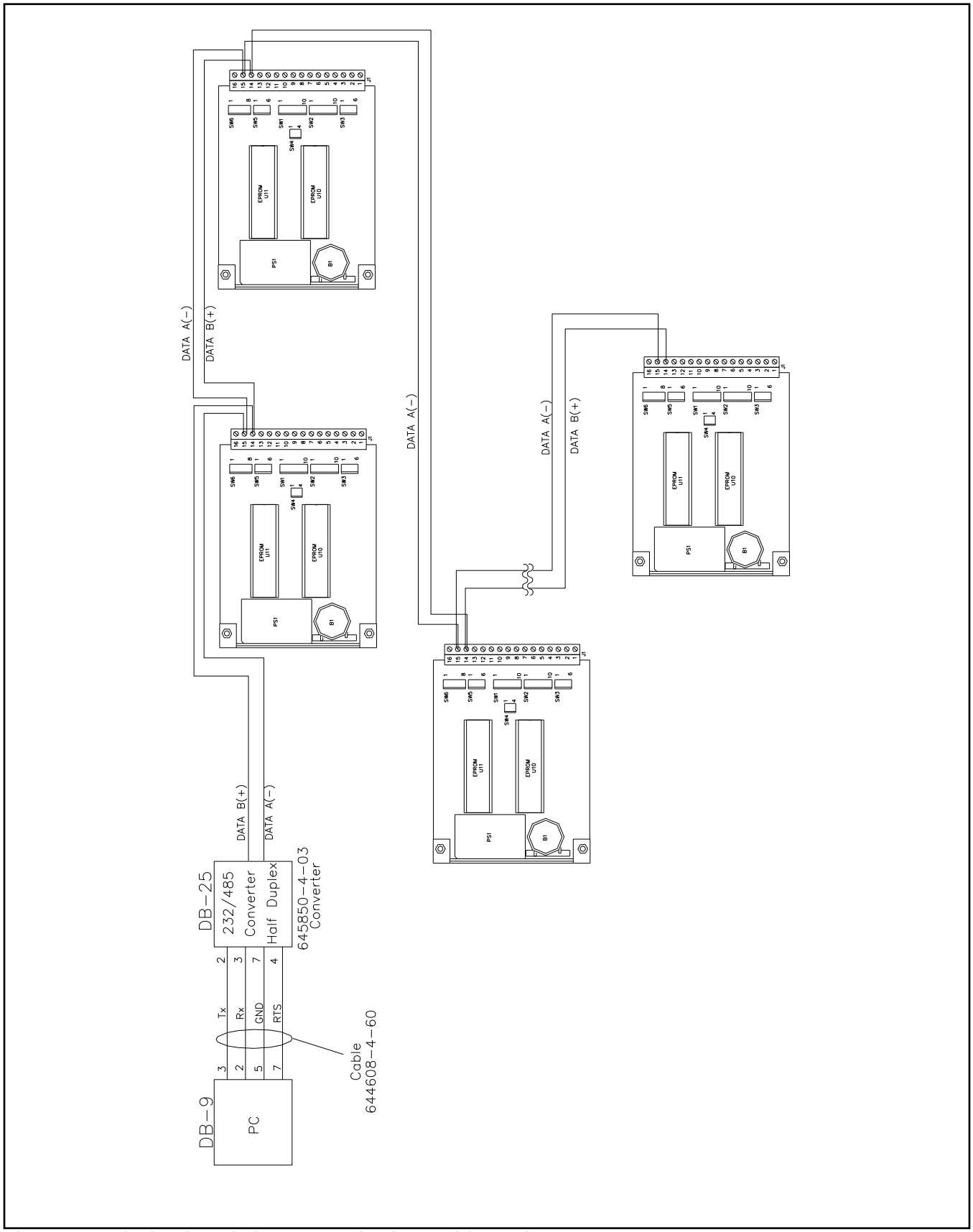


Figure 9. Typical Daisy Chain Communications Wiring Scheme

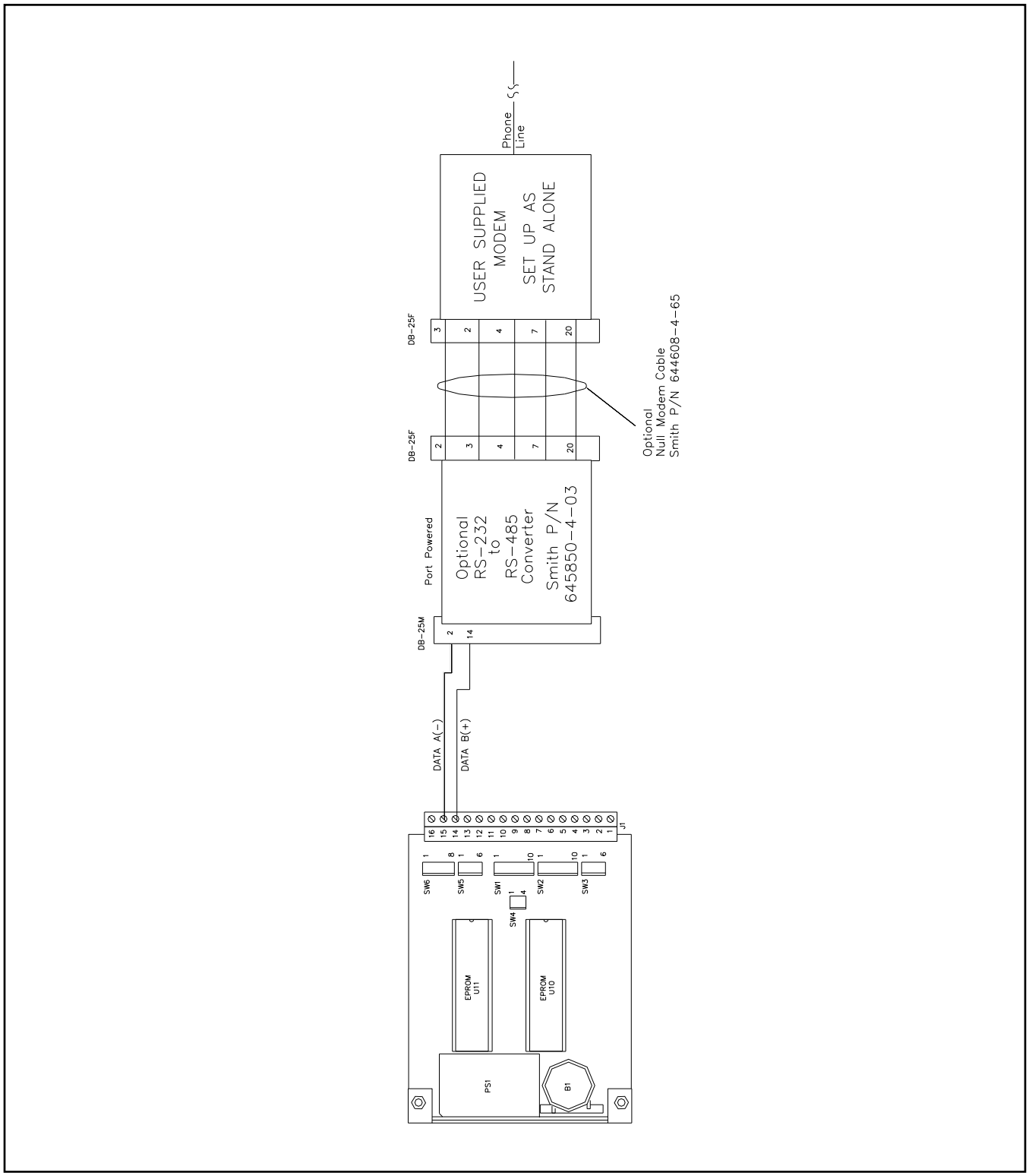


Figure 10. AccuLERT RS-485 Half Duplex Communications with Modem

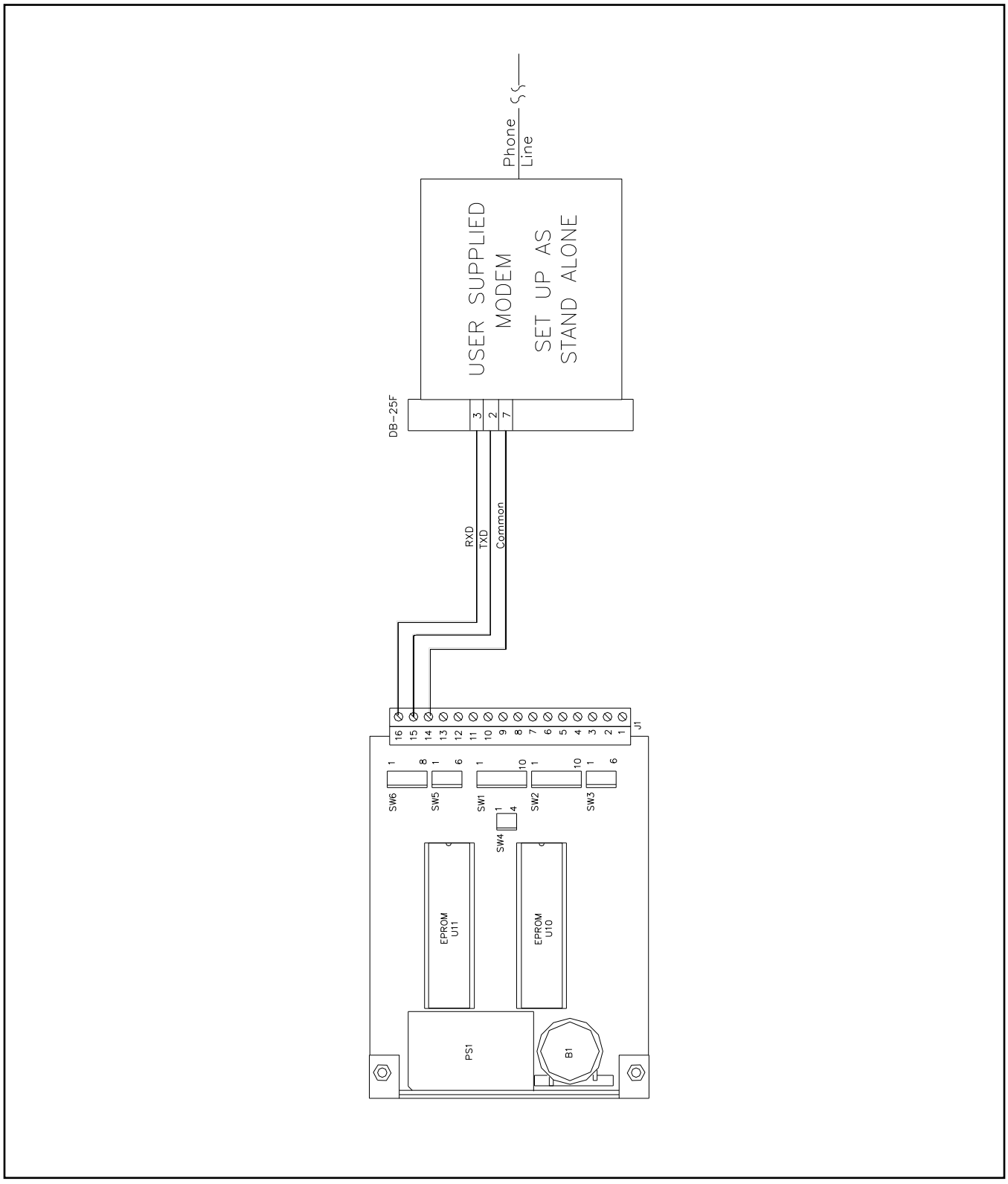


Figure 11. AccuLERT RS-232 Communications with Modem

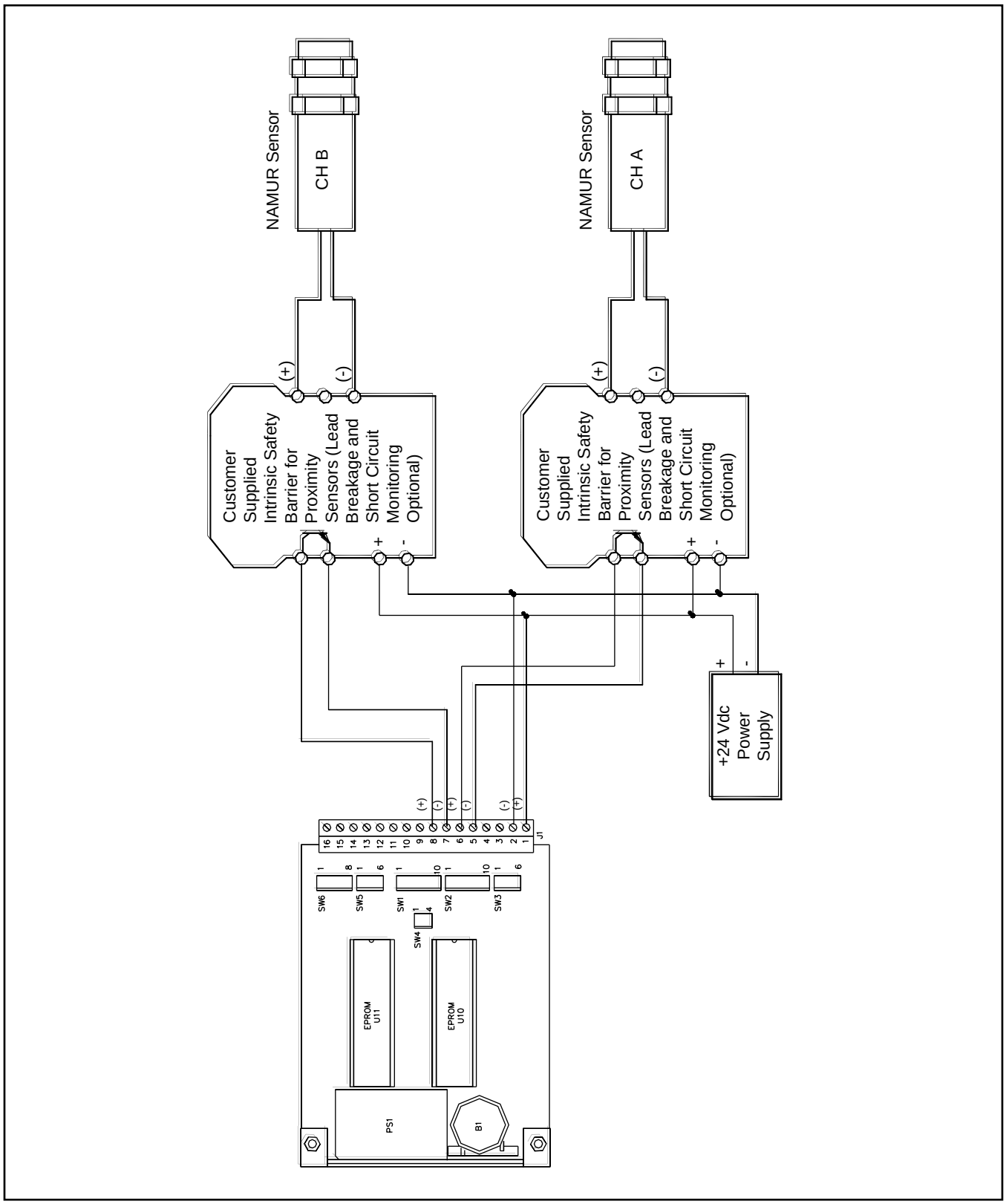


Figure 12. Intrinsic Safe Connections Using an Intrinsic Safe Barrier

Section VIII – Related Publications

The following literature can be obtained from TechnipFMC Measurement and Production Solutions Literature Fulfillment at measurement.fulfillment.com or online at http://info.smithmeter.com/literature/online_index.html

When requesting literature from Literature Fulfillment, please reference the appropriate bulletin number and title.

AccuLERT II ID 2000

Installation/Operation .....Bulletin MN02008

Technical Support

Contact Information:
Field Service Response Center
24/7 Technical Support/Schedule
a Technician: 1-844-798-3819
System Installation Supervision,
Start-Up, Commissioning Services,
and Training Available

Revisions included in MN02008 Issue/Rev. 0.2 (4/06):
Updated the Amplifier Gain Switch Settings.

TechnipFMC.com

TechnipFMC
13460 Lockwood Road
Building S01
Houston, Texas 77044 USA
P:+1 281.591.4000

USA Operation
1602 Wagner Avenue
Erie, Pennsylvania 16510 USA
P:+1 814.898.5000

Germany Operation
Smith Meter GmbH
Regentstrasse 1
25474 Ellerbek, Germany
P:+49 4101 304.0