

Kodai Flow Research User Manual:
Digital Communication with CRE1 Transmitter
Document KFR.MN02.V2
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Disclaimer:

Use of this product is at the users own risk. No liability is implied except for the value of the measurement system. Every effort has been made to ensure the equipment is designed to meet required standards in safety, emissions, and susceptibility, however it is left to the user to insure no interference with other equipment exists, and that the installation complies with codes and regulations.

Please read KFR.MN01 CRE1 Wiring and Installation Requirements before proceeding.

Introduction

The CRE1 Ultrasonic Flow Transmitter is a blind device. For compact size and minimal power, it does not have an integrated keypad or display. It is designed be installed internally in skids and tools. To display data, system diagnostics, or configure the transmitter, the device uses a CRC16 RTU protocol on a RS485 bus or CANBus. The data can be read by any PLC, HDMI, or Panel using a compact 64 Byte message. The system data can also be displayed using an application on a OTG tablet or laptop for set up or troubleshooting.

RS485 Hardware Requirements

The CRE1 uses an industry standard two-wire RS485 bus; A+, B- (also termed DATA+, DATA-). A port is provided for an optional common (ground). It is the user responsibility to keep the bus voltage mid-point with in 10 volts of the isolated common, and with in 24 volts of protective ground (EARTH). Depending on number of instruments on the bus or the length of the bus bias voltage or terminating resistors may be required. The isolation limits also apply to the optional CANBus hardware.

Message Frame

Regardless of RS485 or CAN physical layer, the communication uses a host command / satellite response methodology. The frame for both command and response is the same. A message of length N in bytes is wrapped in a **header** and **footer** as follows:

Byte	
0	Instrument Address (1-32)
1	Command
2	Message Size + 6
3	Reserved
4	Message First Byte
...	...
....
N+3	Message First Byte
N+4	Low Byte of Message CRC
N+5	High Byte of Message CRC

Table 1. Structure for a Modbus Command or Receive Packet

The CRC stands for *Cyclic Redundancy Check*. It is a mathematical algorithm that creates a unique 16-bit number from the binary array of the header and the message. If even one bit of the message is contaminated in the transmission, this value will not match the value calculated when the message is received. Example C code for calculating the CRC-16 is included in the index.

When an instrument responds to a command from the host, it will echo the Address and Command value in the response header as a verification.

Polling Address

All instruments will respond to a command sent with the address of 42. This is the default address in an instrument prior to being installed in a network. **Never use the polling address with multiple instruments on the data bus.** Only use when other instruments are removed from the bus or powered off. The polling address is used to assign an address to an instrument or to determine the address of an instrument. The device will respond to a command directed to the poll address but it will echo its assigned address.

Flow Data Request

To query the flow data from a smart transmitter, the host sends the following message.

Byte	Value	Description
0	MODBUS ID	Address of Instrument (1 to 32 or 42)
1	32	Command to Send Flow Data
2	8	Message Size
3	0	Reserved, must be zero
4	1	Channel number, always 1 for CRE1
5	0 or 1	Non zero clears the batch totals
6	16 Bit CRC	CRC calculated from first 6 bytes of the message
7		

Table 2. Message Structure for Flow Data Host Request

The values in table are loaded into an 8-bit wide byte array. This array is then read into the serial output, byte(0) first.

The flow transmitter will respond with a 48 byte message. Table 3 is the structure of this message. For multi-byte variables, they are transmitted lowest byte first. All values are sent in MKS units.

Byte	Value	Size	Description
0	MODBUS ID	1 Byte	Address Echo
1	32	1 Byte	Command Echo
2	44	1 Byte	Message Size
3	0	1 Byte	Reserved
4	1	1 Byte	Channel Echo
5	0 through 6	1 Byte	Error Code, 0 = No Error
6	Flow Rate	4 Byte	Flow Rate, 32 bit floating point, m^3/s
10	Mass Flow Rate	4 Byte	Mass Rate, 32 bit floating point, kg/s
14	Batch Time	4 Byte	Time Since Batch Reset, 32 bit floating point, s
18	Volume Total	4 Byte	Accumulated Volume, 32 bit floating point, m^3
22	Mass Total	4 Byte	Accumulated Mass, 32 bit floating point, kg
26	Fluid Velocity of Sound	4 Byte	Temperature, 32 bit floating point, K
30	Fluid Viscosity	4 Byte	Kinematic Viscosity 32 bit floating point, $cStokes$
34	Pulsation	2 Byte	Pulsation, 16-bit integer, % of Flow * 10
36	Fluid Temperature	4 Byte	Temperature, 32 bit floating point, K
40	Particle Size	2 Byte	Particle or Void Size, 16-bit integer, micron
42	Particle loading	2 Byte	Fraction of Volume, 16-bit integer, % * 10
44	Acoustic Loss	2 Byte	Transmission Loss, 16-bit integer, dB * 10
46	CRC	2 Byte	Cyclic Redundancy Check, unsign 16-bit integer

Table 3. Transmitter Response to Flow Data Host Request

Modbus Terminal Application

KFR provides a group of applications to communicate with the transmitter, plot data, trouble shoot, and change the configurations. There are versions for both Windows and Linux.

Installing Serial Port Adapter

While industrial panel PC and SBC usually come with serial ports already installed, commercial laptops and tablets only have a central USB hub, from which auxiliary ports must be added. Tablets and other handhelds must be OTG compatible. It is recommended that an OTG adapter is used that has a charging port, so the serial port adapter does not have to be removed to charge the device. Figure 1 is an a picture of a commercially available adapter. Always connect the tablet to power before connecting the serial port adapter for proper charging.

There are many brands of USB to RS485 adapters. The FTDI chip-set is the most common and drivers are already installed for Linux devices. For Window systems, the drivers must be installed before connecting the adapter to the USB port for the first time. Links to most common serial adapters can be found at <https://kodaiflow.com/softpine.html> Decompress the downloaded object and execute the file to install the driver.



Figure 1. OTG Adapter with Power Input Port

Installing the Modbus Terminal Application

For Windows operating system, download the latest version of software from the secure link at Kodai Flow website or use the file provided with the transmitter.

Unzip the package then run the Install Shield utility “CRE_SETUPV4.1.exe” or higher version. If updating versions, use uninstall utility to remove the old software first. Locate the program files as desired. A desktop icon will be created automatically.

For Linux, please contact customer support with your distribution for specific and installation instructions.

Communication Options

If a Windows computer has only 1 serial port installed the application will automatically select it. If the computer has no serial port installed an error will be issued on startup. If the computer has multiple ports, or there is more than one instrument on the network, select COMM as shown in Figure 2

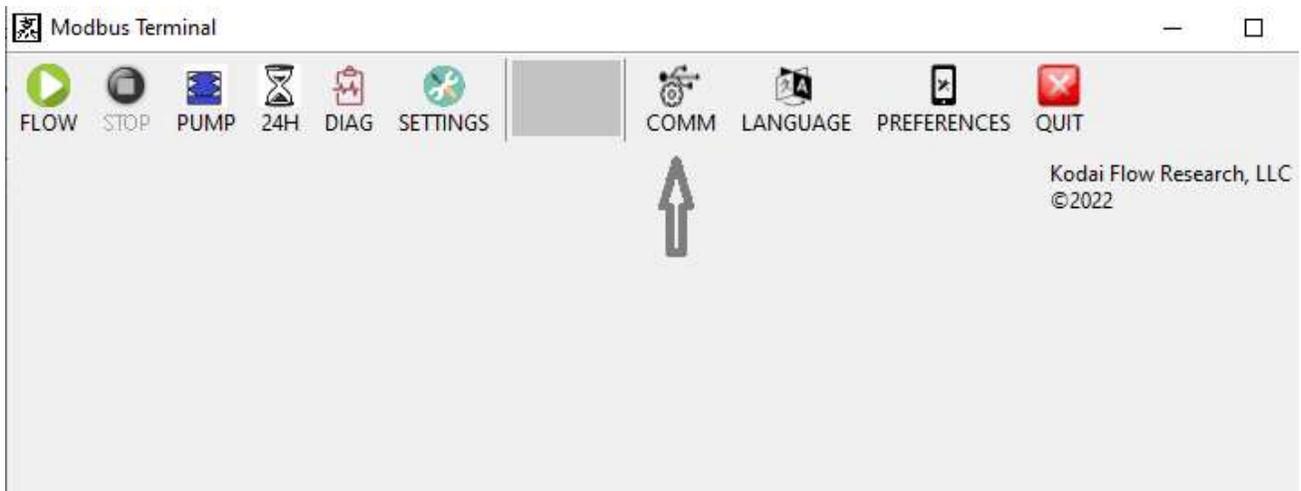


Figure 2. - Menu Block For Selecting Communication Setting

A pop-up screen will show all the available ports. If there is only one meter connected to the Modbus, the meter address can be left as POLL, otherwise select the address of the meter you wish to communicate; as shown in Figure 3.

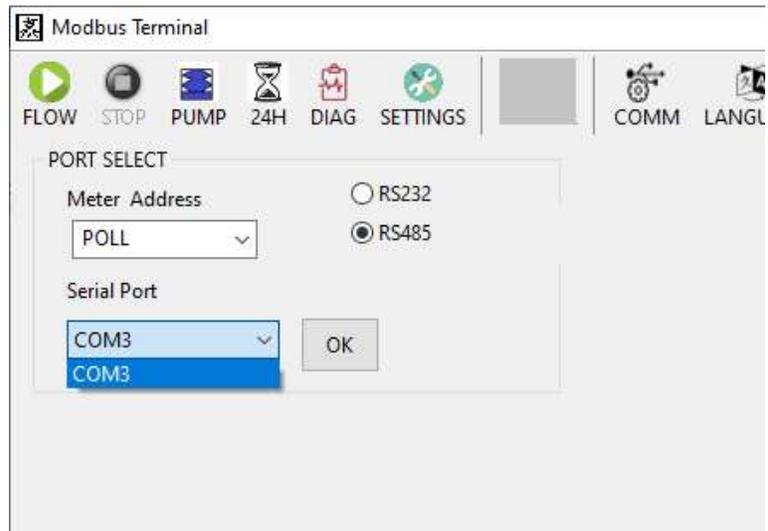


Figure 3. Select Serial Port and Modbus Address

There are also options for selecting display language, and display preferences. Figure 4 shows the menus for selecting units, data to be plotted and plot ranges.

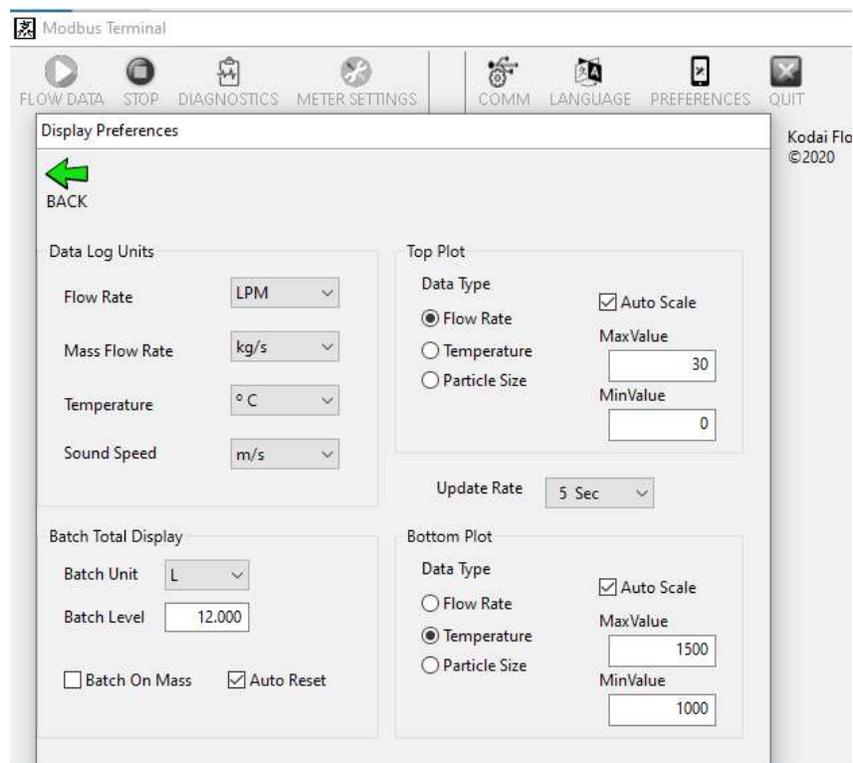


Figure 4. Display and Graphical Preferences

The transmitter calculates not only the average flow rate but the total that has been accumulated. In the graphical display, this is represented as a tank. Select the batch level if you wish to show the tank fill as a batch operation is completed.

The Terminal Display

Once the preferences are set, the terminal is ready to be used. Select “FLOW ” to read all the flow data from the instrument. Figure 5 shows the data from the Modbus message described in Table 3. The Meter ID of 42 is returned when the transmitter has not yet been assigned a network ID (Poll Mode).

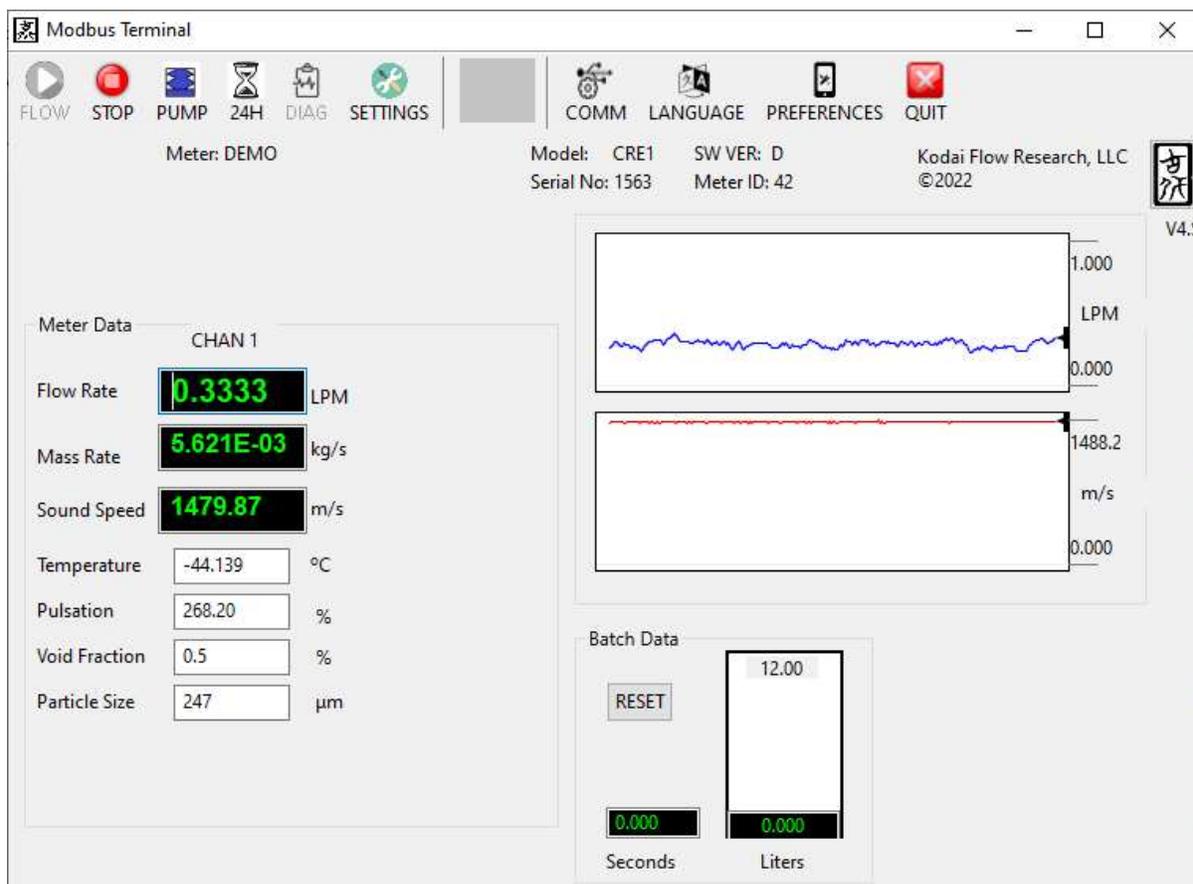


Figure 5. Numeric and Graphical Display of Transmitter Data.

The left side of the screen displays the flow rate and other derived measurement. The transmitter measures the flow rate and velocity of sound of the fluid in the pipe directly. The density and temperature are derived from an equation of state and the velocity of sound. This requires that the correct fluid was selected in the transmitter setup. The transmitter uses forward scattering of the ultrasonic pulse to estimate the size of bubbles or particles and the concentration of the entrained matter.

The right side of the screen contains graphical display of the data. The scale and data-type displayed can be changed in the **PREFERENCES** menu. This is where different units can be selected.

The lower section displays batch information. The transmitter calculates the total volume to flow through the meter. This function is disabled if the TOTAL logic input is pulled low. The total value can be cleared either through a modbus command or by pulling the CLEAR logic input low. These are used for calibration and proving, but also allow the user to do batching and tank filling with out needing a dedicated PLC.

The Diagnostics Display

Selecting DIAG will bring up a screen with all get the internal statistics on the operation of the transmitter. Select save option to down load the data to a ASCII file that can be read by a spreadsheet program. Figure 6 is an example if the data displayed. This screen is useful when developing a new application or solving problems with equipment in the fluid handling system. A transit time flow meter works by sending pulses of ultrasound through the fluid. In the diagnostic mode, the transmitter acts as an oscilloscope and displays the raw ultrasonic signal. The upstream signal is shown in red and the downstream in blue. The point that is scored as the arrival time of the pulse is marked with a green vertical line. Definitions of each parameter is summarized in Table 1.

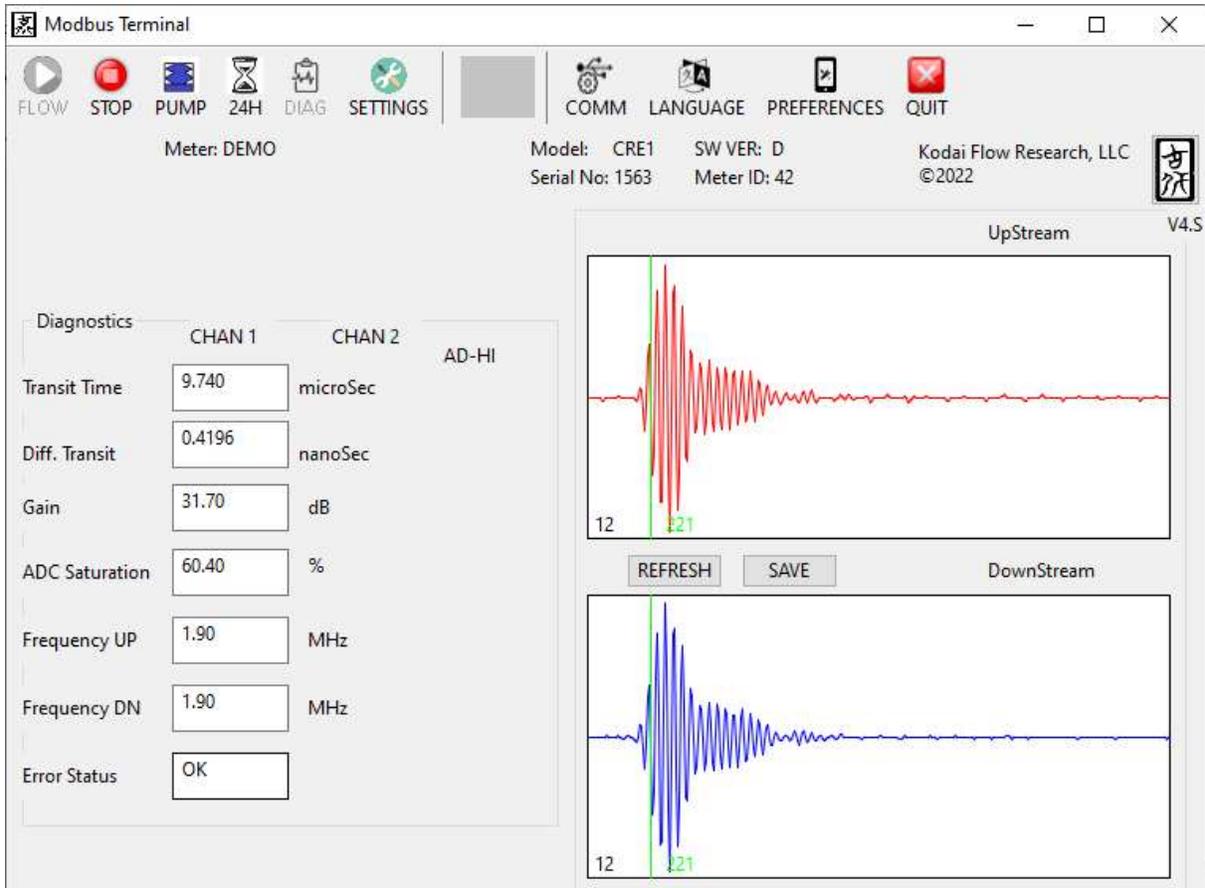


Figure 6. Display of Transmitter Operating Diagnostics.

Transit Time	Average time for pulse to travel across fluid in each direction.
Diff. Transit	Difference in the transit time between the upstream and downstream direction.
Gain	The amount of amplification used on the analog acoustic signal.
ADC Saturation	Saturation of the Analog to Digital Converter (ADC). Should be ~60%.
Frequency UP	Frequency of the upstream signal at reference element.
Frequency DN	Frequency of the downstream signal at reference element. Should match UP.
Error Status	OK if no operational error detected.

Table 1. Definition of diagnostic values

Circular Internal Logs

The transmitter keeps a constant internal log of the last 24 hours of system performance. It is usually difficult to keep a logging device attached to the transmitter. Therefore, it is possible to capture the last days worth of data by pressing the hourglass symbol on the menu. The data can be saved to an ASCII file for export to a spreadsheet. Figure 7 shows the graphical display. Terms like Strokes/min and Duty Cycle only have meaning when the system is used with a bellows or diaphragm pump. The temperature measurement is based on an equation of state so the correct fluid has to be selected to get a valid value.

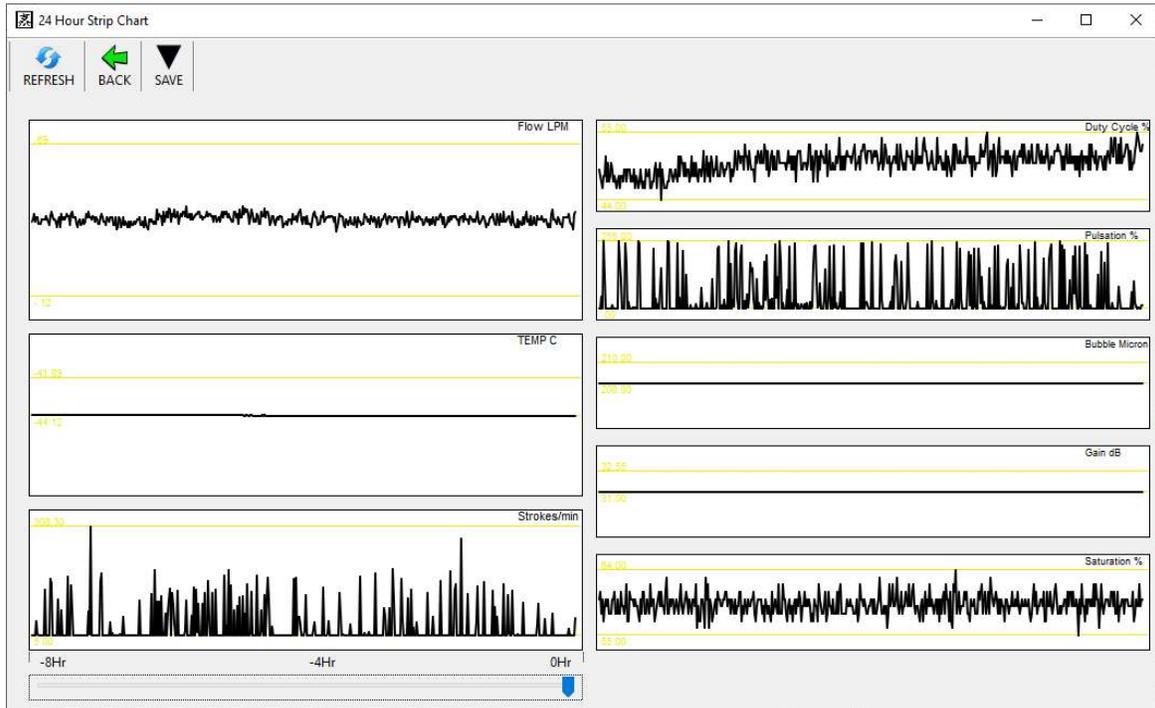


Figure 7. Data from 24 hour circular log.

Changing Transmitter Settings

METER SETTINGS is used to see the actual configuration of the transmitter. The data is read only, unless the user has been granted PIN authorization. Section 3 of the CRE1 Manual (KFR.MN03) details the setup menu.