CARD-CDC-10 & CARD-CDC-20 SERIAL COMMUNICATIONS PLUG-IN OPTION CARDS
MANUAL

1. DESCRIPTION

This bulletin serves as a guide for the installation, configuration and operation of the RS232 and RS485 cards for the PAX family of meters. Only one communication card can be used at a time. The PAX meter can be fitted with up to three different option cards. The slot bays of the option cards are dedicated to a particular card function. The option card functions are : serial communications, analog output and setpoint output. Only one card from each function category can be installed into the meter.

2. SPECIFICATIONS

2.1. RS485 Communication card

2.1.1. Types
RS485 multi-point balanced interface

2.1.2. Isolation to sensor & user input commons
500Vrms for 1 min. Working Voltage: 50V. Not isolated from all other commons.

2.1.3. Baud rate
300 to 19200 Bauds

2.1.4. Data format
7/8 bits; odd, even, or no parity

2.1.5. Bus address
0 to 99, max 32 meters per line

2.1.6. Transmit delay
Selectable; 2 - 50msec or 50 - 100msec

2.2. RS232 Communication card

2.2.1. Type
RS232 half duplex

2.2.2. Isolation to sensor & user input commons
500Vrms for 1 min.
Working Voltage: 50V.
Not Isolated from all other commons.

2.2.3. Baud rate
300 to 19200 Bauds

2.2.4. Data format
7/8 bits; odd, even or no parity

3. INSTALLING AN OPTION CARD

⚠️ **Caution:** The option and main circuit cards contain static sensitive components. Before handling the cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the cards at a static controlled clean workstation. Also, only handle the cards by the edges. Dirt, oil or other contaminants that may contact the cards can adversely affect circuit operation.

⚠️ **Warning:** Exposed line voltage exists on the circuit boards. Remove all power to the meter AND load circuits before accessing the unit.
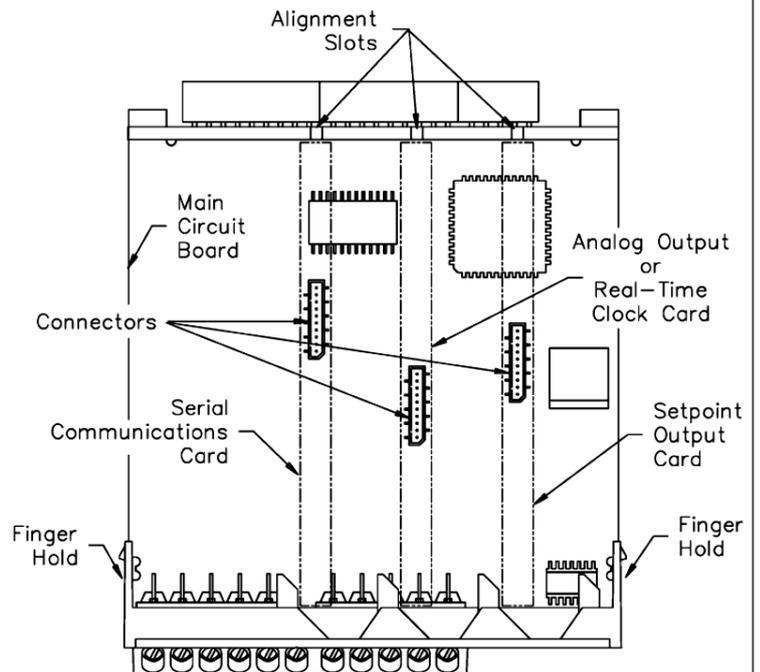
1. Remove the main assembly from the rear of the case. Squeeze the finger holds on the rear cover, or use a small screwdriver to depress the side latches to release it from the case. It is not necessary to separate the rear cover from the main circuit card.
2. Locate the option card connector for the serial communication card. Hold the unit by the rear cover, not the display board, when installing an option card.
3. Install the option card by aligning the option card with the slot in the rear cover. Be sure the connector is fully engaged and the tab on the option card rests in the alignment slot on the display board.
4. Slide the assembly back into the case. Be sure the rear cover latches fully into the case.

4. ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
CARD-CDC	RS485 Serial Communications Output Card with Terminal Block	CARD-CDC-10
	Extended RS485 Serial Communications Output Card with Dual RJ11 Connector	CARD-CDC-1C
	RS232 Serial Communications Output Card with Terminal Block	CARD-CDC-20
	Extended RS232 Serial Communications Output Card with 9 Pin D Connector	CARD-CDC-2C

5. WIRING CONNECTIONS

5.1. RS232 communications

Terminal Block Connection Figure

PIN 2 TXD
PIN 3 RXD
PIN 5 COMMON

FEMALE

**Extended Comms Connection Figure**
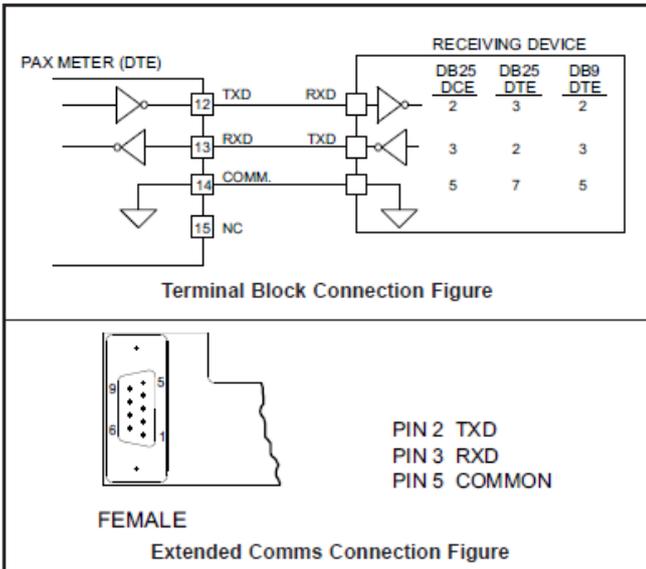
RS232 is intended to allow only two devices to communicate over distances up to 50 feet. Data Terminal Equipment (DTE) transmits data on the Transmitted Data (TXD) line and receives data on the Received Data (RXD) line. Data Computer Equipment (DCE) receives data on the TXD line and transmits data on the RXD line. The PAX emulates a DTE. If the other device connected to the meter also emulates a DTE, the TXD and RXD lines must be interchanged for communications to take place. This is known as a null modem connection. Most printers emulate a DCE device while most computers emulate a DTE device.

Some devices cannot accept more than two or three characters in succession without a pause in between. In these cases, the meter employs a busy function.

As the meter begins to transmit data, the RXD line (RS232) is monitored to determine if the receiving device is "busy". The receiving device asserts that it is busy by setting the RXD line into a space condition (logic 0). The meter then suspends transmission until the RXD line is released by the receiving device.

5.2. RS485 communications

The RS485 communication standard allows the connection of up to 32 devices on a single pair of wires, distances up to 4,000 ft. and data rates as high as 10M baud (the PAX is limited to 19.2k baud). The same pair of wires is used to both transmit and receive data. An RS485 bus is therefore always half-duplex, that is, data cannot be received and transmitted simultaneously.

Terminal Block Connection Figure

Extended Comms Connection Figure
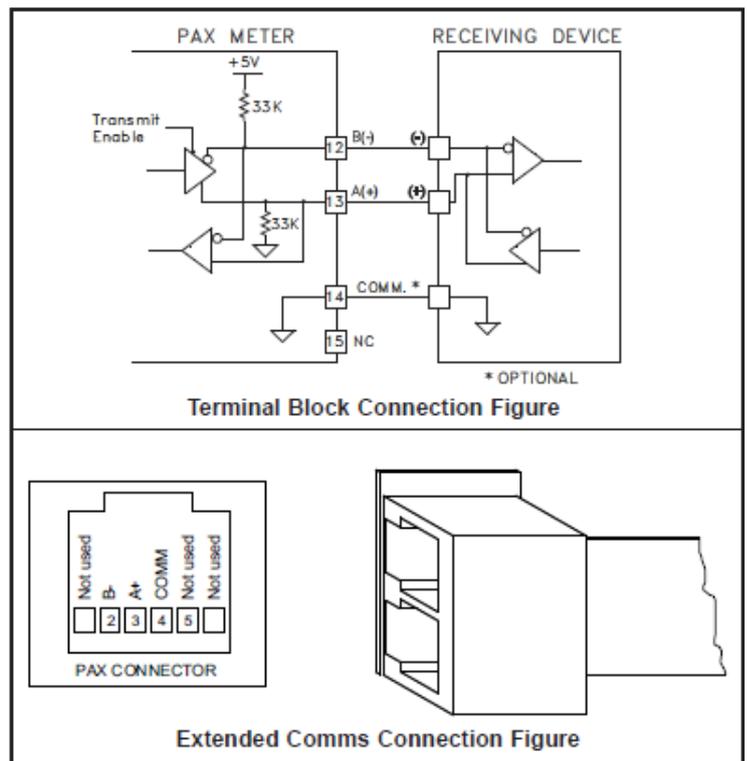
6. MODULE 7 – SERIAL COMMUNICATIONS PARAMETERS
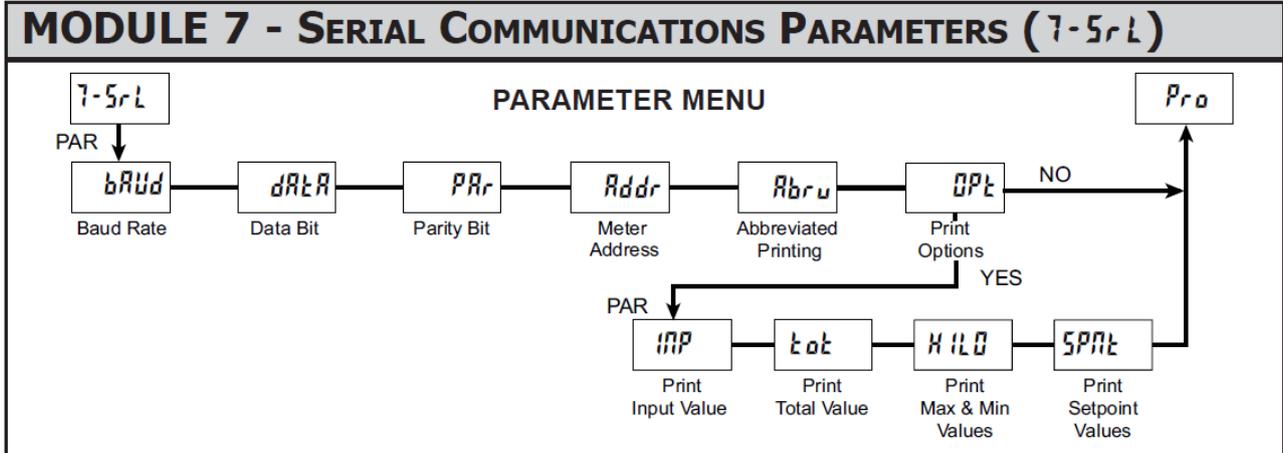
It is necessary to match the PAX meter's serial communications parameters to the host's parameters before communications can be established. This is accomplished by using the PAX front panel keys to enter 7-SrL.

6.1. Baud rate

|		
300	600	1200
2400	4800	9600
	19200	

Set the baud rate to match that of other serial communications equipment. Normally, the baud rate is set to the highest value that all of the serial communications equipment is capable of transmitting.

6.2. Data bit

7   8

Select either 7 or 8 bit data word lengths. Set the word length to match that of other serial communication equipment. Since the meter receives and transmits 7-bit ASCII encoded data, 7 bit word length is sufficient to request and receive data from the meter.

6.3. Parity bit

Odd   EUEn   nO

Set the parity bit to match that of the other serial communications equipment used. The meter ignores the parity when receiving data, and sets the parity bit for outgoing data. If no parity is selected with 7-bit word length the meter transmits and receives data with 2 stop bits. (For example: 10 bit frame with mark parity)

6.4. Meter address

0   to   99

Enter the serial node address. With a single unit on a bus, an address is not needed and a value of zero can be used (RS232 applications). Otherwise, with multiple bussed units, a unique address number must be assigned to each meter. The node address applies specifically to RS485 applications.

6.5. Abbreviated printing

YES   **nO**
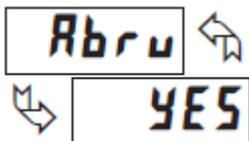
Select abbreviated transmissions (numeric only) or full field transmission. When the data from the meter is sent directly to a terminal for display, the extra characters that are sent identify the nature of the meter parameter displayed. In this case, select **nO**. When the data from the meter goes to a computer, it may be desirable to suppress the node address and mnemonic when transmitting. In this case, set this parameter to **YES**.

6.6. Print option

YES   **nO**
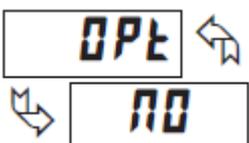
YES - Enters the sub-menu to select those meter parameters to appear in the block print. For each parameter in the sub-menu select **YES** for the parameter to appear with the block print, and **nO** to disable the parameter.

Input Value	InP	YES	nO
Max and Min values	hi LO	YES	nO
Total values	tot	YES	nO
Setpoint values*	SPnt	YES	nO

*Setpoints 1-4 are setpoint plug-in card dependent.

7. SENDING COMMANDS AND DATA

When sending commands to the meter, a string containing at least one command character must be constructed. A command string consists of a command character, a value identifier, numerical data (if writing data to the meter) followed by the command terminator character * or $.

7.1. Command chart

COMMAND	DESCRIPTION	NOTES
N	Node Address Specifier	Address a specific meter. Must be followed by one or two digit node address. Not required when node address = 0.
T	Transmit Value (read)	Read a register from the meter. Must be followed by register ID character.
V	Value change (write)	Write to register of the meter. Must be followed by register ID character and numeric data.
R	Reset	Reset a register or output. Must be followed by register ID character
P	Block Print Request (read)	Initiates a block print output. Registers are defined in programming.

7.2. Command string construction

The command string must be constructed in a specific sequence. The meter does not respond with an error message to illegal commands. The following procedure details construction of a command string:

1. The first 2 or 3 characters consist of the Node Address Specifier (N) followed by a 1 or 2 character node address number. The node address number of the meter is programmable. If the node address is 0, this command and the node address itself may be omitted. This is the only command that may be used in conjunction with other commands.

2. After the optional address specifier, the next character is the command character.
3. The next character is the register ID. This identifies the register that the command affects. The P command does not require a register ID character. It prints according to the selections made in print options.
4. If constructing a value change command (writing data), the numeric data is sent next.
5. All command strings must be terminated with the string termination characters * or $. The meter does not begin processing the command string until this character is received. See timing diagram figure for differences of * and $ terminating characters.

7.3. Register indentification chart

ID	VALUE DESCRIPTION	REGISTER ID	APPLICABLE COMMANDS/COMMENTS	
A	Input	INP	T, P, R	(Reset command [Ver2.5+] zeros the input ["REL" or Tare])
B	Total	TOT	T, P, R	(Reset command resets total to zero)
C	Max input	MAX	T, P, R	(Reset command resets MAX to current reading)
D	Min input	MIN	T, P, R	(Reset command resets MIN to current reading)
E	Setpoint 1	SP1	T, P, V, R	(Reset command resets the setpoint output)
F	Setpoint 2	SP2	T, P, V, R	(Reset command resets the setpoint output)
G	Setpoint 3	SP3	T, P, V, R	(Reset command resets the setpoint output)
H	Setpoint 4	SP4	T, P, V, R	(Reset command resets the setpoint output)
I	Analog output register	AOR	T, V	(Applies to manual mode)
J	Control status register	CSR	T, V	
L	Absolute (gross) input display value	ABS GRS †	T, P	
Q	Offset/Tare (PAXS)	OFS TAR †	T, P, V	(Ver 2.5+)

† -Register ID for the PAXS.

7.4. Command String Examples
1. Node address = 17, Write 350 to Setpoint 1, response delay of 2 msec min
   String: N17VE350$
2. Node address = 5, Read Input value, response delay of 50 msec min
   String: N5TA*
3. Node address = 0, Reset Setpoint 4 output, response delay of 50 msec min
   String: RH*

7.5. Sending numeric data

Numeric data sent to the meter must be limited to 5 digits (-19,999 to 99,999). If more than 5 digits are sent, the meter accepts the last 5. Leading zeros are ignored. Negative numbers must have a minus sign. The meter ignores any decimal point and conforms the number to the scaled resolution.

(For example: the meter's scaled decimal point position = 0.0 and 25 is written to a register. The value of the register is now 2.5 In this case, write a value = 25.0).

Note: Since the meter does not issue a reply to value change commands, follow with a transmit value command for readback verification.

8. RECEIVING DATA

Data is transmitted by the meter in response to either a transmit command (T), a print block command (P) or User Function print request. The response from the meter is either a full field transmission or an abbreviated transmission. In this case, the response contains only the numeric field. The meter response mode is established in programming.

8.1. Full Field Transmission

BYTE	DESCRIPTION
1, 2	2 byte Node Address field [00-99]
3	<SP> (Space)
4-6	3 byte Register Mnemonic field
7-18	12 byte data field; 10 bytes for number, one byte for sign, one byte for decimal point (The T command may be a different byte length)
19	<CR> carriage return
20	<LF> line feed
21	<SP>* (Space)
22	<CR>* carriage return
23	<LF>* line feed

* These characters only appear in the last line of a block print.

The first two characters transmitted are the node address, unless the node address assigned =0, in which case spaces are substituted. A space follows the node address field. The next three characters are the register ID (Serial Mnemonic).
The numeric data is transmitted next. The numeric field is 12 characters long (to accommodate the 10 digit totalizer), with the decimal point position floating within the data field. Negative value have a leading minus sign. The data field is right justified with leading spaces.
The end of the response string is terminated with a carriage return <CR> and <LF>. When block print is finished, an extra <SP><CR> <LF> is used to provide separation between the blocks.

8.2. Abbreviated transmission

BYTE	DESCRIPTION
1-12	12 byte data field, 10 bytes for number, one byte for sign, one byte for decimal point
13	<CR> carriage return
14	<LF> line feed
15	<SP>* (Space)
16	<CR>* carriage return
17	<LF>* line feed

* These characters only appear in the last line of a block print.
The abbreviated response suppresses the node address and register ID, leaving only the numeric part of the response.

8.3. Meter response examples

1. Node address = 17, full field response, Input = 875

   17 INP 875 <CR><LF>

2. Node address = 0, full field response, Setpoint 2 = -250.5

   SP2 -250.5<CR><LF>

3. Node address = 0, abbreviated response, Setpoint 2 = 250, last line of block print

   250<CR><LF><SP><CR><LF>

8.4. (CSR) Control Status Register

The Control Status Register is used to both directly control the meter's outputs (setpoints and analog output), and interrogate the state of the setpoint outputs. The register is bit mapped with each bit position within the register assigned to a particular control function. The control functions are invoked by writing to each bit position. The bit position definitions are:

Bit 0: Setpoint 1 Output Status

   0 = output off

   1 = output on

Bit 1: Setpoint 2 Output Status

   0 = output off

   1 = output on

Bit 2: Setpoint 3 Output Status

   0 = output off

   1 = output on

Bit 3: Setpoint 4 Output Status

   0 = output off

   1 = output on

Bit 4: Manual Mode

   0 = automatic mode

   1 = manual mode

Bit 5: Always stays 0, even if 1 is sent.

Bit 6: Not applied

Bit 7: Always stays 0, even if 1 is sent.

Although the register is bit mapped starting with bit 7, HEX < > characters are sent in the command string. Bits 7 and 5 always stay a zero, even if a "1" is sent. This allows ASCII characters to be used with terminals that may not have extended character capabilities.

Writing a "1" to bit 4 of CSR selects manual mode. In this mode, the setpoint outputs are defined by the values written to the bits b0, b1, b2, b3; and the analog output is defined by the value written to the AOR. Internal control of these outputs is then overridden.

In automatic mode, the setpoint outputs can only be reset off. Writing to the setpoint output bits of the CSR has the same effect as a Reset command (R). The contents of the CSR may be read to interrogate the state of the setpoint outputs.

8.4.1. Examples:

1. Set manual mode, turn all setpoints off:

		7	6	5	4	3	2	1	0:bit location
VJ<30>* or VJ0*	ASCII 0 =	0	0	1	1	0	0	0	0 or <30>

V is command write, J is CSR and * is terminator.

2. Turn SP1, SP3 outputs on and SP2, SP4 outputs off:

		7	6	5	4	3	2	1	0:bit location
VJ<35>* or VJ5*	ASCII 0 =	0	0	1	1	0	1	0	1 or <35>

3. Select Automatic mode:

		7	6	5	4	3	2	1	0:bit location
VJ<40>* or VJ@*	ASCII 0 =	0	1	0	0	0	0	0	0 or <40>

Note: Avoid writing values <0A> (LF), <0D> (CR), <24> ($) and <2E> (*) to the CSR. These values are interpreted by the meter as end of command control codes and will prematurely end the write operation.

8.5. (AOR) Analog Output Register

The Analog Output Register controls the analog output of the meter. The manual mode must first be engaged by setting bit 4 of the Control Status Register. The range of values of this register is 0 to 4095, which corresponds to 0 mA, 0 V and 20 mA, 10 V; respectively. The table lists correspondence of the output signal with the register value.

REGISTER VALUE	OUTPUT SIGNAL* I (mA)	V (V)
0	0.000	0.000
1	0.005	0.0025
2047	10.000	5.000
4094	19.995	9.9975
4095	20.000	10.000

Due to the absolute accuracy rating and resolution of the output card, the actual output signal may differ 0.15% FS from the table values. The output signal corresponds to the range selected (20 mA or 10 V)

Writing to this register, while the meter is in the manual mode, causes the output signal to update immediately. While in the automatic mode, this register may be written to, but the output will not update until the meter is placed in manual mode.

8.5.1. Examples:

1. Set output to full scale:
   VI4095*
2. Set output to zero scale:
   VI0*

9. COMMAND RESPONSE TIME

The meter can only receive data or transmit data at any one time (half-duplex operation). The meter ignores commands while transmitting data, but instead uses RXD as a busy signal. When sending commands and data to the meter, a delay must be imposed before sending another command. This allows enough time for the meter to process the command and prepare for the next command.

Timing Diagram Figure
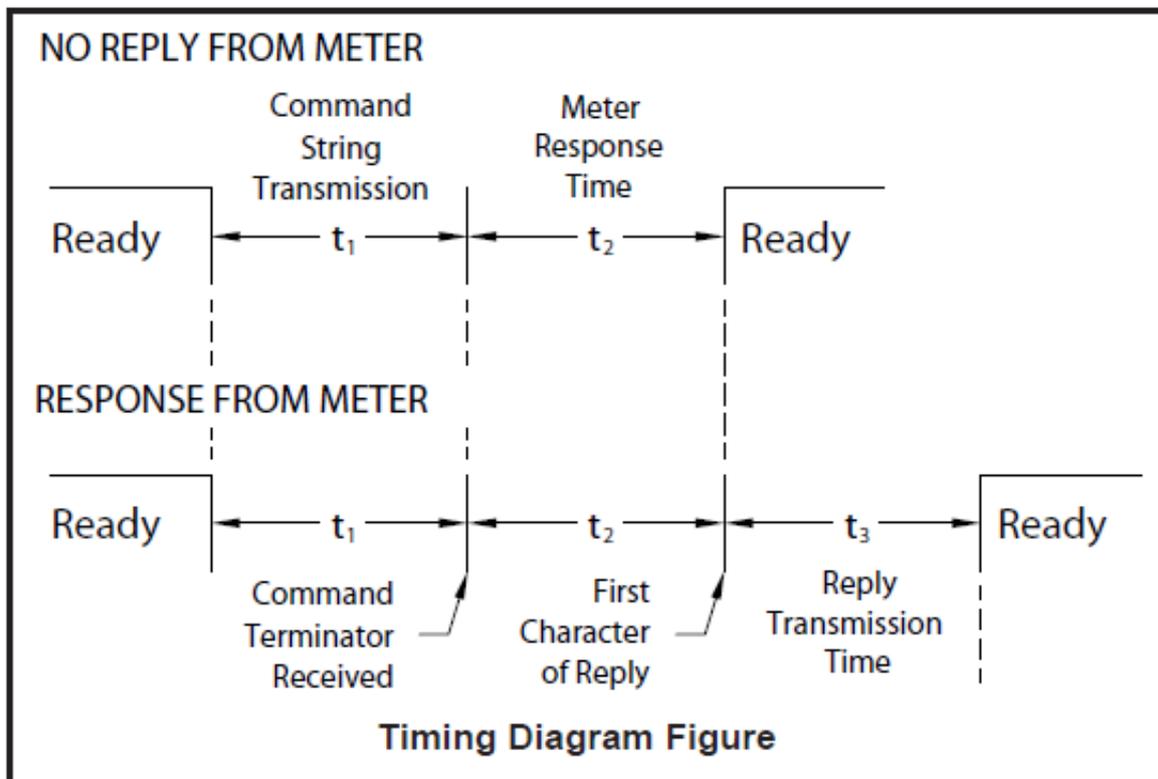
At the start of the time interval t_1, the computer program prints or writes the string to the com port, thus initiating a transmission. During t_1, the command characters are under transmission and at the end of this period, the command terminating character (*) is received by the meter. The time duration of t_1 is dependent on the number of characters and baud rate of the channel.

$$t1 = \frac{(10 * \# \, of \, characters)}{baud \, rate}$$

At the start of time interval t_2, the meter starts the interpretation of the command and when complete, performs the command function. This time interval t_2 varies from 2msec to 50msec. If no response from the meter is expected, the meter is ready to accept another command.

If the meter is to reply with data, the time interval t_2 is controlled by the use of the command terminating character. The standard command line terminating character is '*'. This terminating character results in a response time window of 50msec minimum and 100msec maximum. This allows sufficient time for the release of the sending driver on the RS485 bus. Terminating the command line with '$' results in a response time window (t_2) of 2msec minimum and 50msec maximum. The faster response time of this terminating character requires that sending drivers release within 2msec after the terminating character is received.

At the beginning of time interval t_3, the meter responds with the first character of the reply. As with t_1, the time duration of t_3 is dependent on the number of characters and baud rate of the channel. t_3 = (10 * # of characters) / baud rate. At the end of t_3, the meter is ready to receive the next command.

The maximum serial throughput of the meter is limited to the sum of the times t_1, t_2 and t_3.

10. COMMUNICATION FORMAT

Data is transferred from the meter through a serial communication channel. In serial communications, the voltage is switched between a high and low level at a predetermined rate (baud rate) using ASCII encoding. The receiving device reads the voltage levels at the same intervals and then translates the switched levels back to a character.

The voltage level conventions depend on the interface standard. The table lists the voltage levels for each standard.

LOGIC	INTERFACE STATE	RS232*	RS485*
1	mark (idle)	TXD, RXD; -3 to -15V	a-b < -200mV
0	space (active)	TXD, RXD; +3 to +15V	a-b > +200mV

Voltage levels at the receiver

Data is transmitted one byte at a time with a variable idle period between characters (0 to ∞). Each ASCII character is "framed" with a beginning start bit, an optional error detection parity bit and one or more ending stop bits. The data format and baud rate must match that of other equipment in order for communication to take place. The figures list the data formats employed by the meter.

10.1. Start bit and Data bits

Data transmission always begins with the start bit. The start bit signals the receiving device to prepare for reception of data. One bit period later, the least significant bit of the ASCII encoded character is transmitted, followed by the remaining data bits. The receiving device then reads each bit position as they are transmitted. Since the sending and receiving devices operate at the same transmission speed (baud rate), the data is read without timing errors.

Character Frame Figure
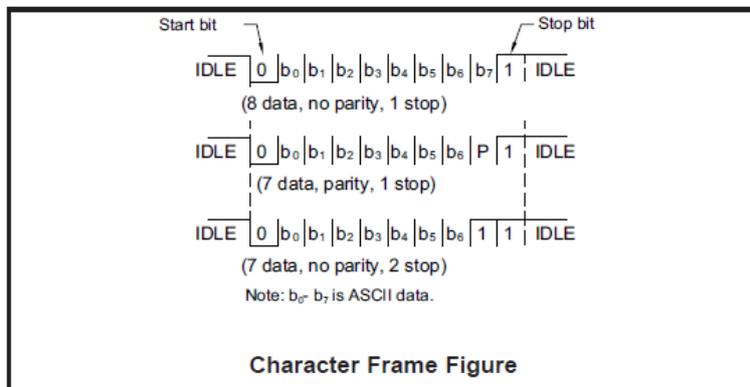
10.2. Parity bit

After the data bits, the parity bit is sent. The transmitter sets the parity bit to a zero or a one, so that the total number of ones contained in the transmission (including the parity bit) is either even or odd. This bit is used by the receiver to detect errors that may occur to an odd number of bits in the transmission. However, a single parity bit cannot detect errors that may occur to an even number of bits. Given this limitation, the parity bit is often ignored by the receiving device. The PAX meter ignores the parity bit of incoming data and sets the parity bit to odd, even or none (mark parity) for outgoing data.

10.3. Stop bit

The last character transmitted is the stop bit. The stop bit provides a single bit period pause to allow the receiver to prepare to re-synchronize to the start of a new transmission (start bit of next byte). The receiver then continuously looks for the occurrence of the start bit.