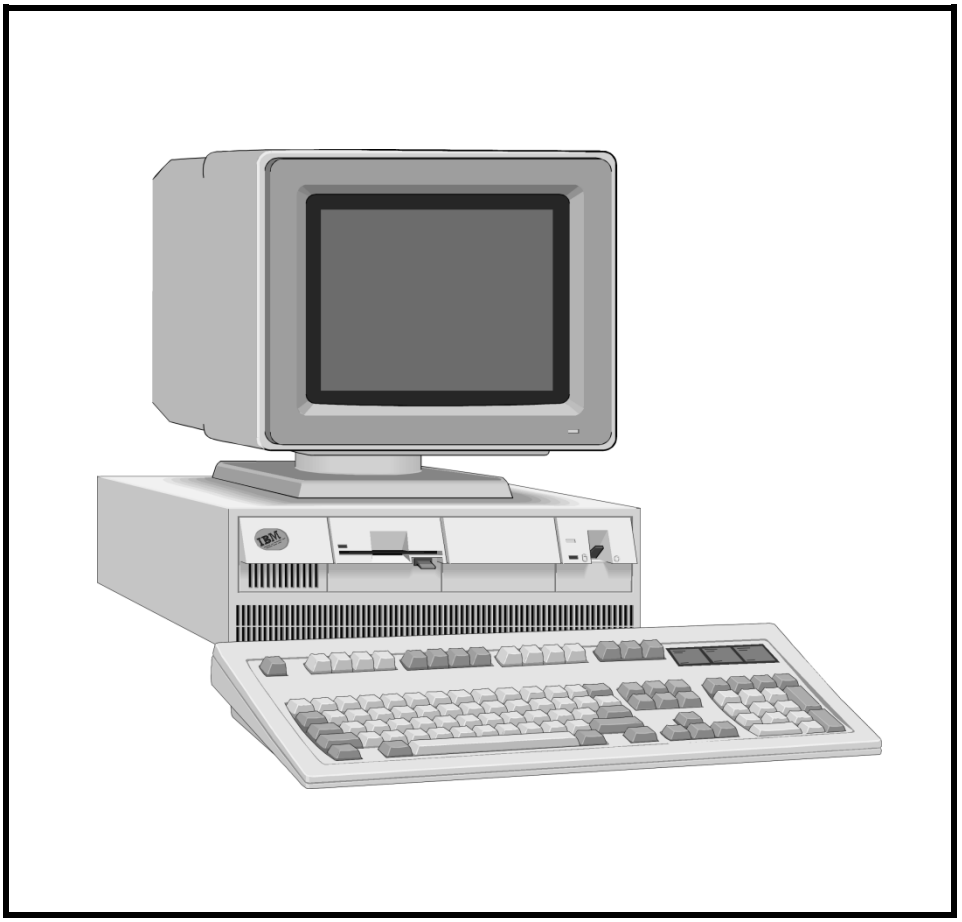
SUPPLEMENT

to INSTRUCTION BULLETINS 10DX4311C & 10D1475Y

ASCII COMMUNICATIONS

RS485 SERIAL COMMUNICATIONS



PN24915

The following document is intended to add RS485 ASCII communications information for the 50XE4000 Converter to the 10DX4311C and 10D1475Y Instruction Bulletins. This information supplements information found in 10DX4311 Instruction Bulletin PN24849 and 10D1475Y Instruction Bulletin PN24763.

1.0 General Discussion

It is common practice to have intelligent instruments with micro-computers communicate through a network connection to a remote control point. This permits plantwide monitoring and control of the instrumentation by a single operator. 50XE4000 Converters use ASCII PROTOCOL for remote data communications.

The 50XE4000 signal converter used in 10DX4311 and 10D1475Y flowmeter systems is available with ASCII protocol which suppports EIA RS485 type communications in a half duplex mode. This link can send data at 9600 baud over lines up to 4000 feet (1200 m). The RS485 ASCII protocol includes line transceivers whose outputs may be alternately enabled and disabled for transmission and reception of data. ASCII protocol is a "query-response" based protocol that permits two way data communication between a communications control device and a 50XE4000 using only two wires. The only restriction is that no part of a reply message can be sent back from the field device while the terminal is sending a query (or visa-versa).

Use of the RS485 hardware permits network configurations with up to 32 properly terminated field XE Converters. Each XE Converter on the network must be configured with its own unique address number in order to avoid data "collisions" resulting from other XE Converters being enabled on the same network.

Successful two-way half duplex communication also requires that the communications control point device is capable of sending its message string (query) and then turning its drivers to a "receive" state while waiting for the addressed XE Converter to send its reply message.

2.0 ASCII Communications Mode

2.1 ASCII Communications Protocol

A communications message exchange (i.e. query-response) between the communications control point and a 50XE4000 Converter is always initiated by the communications control point (query). The 50XE4000 Signal Converter responds to queries with a reply. A terminal device such as a VT100 or a PC with serial port may be used as the host communications control point device in point-to-point (non-multidrop) applications. Signal converter data may be requested by the host in monitor mode, while data modification by the host is reserved for configuration mode.

Communication via the data link always starts with a 'Start of Header' character (SOH = 01H = <CTRL>A), followed by an 'M' for monitor mode (basically a "read" of 50XE4000 data) or 'P' for configuration (or programming) mode, followed by the two digit instrument address. The address is followed by two characters for the requested function, and optionally a maximum of eight data bytes. Carriage return (CR) and line feed (LF) characters are the terminators for a message transfer. A byte is defined as 7 data bits and one stop bit (even parity). An example of signal format is provided in Sub-Section 2.4.

The signal converter reply begins with an "ACK" character, followed by the function characters, addresses and optionally up to eight data bytes. Completion of the message is indicated by the CR and LF characters. Message data may be furnished with a minus sign (-) and a decimal point (.) for fractional decimals. Leading or complimentary zeros need not be sent with the message.

All query messages are checked by the signal converter in various ways. In addition to checking each transmitted byte for even parity, the converter monitors a message for exact conformance with

the protocol conventions (function characters as well as number and type of data). Before the new configuration data is activated, it is examined for validity. If it doesn't conform, an error message is sent back to the host (function character 'X' followed by the instrument's address a two digit error code number). If the data passes the check, it is activated by the 50XE4000 and an acknowledge message of the same format as the received message is returned to the host communications control point. This completes one query-response message exchange.

2.2 Hardware Implementation

Common PC terminal emulators and drivers do not support RS485 half-duplex communications. Accordingly, to use a PC having an RS232C port and the "Term" program present in many versions of Microsoft Windows, it is suggested that an RS232 to RS485 data converter such as the Black Box Corp. Opto-Isolator/Converter Model IC109A be purchased. This device provides two necsssary network functions:

- A pair of isolated RS485 driver/receivers capable of tri-state operation and which can interface directly to RS232C data from a PC
- The ability to turn off (tri-state) the drivers following the transmission of each out-going character

The XE4000 Converter "listens" for query messages directed to its address. A minimum of 50 milliseconds will elapse between the time a converter receives a valid query until it begins to send a reply message. These timing relationships assure that there will not be a collision resulting from the host and the converter attempting to assert the line with data simultaneously.

It must also be recognized that an RS485 multi-node system must be properly terminated in order to result in error-free data transmission and detection. Device driver manufacturers recommend that a 100 ohm resistor be placed across the two transceiver pairs (A & B) which have the greatest length of cable between them.

The signal converter is equipped with a driver conforming to the RS485 standard and connected in "half-duplex" (send-to-receive) mode.

2.3 Specifications

RS485 Engineering Specifications:

Electrical transmission mode:	balanced mode
Number of transceiver pairs:	32
Cable length maximum:	4000 feet (1200 m) (see the following note)
Communications rate, maximum:	10 MBaud (not supported by ASCII protocol)
Signal voltage, no load:	5 Volts
Signal voltage under load condition:	1.5 Volts

RS485 Installation:

I/O TERMINAL ID:

A Transmit/Receive Data +

B Transmit/Receive Data -

NOTE
Refer to network wiring diagram shown in Figure 1 for recommended wiring. Cable length is a function of transmission speed.

2.4 Communications Protocol

2.4.1 Monitor Mode

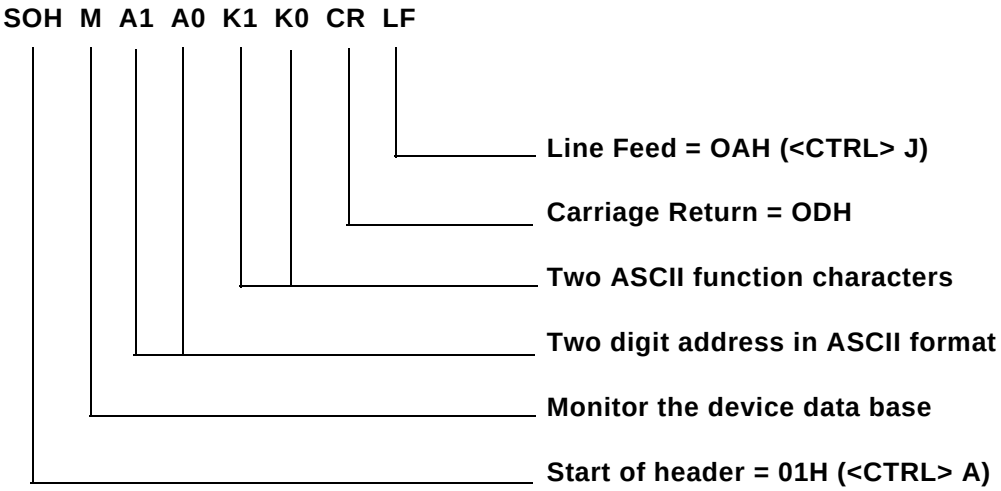
Various elements of the 50XE4000 Converter data base (see later sections) may be examined and re-configured using a simple ASCII information exchange which can be produced by most terminal emulators, such as Windows "Term".

The software must be set up with the following attributes:

- One of the following baud rates - 110, 300, 600, 1200, 2400, 4800, 9600 (must be the same as each network converter)
- Word length 7 bits
- One stop bit
- Even parity bit sent with each character

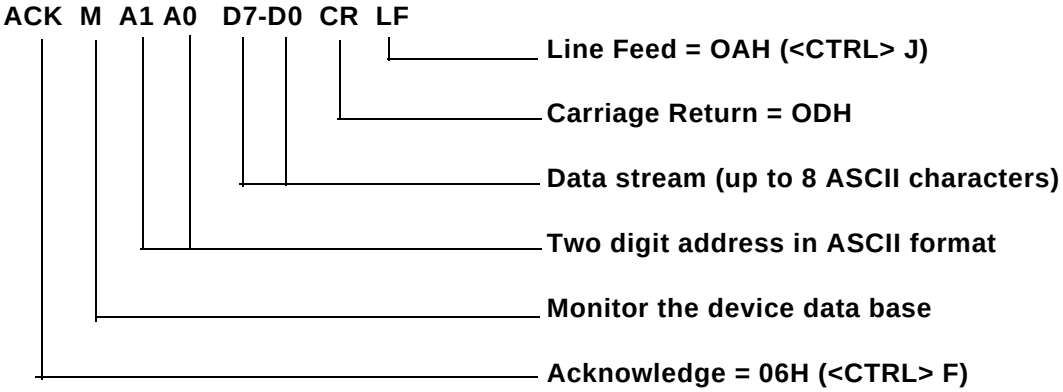
A monitor-mode query to any converter on the network appears as follows:

BYTE: 1 2 3 4 5 6 7 8



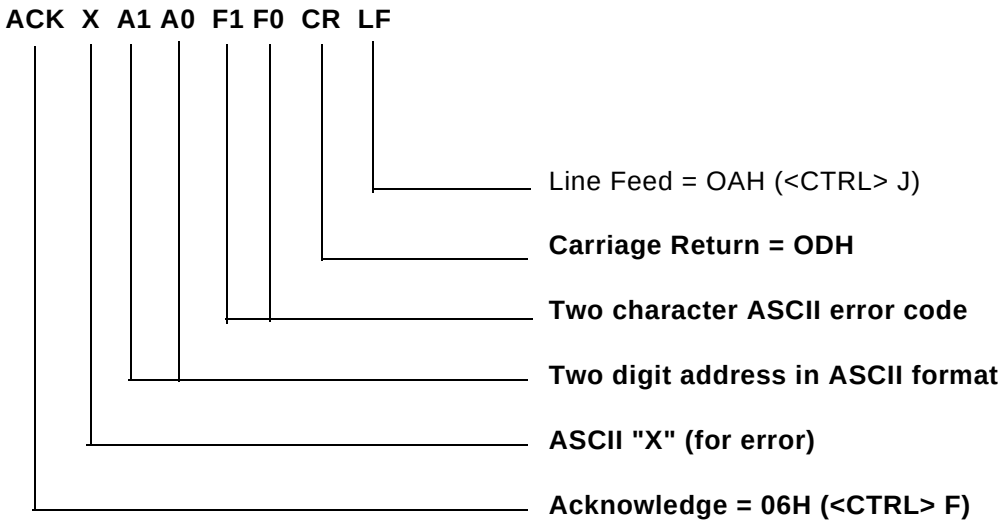
Upon successful receipt of its message, the converter being addressed will reply as follows:

BYTE: 1 2 3 4 5 - 12 13 14



Should the converter find its data string to contain an error, it will reply as follows:

BYTE: 1 2 3 4 5 6 7 8



2.4.1.1 Listing of Monitor Commands

Function characters are the means of addressing the signal converter operating parameters and status data. Only UPPER-CASE letters are accepted as proper entry. A list of function codes and their data types is shown in TABLE 1.

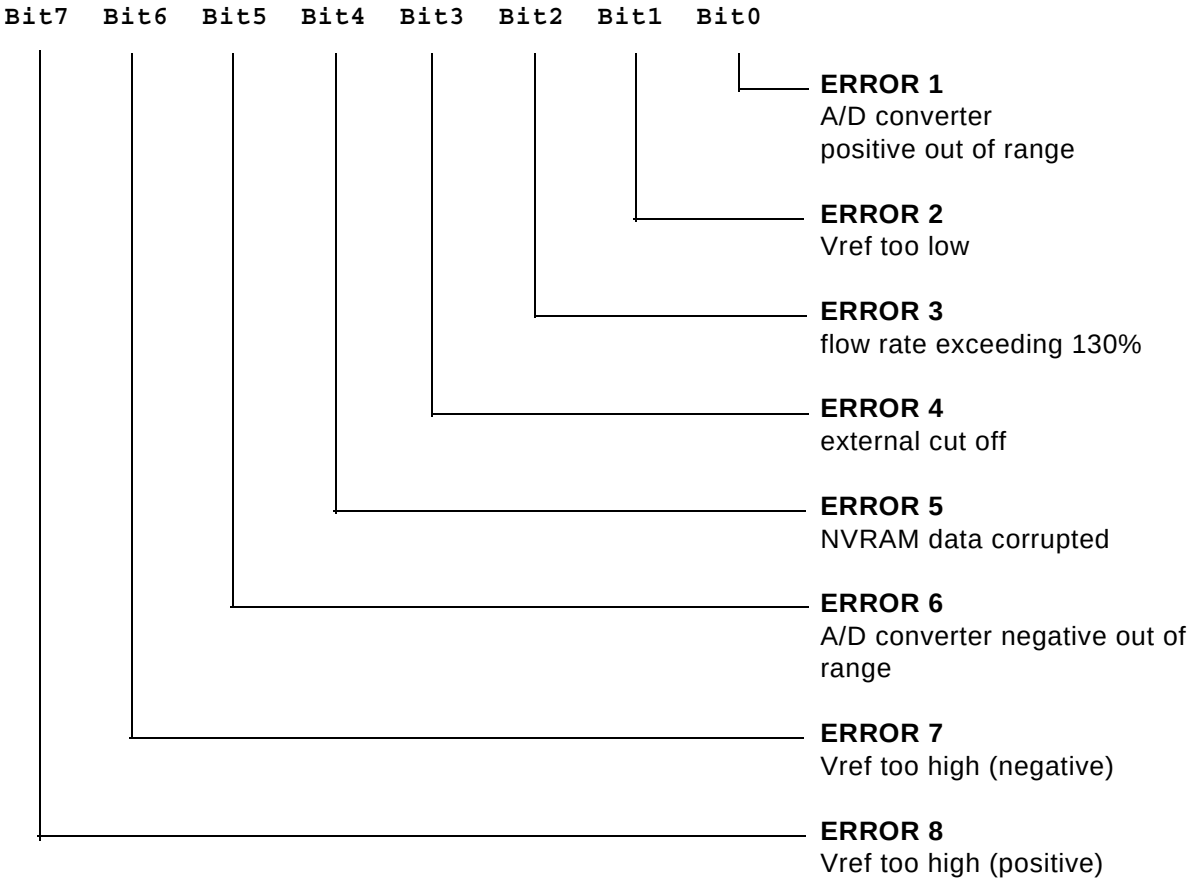
TABLE 1. FUNCTION CODES

FUNCTION	CODE	DATA TYPE
Display (in % or units)	AN	Binary (0 or 1)
Damping (seconds)	DP	Numeric Floating Point
Density (g/cm^3)	DI	Numeric Floating Point
Flow Rate in Engr Units	DF	Numeric Floating Point
Multiplexed Display (On/Off)	DM	Binary (0 or 1)
Empty Pipe Detector (On/Off)	DL	Binary (0 or 1)
Threshold (Empty Pipe Detector)	DS	Numeric, 3-Digit
Error Register 0	ER	Binary, 8-character
Error Register 1	E1	Binary, 8-character
Engr Units for Maximum Flow	EI	Tabular
Engr Units for Totalizer	EZ	Tabular
Pulse Scaling Factor	I>	Numeric Floating Point
Current Signal Output, (LO/HI mA)	IO	Tabular
Alarm Current Signal Output	IA	Binary (0 or 1)
Percentage Flow Rate	M	Numeric Floating Point
System Zero Reference (Hz)	NG	Numeric Floating Point
Meter Size	NW	Tabular
Firmware Version	PR	Numeric Floating Point
Maximum Forward Flow Rate (range)	Q>	Numeric Floating Point
Maximum Flow Rate of Meter Size	QN	Numeric Floating Point
Status Register	ST	Binary, 8-character
Noise Suppression (On/Off)	SU	Binary (0 or 1)
Low Flow Cut-off (% of Range)	SM	Numeric Floating Point
Language	SP	Tabular
Totalizer Forward Flow	Z>	Numeric Floating Point
Totalizer Reverse Flow	Z<	Numeric Floating Point

2.4.1.2 ER: Error Register 0

> NOTE
> Do not confuse data presented in the Error Registers with the error codes described in section 2.4.3.1 and 2.4.3.2.

This data register provides information about the 50XE4000 Converter communications errors. The eight register bits represent eight different error types which are displayed as ASCII characters with the following format:



Error message replies are valid if the appropriate bits are set in the error register and if bit 7(=1) of the status register is set simultaneously (ST - Section 2.4.1.9). Data presentation is always eight digits long.

Example:

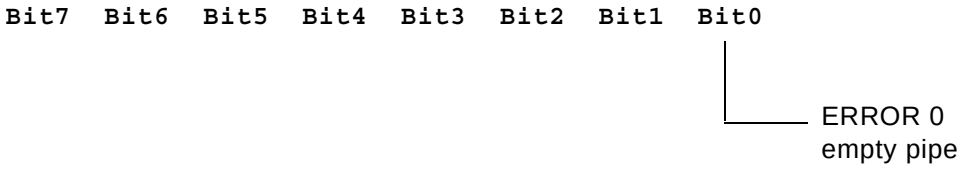
Instrument 05 is interrogated.

Host	SOH M 0 5 E R CR LF	error?
Converter	ACK E R 0 0 0 0 0 1 0 0 CR LF	error 3 (see "Bit 2" above)

Converter 05 reports an error: flow rate > 130 %.

2.4.1.3 E1: Error Register 1

See Error Register 0 (Section 2.4.1.2 - ER).



(Bit 1 through bit 7 have no meaning.)

2.4.1.4 IO: Current Signal Output

The presently configured current output signal is coded into a three digit parameter.

Index Number	Meaning
000	0-20 mA
001	4-20 mA
002	0-10 mA
003	2-10 mA
004	0-10-20
005	4-12-20

2.4.1.5 IA: Alarm Current Signal Output

In case of an alarm status both the current and frequency outputs will go to the predetermined value. Data presentation is a single digit.

Index Number	Meaning
0	0%
1	130%

2.4.1.6 M: Percentage Flow Rate

In this case only one function character needs to be sent, a second one will be ignored.

Depending on the flow direction the converter will respond either with a '>' for forward flow or with a '<' character for reverse flow as the second function character. Data presentation is six digits .

Example:
The flow rate of converter 08 is interrogated.

Host	SOH M 0 8 M CR LF	flow rate?
Converter	ACK M < 9 0 . 0 1 5 CR LF	90.015% reverse.

2.4.1.7 NW: Meter Size

The meter size is reported as a three digit index number. Refer to TABLE 2 for an index of meter sizes.

TABLE 2. INDEX OF METER SIZES

Index Number	Meter Sizes	
	inches	mm
000	1/10	3
001	5/32	4
002	3/16	5
003	1/4	6
004	5/16	8
005	3/8	10
006	1/2	15
007	3/4	20
008	1	25
009	1 1/4	32
010	1 1/2	40
011	2	50
012	2 1/2	65
013	3	80
014	4	100
015	5	125
016	6	150
017	8	200
018	10	250
019	12	300
020	14	350
021	16	400
022	18	450

Index Number	Meter Sizes	
	inches	mm
023	20	500
024	24	600
025	28	700
026	30	750
027	32	800
028	36	900
029	40	1000
030	42	1100
031	48	1200
032	51	1300
033	54	1400
034	60	1500
035	64	1600
036	66	1700
037	72	1800
038	78	2000
043	1/25	1
045	1/12	2
044	1/17	1.5
039	82	2100
040	86	2200
041	90	2300
042	94	2400

Example:

The converter at address 25 is requested to report the meter size.

Host	SOH M 2 5 N W CR LF	meter size?
Converter	ACK N W 0 2 3 CR LF	20 inch (500 mm)

2.4.1.9 PR: Firmware Version

Reporting of the firmware version number. The data length is eight alphanumerics.

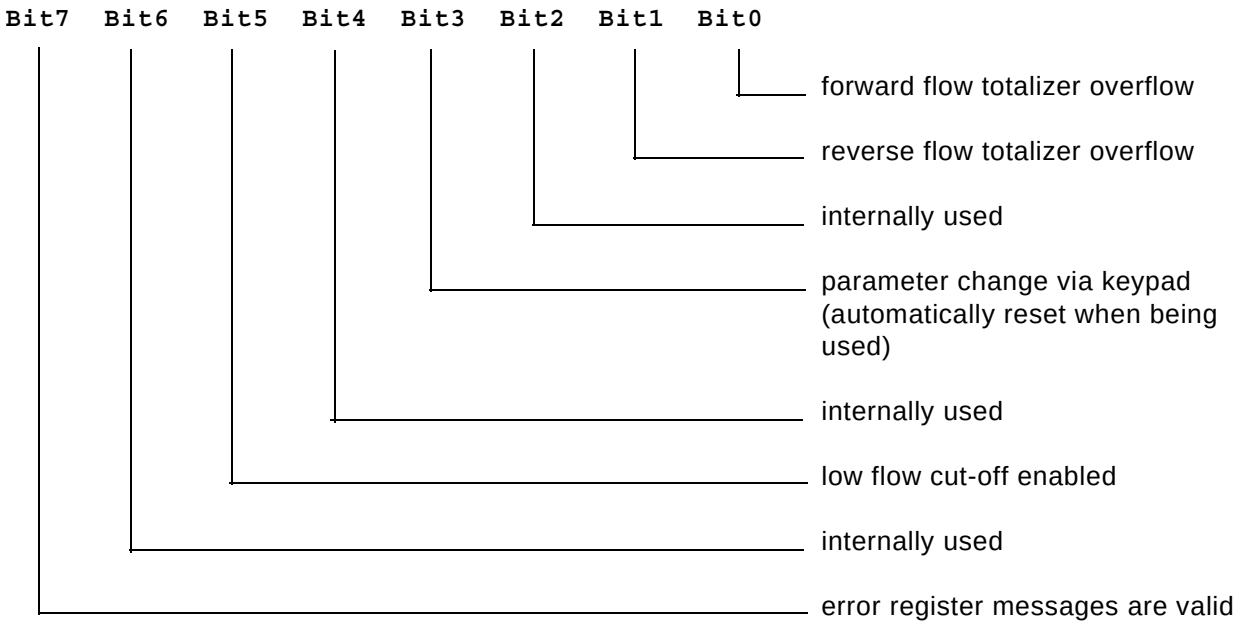
Example:

What is the firmware version number of Instrument 09?

Host	SOH M 0 9 P R CR LF	firmware version?
Converter	ACK P R B 179 B00 CR LF	Rev. B.00 implemented

2.4.1.9 ST: Status Register

The status register bits are represented as ASCII characters '0' or '1' in the following order:



Data is presented as eight characters. For example, the "status" response from the instrument at address 09 could be:

Host	SOH M 0 9 S T CR LF	status
Converter	ACK S T 0 0 0 0 0 0 1 1 CR LF	forward and reverse flow totalizers overflow

2.4.1.10 SP: Language

Reporting of the currently set signal converter language as a three digit index number.

TABLE 3. LANGUAGE INDEX

Index Number	Language
000	German
001	English
002	French
003	Italian
004	Spanish
005	Finnish
006	Dutch
007	Danish
008	Swedish

Example:
Which language is used for the message display of Converter 23?

Host	SOH M 2 3 S P CR LF	language?
Converter	ACK S P 0 0 1 CR LF	English

2.4.2 Configuration Mode

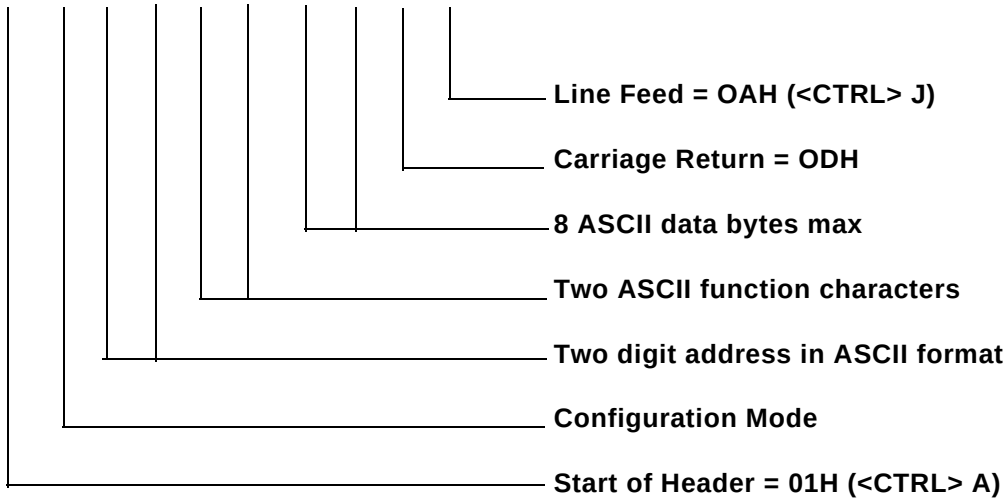
Configuration mode provides the capability to change parameters or to execute a function. This is made possible by means of the function codes. The host addresses the signal converter as follows:

> NOTE
> Floating point numbers can be 7 characters including the decimal point.
> Table selection numbers can have leading zeros and be up to 3 characters.

Host device to Signal Converter:

BYTE: 1 2 3 4 5 6 7 - 14 15 16

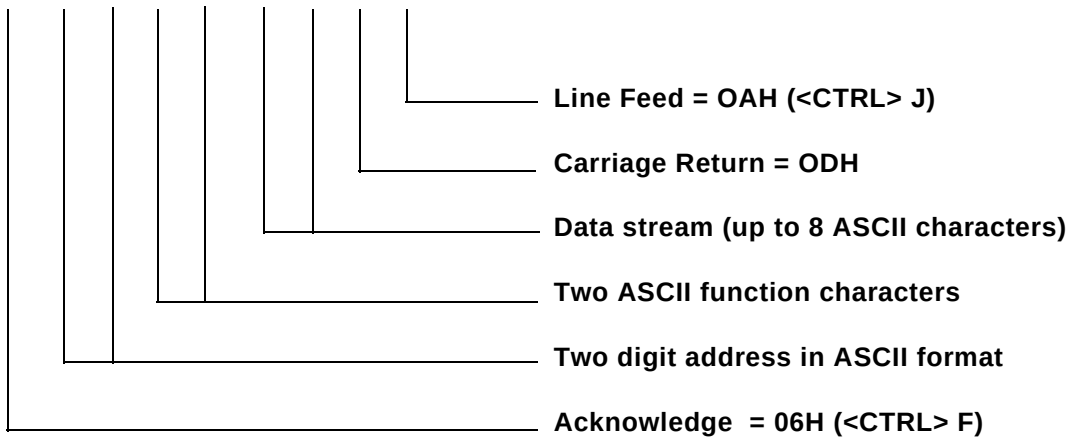
SOH P A1 A0 K1 K0 D7-D0 CR LF



Response from Signal Converter to Host Computer:

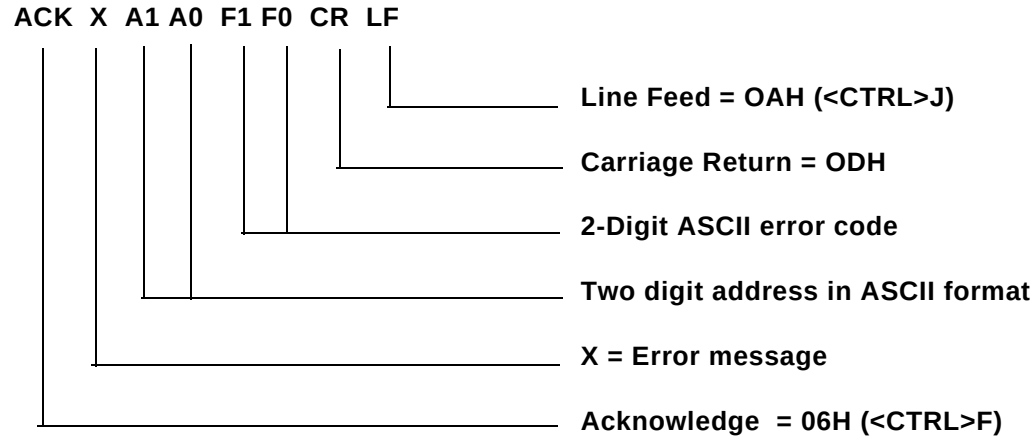
BYTE: 1 2 3 4 5 6 - 13 14 15

ACK A1 A0 K1 K0 D7-D0 CR LF



If the input is numerically out of limits, the converter responds with an error message:

BYTE: 1 2 3 4 5 6 7 8



2.4.2.1 Listing of Configuration Commands

Function characters are the means of addressing the signal converter operating parameters and status data. Only UPPER-CASE letters are accepted as proper entry. A list of function codes and their data types is given in Table 4.

TABLE 4. FUNCTION CODES

FUNCTION	CODE	DATA TYPE
Address	AD	Numeric, 3-Digit
Baud Rate	BA	Tabular
Restart Totalizer	LZ	no data
Reset FWD Totalizer	LV	no data
Reset REV Totalizer	LR	no data

2.4.2.2 BA: Baud Rate

The signal converter serial communications transmission speed can be reconfigured by changing the BA function parameter. After the change the converter operates with the new baud rate. No response message is issued to this configuration change. In case of an unsuccessful parameter change the converter issues an error message containing the old and still valid baud rate. The transmission baud rate is configured by an encoded index number. Refer to Table 5.

NOTE
The Baud rate can be set higher than the rate at which the particular combination of terminal and converter can operate. Also, any inadvertent change in the baud rate that results in a mis-match between the terminal and the converter can cause a loss of communication. A 1200 Baud rate is recommended as the upper limit for ASCII mode.

TABLE 5. BAUD RATE INDEX

Index Number	Baud
000	110
001	300
002	600
003	1200
004	2400
005	4800
006	9600

Note: The host will have to operate at the new baud rate when this command is given.

Possible error message:

Error Code	Cause
24	entry > 8

Example:

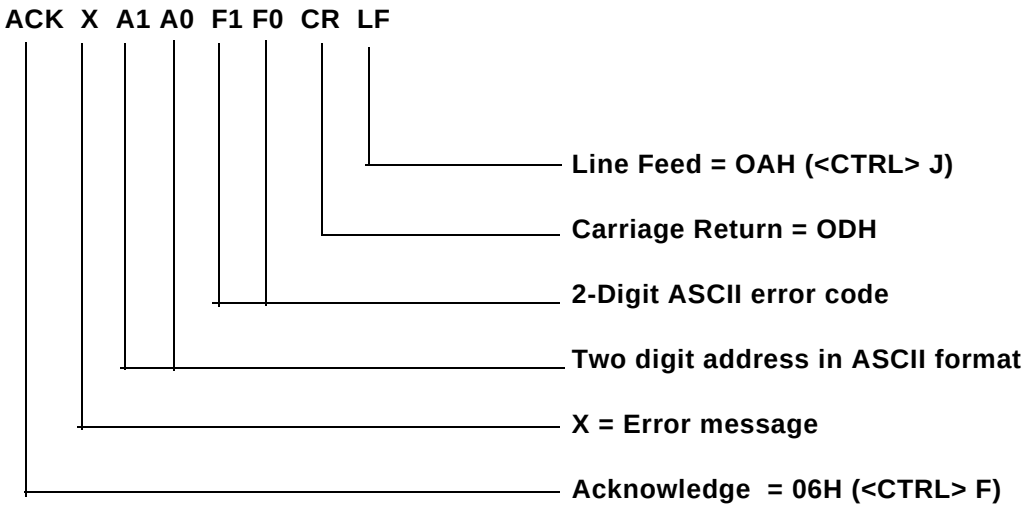
The communications transmission speed of instrument 0 is to be set to 1200 Baud.

Host	SOH P 0 0 B A 3 CR LF
Converter	no response (change successful)

2.4.3 Error Messages

The signal converter data received is checked for conformance with the communications protocol and for validity. If an error is detected the converter returns an error message:

BYTE: 1 2 3 4 5 6 7 8



2.4.3.1 Protocol and Communications Errors

Error No.	Cause
01	Bad operation mode (M for Monitor Mode and P for Configuration Mode only)
02	Bad function characters
03	Configuration not permitted, since this is a protected calibration parameter
04	Number of data bytes exceeded
05	Parity error

Example:

The instrument at address number 11 should have been configured for 100 l/min. The number of transmitted parameter configuration data bytes however, was eight instead of seven.

Host	SOH P 1 1 Q > 1 0 0 . 0 0 0 0 CR LF
Converter	ACK X 1 1 0 4 CR LF

2.4.3.2 Configuration Error Messages

Error No.	Function Character	Cause
10	Q > Q <	Entry > Qmax DN
11	Q > Q <	Entry < 0.05 Qmax DN
12	QN	Qmax DN not configurable
13	QN	Qmax DN < = 0
16	SM	Entry > 10
17	SM	Entry < 0
20	DP	Entry > = 100
21	DP	Entry < 0
22	AD	Entry > 99
24	BA	Entry > 8
30	NW	Entry > 45
36	SP	Entry > 8

38	I>	Entry > 1000
39	I>	Entry < 0.001
40	I > I < DI EZ	Totalizer frequency > 4 kHz
44	DI	Entry > 5
45	DI	Entry < = 0.01
48	EI	Bad Index Number
52	EZ	Entry > 9
54	NG	Entry > 500 or < -500
56	DS	Entry > 155
62	IO	Entry > 5

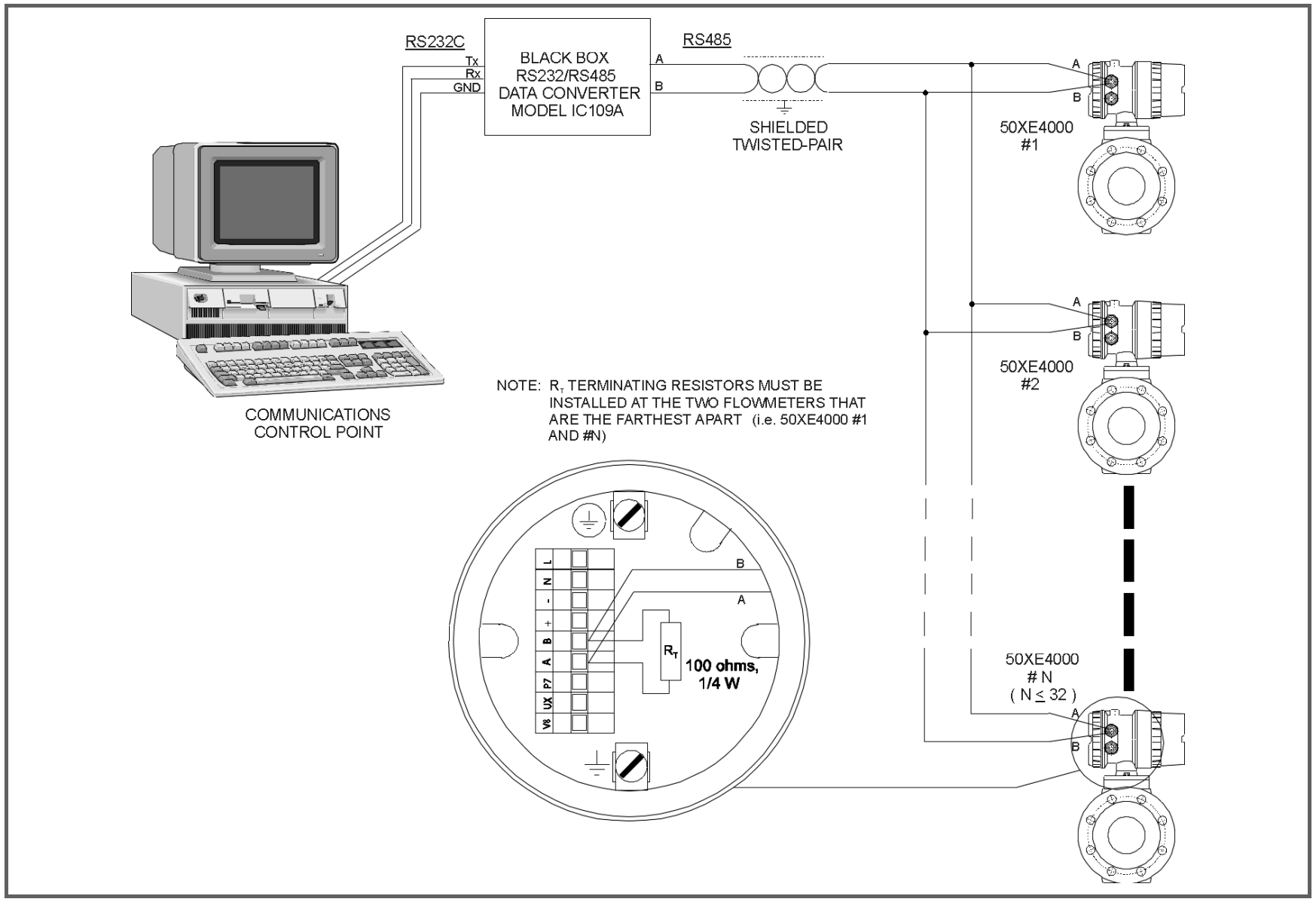


FIGURE 1. TYPICAL MULTI-DROP 50XE4000 RS485 NETWORK

PN24915

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