Installation and Operation Manual
X-DPT-RS485-GF40-GF80-MFC-eng
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RS485 S-Protocol Communications Supplemental Manual for Brooks® GF40/GF80 Series Mass Flow Controllers and Meters

Brooks® GF40/GF80 Series
with RS485 Communications

Dear Customer,

We recommend that you read this manual in its entirety as this will enable efficient and proper use of the RS485 thermal mass flow controllers and meters. Should you require any additional information concerning the RS485 thermal mass flow controllers and meters, please feel free to contact your local Brooks Sales and Service Office; see back cover for contact information, or visit us on the web at www.BrooksInstrument.com. We appreciate this opportunity to service your fluid measurement and control requirements, and trust that we will be able to provide you with further assistance in future.

Yours sincerely,
Brooks Instrument

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1-1 Introduction

The Brooks® Digital Communication RS485 S-Protocol provides a reliable, transaction oriented service between a master device, such as a Personal Computer, and one or more Brooks® S-Protocol compatible Mass Flow Meters and Controllers. The protocol is designed to allow a centralized controller to acquire measurement data from a Mass Flow device and, in case of Mass Flow Controllers, send setpoint values.

The Brooks GF40/GF80 Series S-Protocol devices support digital communications as defined by this manual. This protocol is based on the HART® Communication Foundation (HCF) protocol. Brooks GF40/GF80 Series S-Protocol devices support all the Universal Commands and many of the Common Practice commands as defined by the HCF. However, conformance to the HCF specifications is neither claimed nor implied.

The only physical layer supported by the GF40/GF80 Series S-Protocol devices is RS-485 (see Section 2). The HART Communication Foundation FSK physical layer (Bell-202 modem) is NOT supported by the Brooks S-Protocol devices. Therefore, the commonly available HART "Hand Held Configurators" are NOT compatible with Brooks S-Protocol devices.

This document is intended to give a user the means to implement the protocol structure into his own control system in order to establish communication between the control system and the Brooks GF40/GF80 Series S-Protocol devices. It does not cover the non-communication functionality of the Brooks S-Protocol Mass Flow Meters and Controllers. For this description please refer to Installation and Operation Manual for your specific device.

The remaining sections of this document are summarized below:

- **Section 2 – Device Configuration and Wiring** defines how to properly configure and wire Brooks GF40/GF80 Series S-Protocol devices for digital communications.
- **Section 3 – Message Protocol Structure** describes the HART message protocol.
- **Section 4 – Master/Slave Communications** describes the requirements of the Master in the HART protocol.
- **Section 5 – General Transmitter Information** defines transmitter specific information such as communication response times and units conversions.
- **Section 6 – Universal Commands** defines the message formats for all supported universal commands.
- **Section 7 – Common Practice Commands** defines the message formats for all supported common practice commands.
- **Section 8 – Transmitter Specific Commands** defines the message formats for all supported transmitter specific commands.
- **Section 9 – Transmitter Specific Tables** defines the meanings of various codes utilized by individual commands.

Tables 1-1 through 1-3 provide a summary of S-Protocol commands available in the Brooks GF40/GF80 Series S-Protocol devices. This manual provides details that apply specifically to the Brooks GF40/GF80 Series S-Protocol products:

Tables 1-1 Universal Commands

Command	Description
#0	Read Unique Identifier
#1	Read Primary Variable
#2	Read Primary Variable Current and Percent Range (Supported)
#3	Read Current and all Dynamic Variables (Primary flow and secondary temperature variable supported)
#6	Write Polling Address
#11	Read Unique Identifier associated with Tag
#12	Read Message
#13	Read tag, Descriptor, Date
#14	Read Primary Variable Sensor Information
#15	Read Output Information
#16	Read Final Assembly Number
#17	Write Message
#18	Write Tag, Descriptor, Date
#19	Write Final Assembly Number

Tables 1-2 Common Practice Commands

Command	Description
#37	Set Primary Variable Lower Range Value (Zero)
#38	Reset Configuration Changed Flag
#39 E	EPROM control
#42	Perform master reset
#48	Read Additional Transmitter Status
#50	Read dynamic variable assignments
#59	Write Number of Response Preambles
#66	Enter/Exit Fixed Analog Output Mode
#67	Trim Analog Output Zero
#68	Trim Analog Output Span
#122	Write device identification number (NON-PUBLIC)
#123	Select Baud Rate

Tables 1-3 Transmitter Specific Commands

Command	Description
#128	Enter/Exit Write Protect Mode (Non-Public)
#131	Read Brooks order number (Serial Number)
#132	Read Model Number
#134 R	ead Software Rev
#150	Read Process Gas Type
#151	Read Gas Density, Flow Reference and Flow Range
#152	Read Full Scale Flow Range
#190	Read Standard Temperature and Pressure
#191	Write Standard Temperature and Pressure
#193	Read Operational Settings
#195 Se	lect Gas Calibration
#196	Select Flow Unit
#197	Select Temperature Unit
#215	Read Setpoint Settings
#216	Select Setpoint Source
#218 Se	lect Softstart
#219	Write Linear Softstart Ramp Value
#220	Read PID Controller Values
#221	Write PID Controller Values
#222	Read Valve Range and Valve Offset
#223	Write Valve Range and Valve Offset
#226	Trim Setpoint Input
#230	Get Valve Override Status
#231	Set Valve Override Status
#235	Read Setpoint in % and Selected Units
#236	Write Setpoint in % or Selected Units
#237	Read Valve Control Value
#240 R	ead Totalizer Status
#241	Set Totalizer Control
#242	Read Totalizer Value and Unit
#245	Read Alarm Enable Setting
#246	Write Alarm Enable Setting
#247	Read High/Low Flow Alarm
#248	Write High/Low Flow Alarm
#250	Change User Password

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2 Device Configuration and Wiring

2-1 Device Configuration

The RS-485 communications interface is standard on all Brooks GF40/GF80 Series S-Protocol devices. No hardware configuration is required.

All devices are shipped with the communication data rate set to 19200 baud unless otherwise specified when ordering the device.

WARNING

Before operating the device, ensure all fluid connections have been properly tightened and, where applicable, all electrical connections have been properly terminated.

2-2 Wiring

The RS-485 communications interface is a multidrop connection making it possible to connect up to 32 devices to a computer on a single multidrop line as shown Figure 2-1. Most Computers are NOT equipped with RS-485 ports. In order to connect an RS-485 to a computer, you will need an RS-485 to RS-232C converter. Figure 2-1 shows the connection of three Brooks GF40/GF80 Series S-Protocol devices via an RS-485 bus utilizing an RS-485 to RS-232C converter to the RS-232 serial port of a typical computer. The RS-485 bus requires two matching resistors of 120 Ohm, one at the end of the bus and one at the beginning, near the converter Note that a control line from the PC to the converter is necessary to control the data direction of the RS-485 buffers. The RTS (“Request To Send”) line is shown in Figure 2-1 because this line is used to control data direction in many of the commercially available converters. The actual line used depends on the converter selected.

Table 2-1 - D-Connector Communication Pins

D-Connector Pin Number	RS-485
Pin #14	B (inverted driver side)
Pin #15	A (non-inverted driver side)

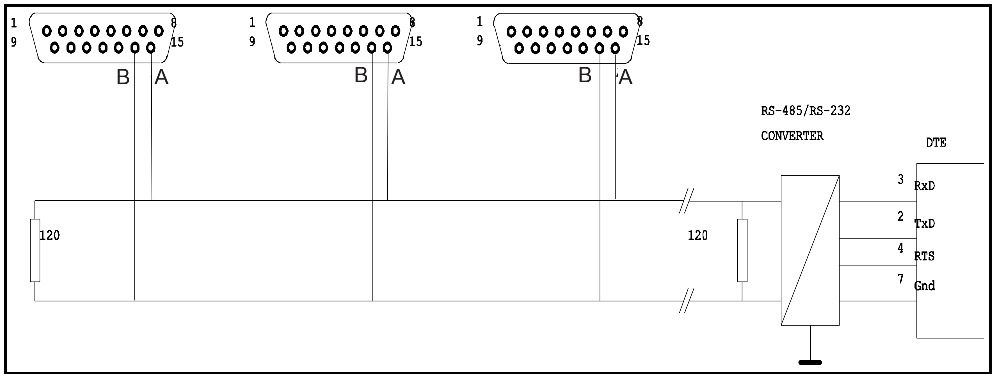

Figure 2-1 - RS-485 Multidrop Interconnection DMFM/C and PC

3-1 Message Protocol Structure

HART is a “master-slave” protocol: each message transaction is originated by the master (central) station, whereas the slave (field) device only replies when it receives a command message addressed to it. The reply from the slave device will acknowledge that the command has been received and it may contain the data requested by the master.

Brooks GF40/GF80 Series S-Protocol devices do not guarantee the timing required to support multiple masters communicating simultaneously to slave devices as defined by the HART Communications Foundation. Brooks GF40/GF80 Series S-Protocol devices do not support Burst Mode.

3-2 Addressing Concept

HART utilizes two possible addressing modes: short frame addressing and long frame addressing. The short frame addressing uses a one byte address of which the least significant nibble (four bits) is used to indicate the slave address. Because slave address 0 is reserved as a broadcast address, this provides the possibility to attach up to 15 different field devices and one master device on one multidrop bus. The long frame addressing mode uses 5 bytes (40 bits) as an address of which 38 bits are used to indicate the slave device. The slave address is built up from the manufacturer code (1 byte), the device type code (1 byte) and a device identification number (3 bytes). Details on addressing are explained in Section 3-4-4.

3-3 Character Coding

HART messages are coded as a series of 8-bit characters or bytes. These are transmitted serially, using a conventional UART (Universal Asynchronous Receiver/ Transmitter). As in normal RS-232C and other asynchronous communication links, a start bit, a parity bit and a stop bit are added to each byte. These allow the receiving UART to identify the start of each character and to detect bit errors due to electrical noise or other interference. A HART character is built up from:

1 Start bit - 0 bit
8 Databits
1 Odd parity bit
1 Stop bit - 1 bit

This sequence is summarized in Figure 3-1. Since HART is an asynchronous protocol, successive characters may be separated by idle periods (logical 1 level), but the idle period must not exceed 1 character time.

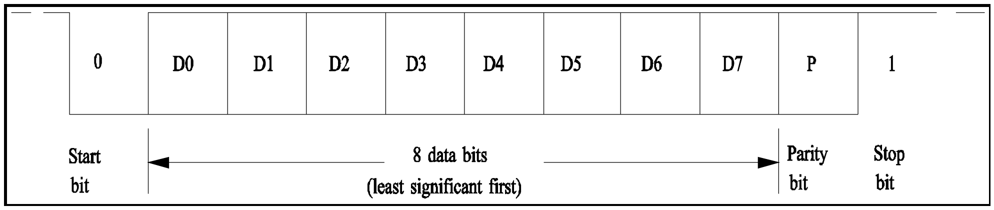

Figure 3-1 Single Character Bit Sequence

3-4 Message Format

3-4-1 Message Structure

HART specifies a message structure which is given in Figure 3-2 below.

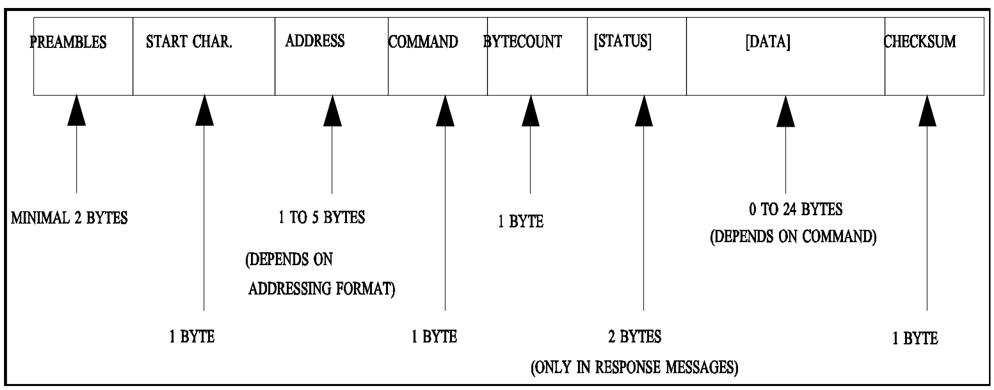

Figure 3-2 HART Message Structure

This structure is used for both the request (master to slave) and the response (slave to master) messages. The status part and the data part are shown in square brackets, because their occurrence in the message depends on the type of message (response or request message) and the command number. The individual items are explained below.

3-4-2 Preamble Characters

Every message, whether from a master or a slave device, is preceded by a specified number of hexadecimal FF characters (databyte with all 1's). These characters, called preamble characters, are used in the message-detect pattern together with the start character. The preamble characters are used to synchronize the field device. The Brooks GF40/GF80 Series S-Protocol devices require at least 2 preamble characters in order to be able to proceed in the message detection with the start of message character. Note that due to potential losses due to RS-232 to RS-485 converters, a master should send a minimum of 5 preamble characters in order to guarantee that slave device receives the required 2 preamble characters.

3-4-3 Start Character

The start character or delimiter is a one byte code used to detect the type of frame (type of message) being transmitted and the type of addressing being used. The most significant bit indicates the addressing mode used: 0 for short frame and 1 for long frame addressing, whereas the three least significant bits indicate the frame type of the message: 010 indicates a Start-Of-Text character and 110 indicates an Acknowledge character. The Start-Of-Text character is used to indicate a message from the master to a slave device whereas the Acknowledge character is used to indicate the response messages from slave devices to the master. The rest of the bits in the character are all zeros. See Figure 3-3 and Table 3-1 below.

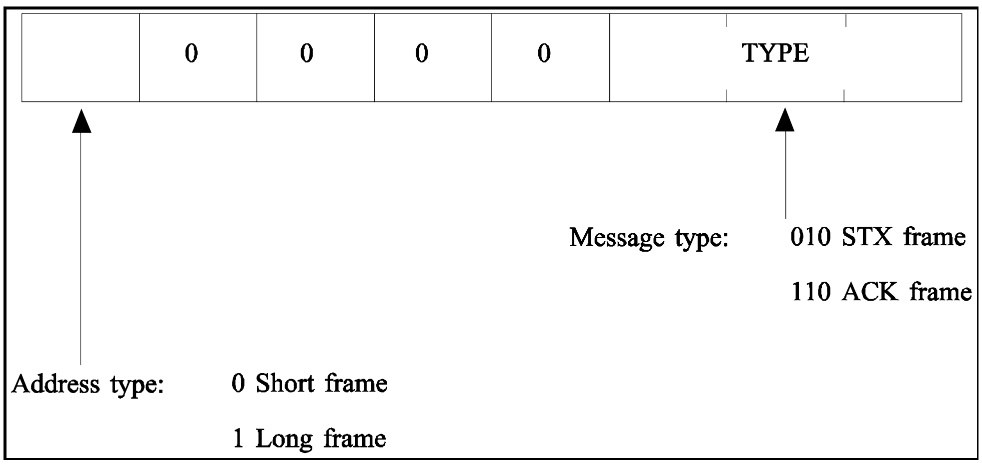

Figure 3-3 Start Character Settings

Table 3-1 Start Character Codings (Hexadecimal)

	Short frame	Long frame
Master to slave (STX)	02	82
Slave to master (ACK)	06	86
Address field length	1 byte	5 bytes

3-4-4 Address Characters

The address field contains both the master and the field device addresses for the message. These may be contained in a single byte (short frame format) or in five bytes (long frame format). In either format, the most significant bit is usually the single-bit address of the master device taking part in the message transaction (either sending a command or receiving a reply from a slave device). Since only two masters are allowed only one bit is needed for the master address. This bit will be 1 if it indicates the primary master system, and 0 if it indicates the secondary master system. The rest of the address field is determined by the frame format.

Figure 3-4 below shows the address character in the short frame format. The 4 least significant bits are the slave address, which can be used as a polling address.

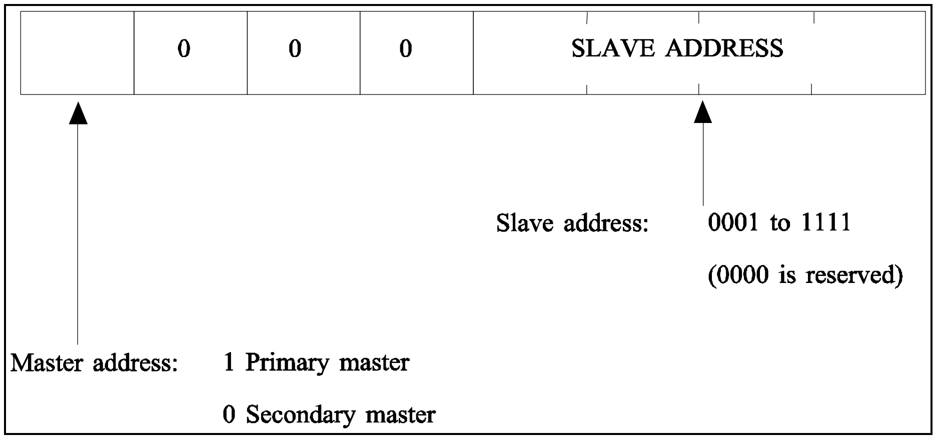

Figure 3-4 Short Frame Address Character

In the long frame format the slave device address is represented by a 38-bit number. The structure of the address is given in Figure 3-5 below.

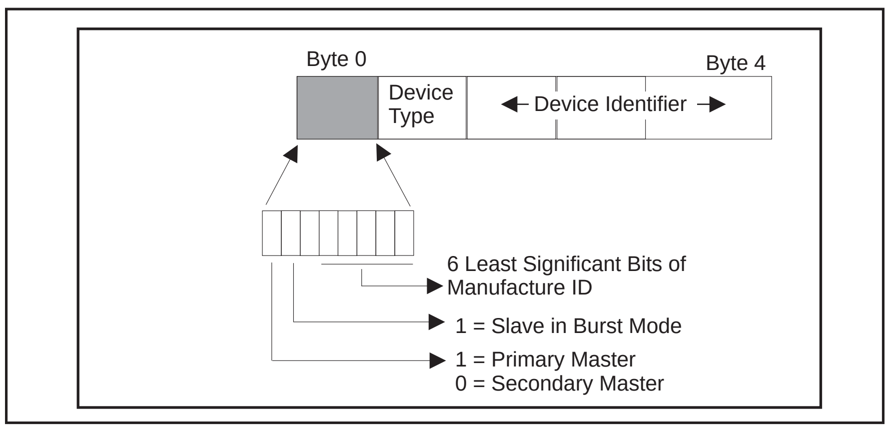

Figure 3-5 Long Frame Address Characters

In the long frame format the slave address part of the five address characters is build up from three sources: The 6 bits of the first byte of the slave address part represent the manufacturers code. In case of devices made by Brooks Instrument this is the number 10 (decimal). The manufacturer number is a number which is stored in the device by the manufacturer and which can not be changed by the user.

The second byte in the address is the device type code. This code indicates the type of the device addressed. The device type code will be 90 for all Brooks GF40/GF80 Series S-Protocol devices. The device type code is a number which is stored in the Brooks GF40/GF80 Series S-Protocol devices by the manufacturer and which can not be changed by the user.

The last three bytes form a 24-bit unique identification number. As the name implies, this value must be unique to each Brooks GF40/GF80 Series S-Protocol device on a network. For legacy products this value was derived from the serial number of the device, however for the GF40/GF80 this value is a random value. Command #122 can be used to change this value.

A special case occurs when all bits of the slave address part are set to 0. A message with this type of address, called a broadcast address, will be accepted by all slave devices attached to the bus. A slave device will always respond to a message with the broadcast address unless the message contains additional information in the data portion of the message that allows the slave device to determine that the message is not addressed to that device. Brooks GF40/GF80 Series S-Protocol devices support only one such command, Command #11. This type of addressing can be used to address devices of which the manufacturer and the device type codes and the unique identification number are not available to the host system and with which this information can still be retrieved from the unknown device. Command #11 data contains a Tag Name. Only a slave device with the specified Tag Name will respond to Command #11 even if the address in the message is the broadcast address. The Tag Name is an 8 character field which is equal to the last 8 digits of the device's serial number. See Section 4-2 for a detailed description of the use of Command #11.

3-4-5 Command Character

The command character is a 1 byte unsigned integer in the range from 0 to 255 (decimal), which indicates the action the slave device has to perform. A larger range of commands is theoretically possible by using the expansion code or 254 (decimal) followed by a second byte. This feature however is not implemented by the Brooks GF40/GF80 Series S-protocol devices. The received command is echoed back by the slave device in its reply to the master.

Three types of commands are available to the user: the ‘Universal Commands’, the ‘Common-Practice Commands’ and the ‘Transmitter-Specific Commands’. The Universal Commands are a number of commands in the range from 0 to 19, which are implemented by all field devices utilizing the HART protocol. Refer to Section 6 for descriptions of all available universal commands. The Common-Practice Commands are a number of commands in the range from 32 to 127, which can be implemented by all devices. These commands perform tasks which are often common to most devices. Refer to Section 7 for descriptions of all implemented Common-Practice Commands. The last category, Transmitter-Specific Commands are a number of commands, ranging from 128 to 250 which are specific to the type of device. Refer to Section 8 for descriptions of all available Transmitter-Specific Commands. The commands #251 to #255 are reserved.

3-4-6 Byte Count Character

The bytecount character is a 1 byte unsigned integer indicating the number of bytes which will form the remainder of the message. This number includes the two status bytes (only if the message is a response message) and the bytes in the data part. It does NOT include the checksum byte. The byte count character is used by the receiving device to identify the checksum byte and to determine when the message is finished.

3-4-7 Status Characters

Status Characters consists of two bytes, which contain bit-coded information about communications errors, command errors, and device status as defined in Table 3-2. Only response messages from the slave device to the master device will contain status characters.

Table 3-2 Status Byte Coding

	First Byte	Second Byte
Communication errors	Bit 7 1 = Communication error	Bit 7 0
	Bit 6 Parity error (hex C0) Bit 5 Overrun error (hex A0) Bit 4 Framing error (hex 90) Bit 3 Checksum error (hex 88) Bit 2 Reserved (hex 84) Bit 1 Rx Buffer Overflow (hex 82) Bit 0 Undefined	Bit 6 Bit 5 Bit 4 All 0 Bit 3 Bit 2 Bit 1 Bit 0
Command errors	Bit 7 0 = Communication error	Bit 7 Device Malfunction
	Bit 6 to 0 (not bit-mapped): 0 Non command specific error 1 Undefined 2 Invalid selection 3 Passed parameter too large 4 Passed parameter too small 5 Incorrect byte count 6 Transmitter specific command error 7 IIn write-protect mode 8-15 Command specific errors 16 Access restricted 32 Device is busy 64 Commanded not implemented	Bit 6 Configuration Changed Bit 5 Cold Start Bit 4 More Status available. Use Command # 48 to get more information Bit 3 Primary variable analog output fixed Bit 2 Primary variable analog output saturated Bit 1 Non primary variable out of range Bit 0 Primary variable out of range

If the communication failed (i.e. the slave received distorted information) the first byte indicates the receiver error(s) of the slave device. The second byte will then be 0. If communication did not fail, the first byte will give command execution information, whereas the second byte will give information on the status of the device. The command specific errors 8 - 15 are errors which can have a different meaning for different commands. Refer to the Sections 6, 7 and 8 for more information.

3-4-8 Data Characters

For the commands that contain data, the data field may contain up to a maximum of 24 8-bit data bytes. The data can appear in a number of formats described in the following sections.

3-4-8-1 8-Bit Unsigned Integer Format

This format can be used to transfer codes (e.g unit codes), indexes (e.g analog output numbers) and raw data. If a parameter, represented by an 8-bit unsigned integer in a command data part is not implemented, codes like 250, “Not Used” or 0 will be used.

3-4-8-2 24-Bit Unsigned Integer Format

This format can be used to transfer large integer data numbers (e.g. the valve values).

3-4-8-3 IEEE 754 Floating Point Format

This format is based on the IEEE 754 single precision floating point standard:

S EEEEEEE	E MMMMMMM	MMMMMMMM	MMMMMMMM
byte # 0	byte # 1	byte # 2	byte # 3

Where: S - Sign of mantissa (1 = negative)
E - Exponent; Biased by 127 in two's complement format
M - Mantissa; 23 least significant bits, fractional portion

The value of a parameter described in the above format can thus be found by:
Value = S 1.M * $2^{(E - 127)}$
This format is also used in most personal computers.
The floating point parameters not used by a device will be filled with 7F A0 00 00 (hexadecimal) or 'Not-A-Number'.

3-4-8-4 ASCII Data Format

Some of the alphanumeric data passed by the protocol is transmitted to and from the devices in the ASCII format. Refer to any ASCII Code table for the alphanumeric code assignments.

3-4-8-5 Packed-ASCII (6-bit ASCII) Data Format

Some of the alphanumeric data passed by the protocol is transmitted to and from the devices in the Packed-ASCII format. Packed-ASCII is a subset of ASCII (See Table 3-3) produced by removing the two most significant bits from each ASCII character. This allows four Packed-ASCII to be placed in the space of three ASCII characters. Typically four Packed-ASCII strings are even multiples of three bytes. Figure 3-6 illustrates the byte sequence.

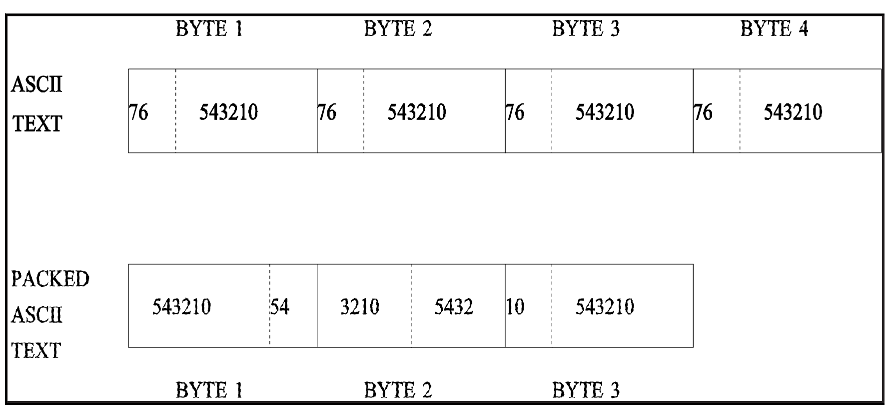

Figure 3-6 Packed-ASCII Construction

Construction of Packed-ASCII:
a. Remove bit #7 and bit #6 from each ASCII character.
b. Pack four 6-bit ASCII bytes into three bytes.

Reconstruction of ASCII characters:
a. Unpack the four 6-bit ASCII characters into four bytes.
b. Place the complement of bit #5 of each unpacked 6-bit ASCII character into bit #6.
c. Set bit #7 of each unpacked ASCII to zero.

Table 3-3 Packed-ASCII Codes

Char	Code	Char	Code	Char	Code	Char	Code
@	00	P	10	(space)	20	0	30
A	01	Q	11	!	21	1	31
B	02	R	12	“	22	2	32
C	03	S	13	#	23	3	33
D	04	T	14	$	24	4	34
E	05	U	15	%	25	5	35
F	06	V	16	&	26	6	36
G	07	W	17	‘	27	7	37
H	08	X	18	(	28	8	38
I	09	Y	19	)	29	9	39
J	0A	Z	1A	*	2A	:	3A
K	0B	[	1B	+	2B	;	3B
L	0C	\	1C	,	2C	<	3C
M	0D	]	1D	-	2D	=	3D
N	0E	^	1E	.	2E	>	3E
O	0F	_	1F	/	2F	?	3F

3-4-8-6 Checksum Characters

The checksum byte contains the ‘exclusive-or’ (‘longitudinal parity’) of all the characters preceding it in the message starting with the start character. It provides a further check on transmission integrity, beyond the one provided by the parity check on each individual byte. The exclusive-or of all the message bytes (including the start character, excluding the checksum byte) and the checksum byte itself should read exactly zero.

4-1 Master/Slave Communications

Section 3 of this manual defined the S-Protocol message structure in detail. Section 4 of this manual will describe how to utilize the S-Protocol message structure to perform master slave communications with a Brooks GF40/GF80 Series S-protocol device. This section focuses on RS-485 line handling, establishing communications with a device, error recovery, and timing. Sections 6, 7, and 8 of this manual define all S-Protocol commands available in Brooks GF40/GF80 Series S-protocol devices. This section will conclude with examples of typical communications sequences.

Master devices initiate all communications on a Master/Slave communications network. Master devices are typically a computer of some kind but other devices such as PLC's can also operate as a Master device.

Slave devices only respond to messages initiated by a Master. Brooks GF40/GF80 Series S-Protocol devices are always Slaves on the communications network.

4-1-1 RS-485 Line Handling

The physical communications layer used by Brooks GF40/GF80 Series S-Protocol devices is RS-485. On an RS-485 physical communications layer, all data is transmitted and received using differential signals on a single pair of wires. Since both the Master and the Slave devices use the same pair of wires to transmit their data, care must be taken to ensure that only one device has its transmitter enabled at any point in time.

Figure 4-1 shows a typical message exchange using RS-485. Notice that the Master's transmitter is enabled only during the Master Request message and the Slave's transmitter is enabled only during the Slave Response message. At all other times, the transmitters on the Master and all Slaves connected to the network must be in their high impedance state, leaving the network "Un-Driven."

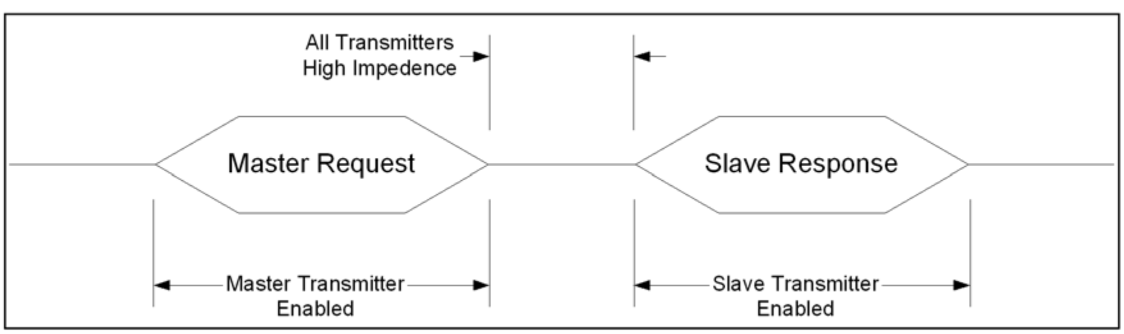

Figure 4-1 Typical Message Exchange Using RS-485 Communications

It is the user's responsibility to guarantee that the Master's transmitter is enabled only during the Master Request message. Control of the Master's transmitter is dependent upon the hardware used by the Master. If an RS-232 to RS-485 converter is used, the most common control is the RTS signal on the RS-232 interface as shown in Figure 2-1 (See Section 2-2). Refer to the user manual for your hardware to determine the proper control method required in your system.

Timing the enabling/disabling of the transmitter is very important. The transmitter must be enabled before the first bit of the first character is transmitted and must be disabled only after the last bit of the last character is transmitted. Additionally, all transmitters have some finite turn-on/turn-off delays which may be affected by the wire length and wire quality of your network. The S-Protocol message structure attempts to minimize these affects by requiring all messages to have at least 5 preamble characters while only 2 are required for the receiving device to detect a valid message (see Section 3-4-2). This allows up to 3 lost characters due to turn-on/turn-off delays.

Disabling a transmitter at the proper time is frequently a difficult task. Many UARTS/systems do not provide an indication when the last byte of a message is completely transmitted. It is more likely that an indication is provided when the last byte of a message is starting to be transmitted. Since the last byte of an S-Protocol message is the checksum byte for the message, it is critical that the transmitter remain enabled until the last byte is completely transmitted. One solution is to transmit an extra character at the end of a message (typically 0x00) and then disable the transmitter when the indication is received that the extra character is starting to be transmitted. However, the transmitter cannot be enabled too long after a message is complete. Slave devices will begin transmitting a response as soon as 5 msec after the reception of an error free request message.

High data rates increase the importance of disabling the transmitter quickly. At 19200 baud, one character time is 0.57 msec. Thus, the 3 lost character “cushion” represents only 1.72 msec. While the response of a Brooks GF40/GF80 Series S-Protocol device is always at least 5 msec regardless of the data rate, lower data rates provide a longer “cushion” and thus is a possible solution if disabling the transmitter in a timely manner proves difficult. Another solution is to increase the number of preamble characters transmitted by the Master and/or the slave.

4-2 Establishing Communications with a Device

In order for a Master to establish communications with a Brooks GF40/GF80 Series S-Protocol device, the Master must know the address of the Brooks device. The S-Protocol supports both Short Frame Addressing and Long Frame Addressing as defined in Section 3-2.

Short Frame Addressing allows a master to communicate with up to 15 devices. Each device on the network must have a unique Polling Address with a value of 1–15. Short Frame Addressing has one side effect which will be undesireable in many applications. If the Polling Address is set to a non-zero value (as required for Short Frame Addressing), the Primary Analog Output will be fixed at the low range of the output and will not respond to the applied process. If your system requires the use of the Primary Analog Ouput, then Long Frame Addressing must be used.

Long Frame Addressing allows a master to communicate with up to 16,777,215 devices on a wide area network (RS-485 has a limit of 32 devices per daisy chain). Each device is pre-programmed at the factory with a unique long address. Using the process described below, the Master can obtain the long address from the device by knowing only the device Tag Name. The Tag Name is pre-programmed at the factory and is printed on the devices's calibration sheet.

The following procedure can be performed online in order to obtain a device's long address:

1. Send Command #11 (See Section 6-6) using Long Frame Addressing and an address of 0. In the data section of Command #11, use the device's Tag Name to identify the device. Command #11 requires that the Tag Name be transmitted in Packed-ASCII format as defined in Section 3-4-8-5.
2. Extract the Manufacturer ID, Manufacturer's Device ID, and Device ID Number from the response and construct the Long Address Frame as shown in Figure 4-2.

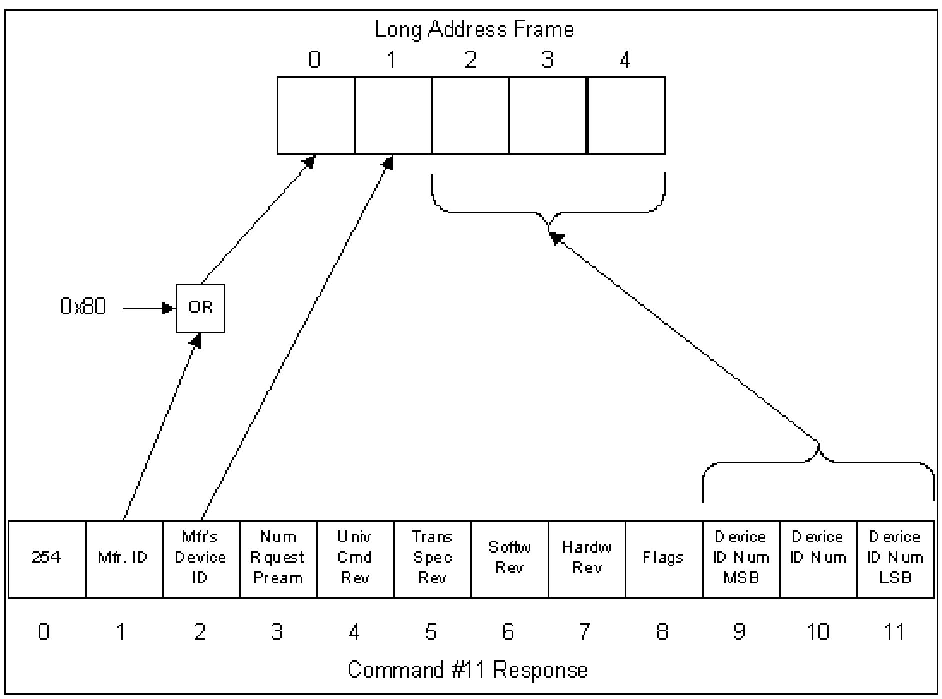

Figure 4-2 Command #11 Response to Long Frame Address

4-2-1 Example of Using Command #11

Command #11 reads the unique identifier from a device whose Tag Name is specified in the Command #11 request from the Master. Tag Names are strings of up to 8 characters which are limited to the reduced ASCII set defined in Table 3-3. A Tag Name consists of the last 8 digits of the device's serial number. Table 4-1 is an example of converting an 8 character Tag Name to 6 bytes in the Packed-ASCII format. In this example, the Tag Name of the device will be “MFC-1234”.

Table 4-1 Converting Tag Name to Packed ASCII

	Representation							
Tag Name	MFC-1234							
Characters	M	F	C	-	1	2	3	4
8- bit ASCII (hex)	4D	46	43	2D	31	32	33	34
Bit 7 & 8 removed:								
6 bit ASCII (hex)	0D	06	03	2D	31	32	33	34
6 bit ASCII (binary)	001101	000110	000011	101101	110001	110010	110011	110100
Packed (binary)	00110100 0110 0000 11101101 11000111 00101100 11110100							
Packed (hex)	34 60 ED C7 2C F4							

Figure 4-3 shows the request message for Command #11 sent by the Master to the Brooks GF40/GF80 Series S-Protocol device whose Tag Name is MFC-1234.

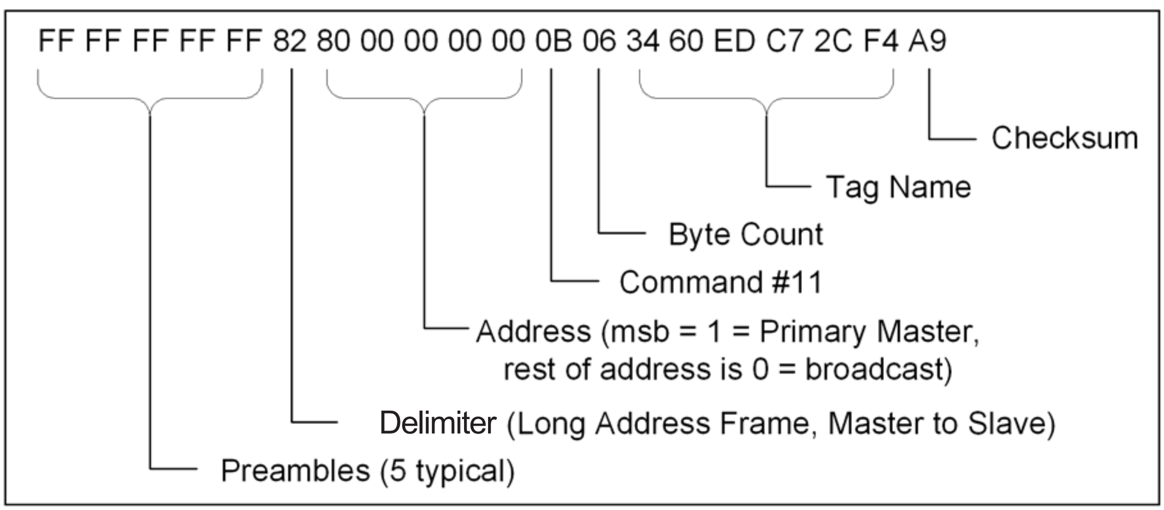

Figure 4-3 Command #11 Master Request

A possible Response Message from a Brooks GF40/GF80 Series S-Protocol device is shown in Figure 4-4.

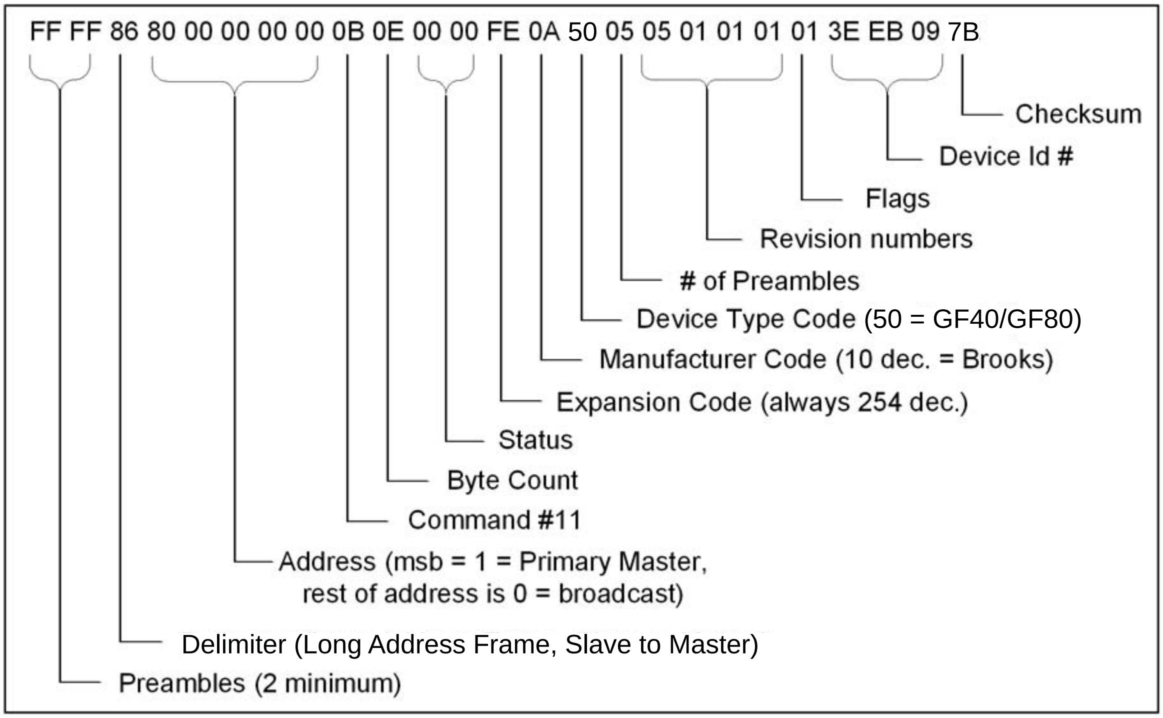

Figure 4-4 Command #11 Response Message

From the response, the long address can be extracted as shown in Figure 4-5.

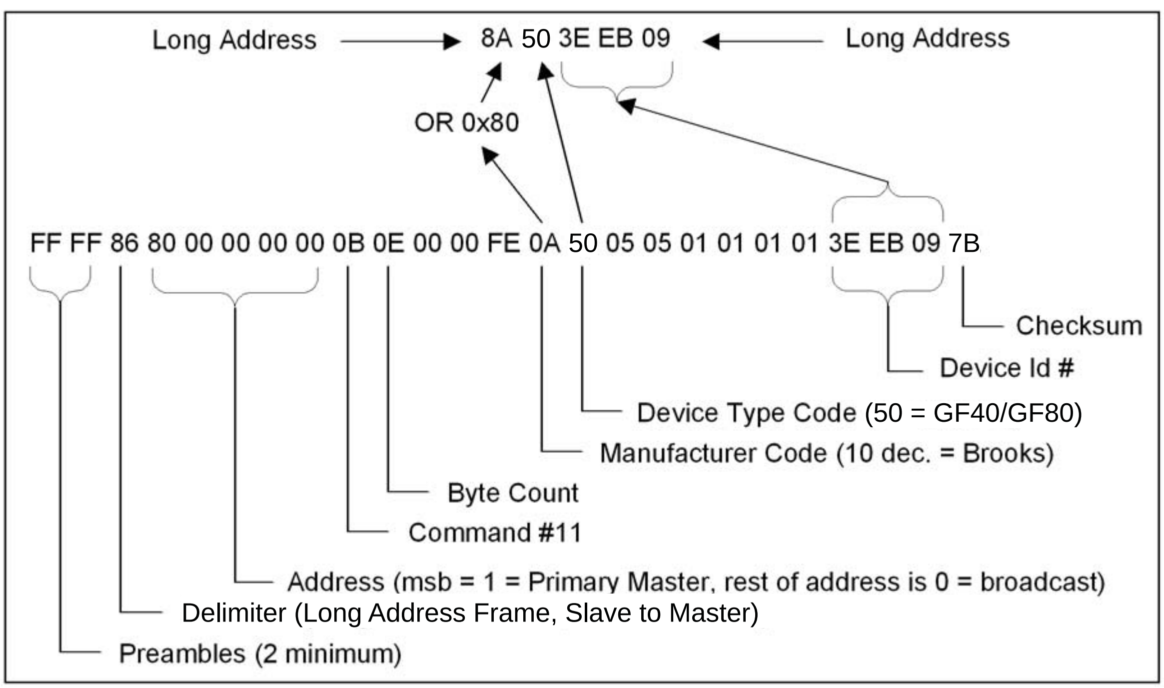

Figure 4-5 Extracting the Long Address

4-3 Alarm Configuration and Monitoring

Brooks GF40/GF80 Series S-Protocol devices monitor for various alarm conditions such as Flow Rate, Totalizer Overflow, and Diagnostics. To determine which alarms conditions have been detected, use Command #48 (See Section 7-3). However, it is not necessary to constantly poll Command #48 to determine when an alarm condition has been detected. All slave response messages contain a 2 byte status. If an alarm condition has been detected, then bit 4 of the second status byte will indicate “More Status Available”. Then Command #48 can be used to determine the alarm condition(s) that has been detected.

To configure which alarm conditions are monitored and reported by the device, refer to Commands 245, 246, 247, and 248 in Section 7, also Table 9-15.

4-4 Error Handling

In all communications networks, communications errors can and will occur. Both the Master and the Slave devices must be able to properly handle errors in order to maintain a operating network. When a Brooks GF40/GF80 Series S-protocol device detects a communications error, one of two results may occur. It may respond with an error code, or it may not respond at all to the request. The result depends upon the type of error that was detected, and where in the message the error was detected. It is important that the Master handles the situation correctly.

There are two basic type of errors defined by the S-Protocol: Communications Errors and Command Response errors. The type of error can be determined by examining the Status Code returned by the slave device (See section 3-4-7). Command Response errors are typically the result of a programming error in the Master and should not normally occur in a mature system. The main focus of this section will be Communication Errors.

Communications Errors are frequently the result of external environment issues, faulty wiring, etc. In a properly designed network, Communications Errors should be rare. A Communications Error can occur in either the Master to Slave Request or the Slave to Master response. If the error occurs in a Master to Slave request, one of two results may occur. It may respond with an error code, or it may not respond at all to the request.The result depends upon the type of error that was detected, and where in the message the error was detected. It is the responsibility of the Master device to check all Slave to Master responses for errors including message frame formatting, longitudinal parity, and vertical parity.

Regardless of the type of error and when or where it was detected, the normal way to handle a Communications Error is to simply retry the message. Typically, a master would attempt to retry a message at least twice to allow any external disturbance to clear. In the event that the retries are unsuccessful, then the Master device must handle the situation in a manner consistent with the requirements of the system. Typical responses to such an error are: Taking the device off-line so that the remainder of the network is not affected; Notifying an operator; Triggering a system alarm; etc.

A Master device must allow sufficient time for a Slave to respond before attempting to retry the message. The average response time for a Brooks GF40/GF80 Series S-Protocol device is less than 1 msec, but it is possible to for the response to be as along as 10 msec. The Master should wait 4 times the maximum response time (40 msec) before retrying the message. As long as communications errors are infrequent, this retry delay time should not affect system performance.

4-5 Examples

The following 2 examples show the most typical messages used by a Master when communicating to a Brooks GF40/GF80 Series S-Protocol device: Reading Flow Rate and Sending the Setpoint. These examples will use the Long Addressing Frame with the long address established in the example in Section 4-2-1. The calibrated full scale of the device used in these examples is 1.0 liters per minute.

4-5-1 Reading Flow Rate

The flow rate of the device can be read using any of the following commands:

- Command #1 – Read Primary Variable
- Command #2 – Read Primary Variable Current and Percent of Range
- Command #3 – Read Current and All Dynamic Variables

This example will use Command #1 to read the Flow Rate of the device. This command returns the flow rate in the unit of measure as configured in the device. The units can be changed using Command #196, Select Flow Unit.
In the example shown in Figure 4-6, the device returns a flow of 0.8502 liters/min.

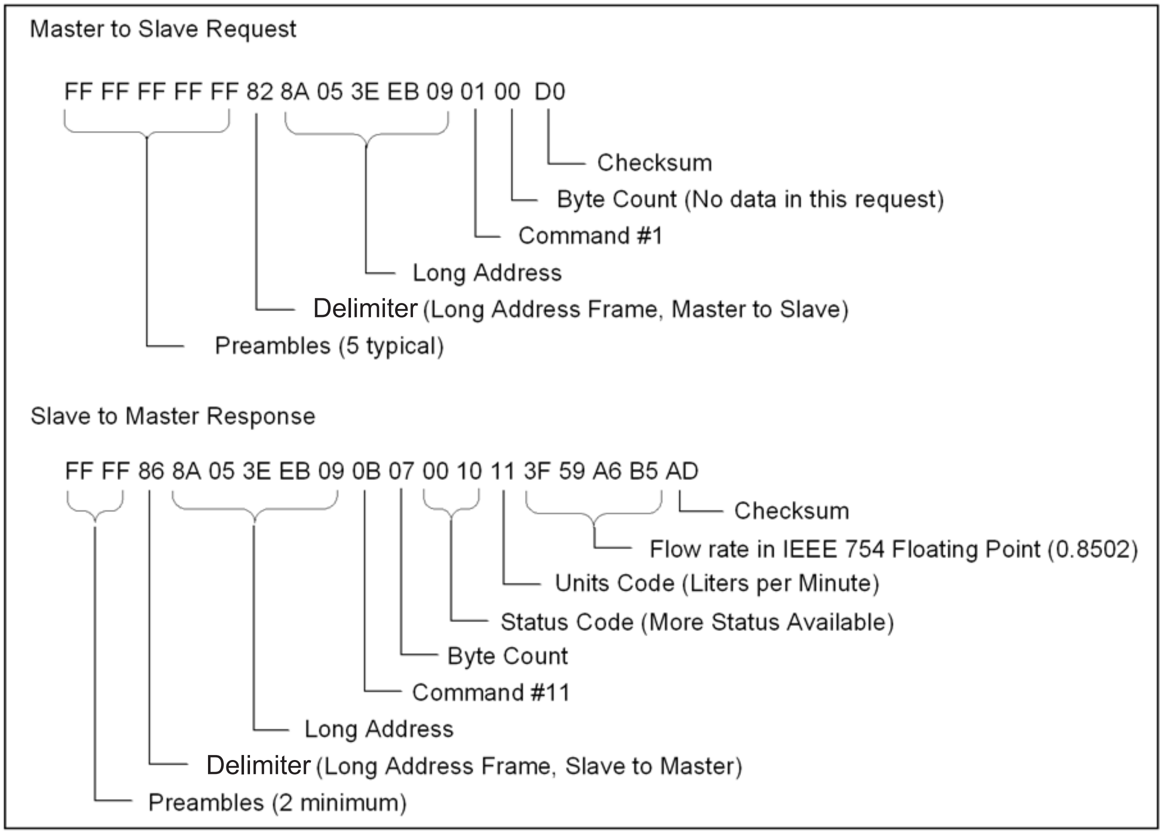

Figure 4-6 Reading Flow Rate Example

4-5-2 Sending the Setpoint

The Setpoint can be controlled via the network using Command #236. In the example shown in Figure 4-7, the setpoint is set to 85% of full scale.

If Setpoint is controlled via an analog input, then Setpoint can be read using Command #235.

When Command #236 is received by a Brooks GF40/GF80 Series S-Protocol device, the Setpoint Source is automatically changed to digital mode. Setpoint source can be changed back to analog by using Command #216 or by cycling power to the device.

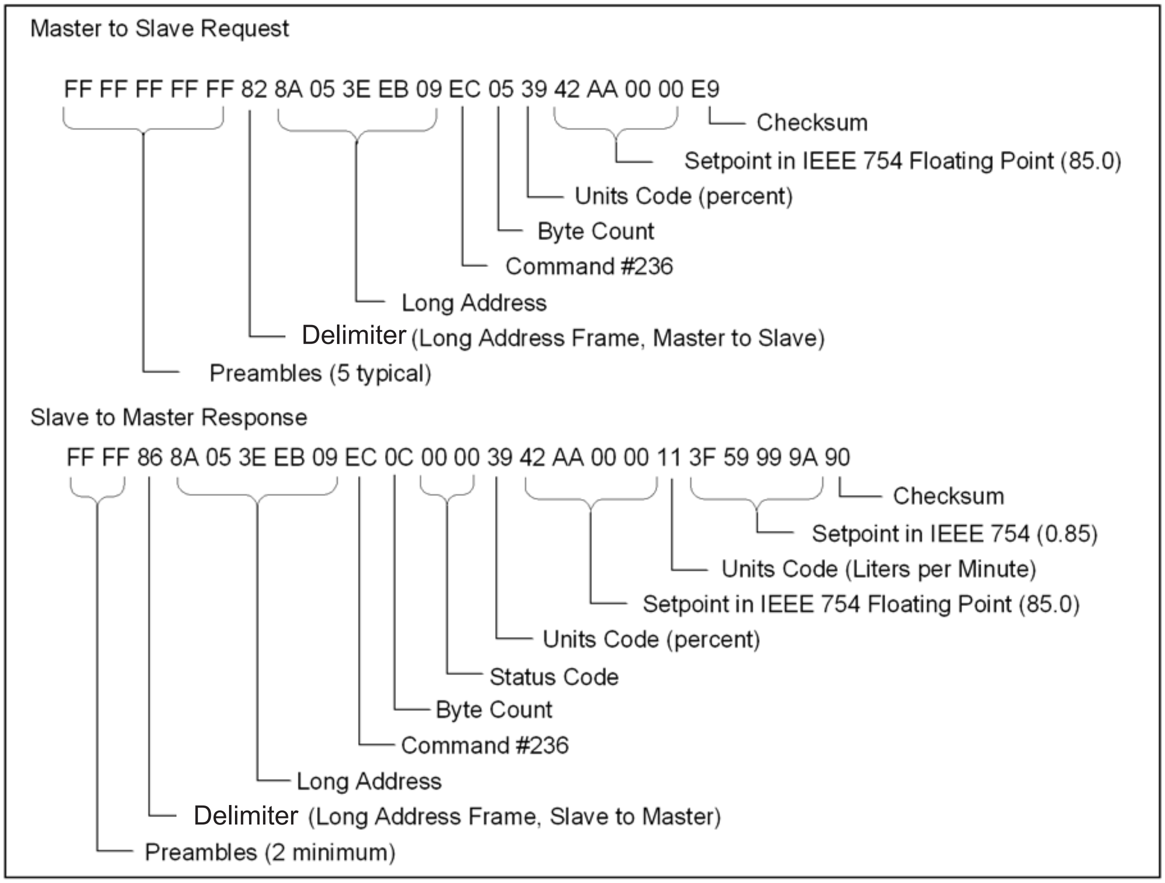

Figure 4-7 Writing Setpoint Example

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5-1 Referenced Documents

The following HART documents where referenced in order to implement the protocol:

Data Link Layer Specification Rev.	HCF_SPEC-81	Rev 7.1
Command Summary Information Rev.	HCF_SPEC-99	Rev 7.1
Command-Specific Response Code Defs. Rev.	HCF_SPEC-307	Rev 4.1
Universal Command Specification Rev.	HCF_SPEC-127	Rev 5.2
Common-Practice Command Specification Rev.	HCF_SPEC-151	Rev 7.1
Common Tables Rev.	HCF_SPEC-183	Rev 11.0

5-2 Unit Conversions

5-2-1 Flow Rate Conversions

All flow values involved in the exchange of data during communication are converted to/from the user specified flow units. A list of supported flow units is provided in Section 8-3. The user can change the flow units to be used for all flow rate conversions with Command #196.

Volume flow units are always reported at specific reference conditions. Using Command #196, the user can select reference condition type from 3 options as listed in Section 8-3.

- Normal - reference conditions of 0 ℃ and 1 atmosphere. (273.15 degrees K/ 101325 Pascals).
- Standard – user specified reference conditions. Use Brooks Service Suite software to change the user specified reference conditions.
- Calibration – reference conditions used at calibration.

Reference condition conversions are done using the Boyle-Gay-Lussac law

$$\frac{P_1 \bullet V_1}{T_1} = \frac{P_2 \bullet V_2}{T_2} = Constant \quad (1)$$

Where P is pressure, T is temperature and V is volume (per unit of time). The indexes 1 and 2 represent the two different reference conditions. This results in the reference conversion formula

$$V_2 = \frac{(P_1 \bullet T_2)}{(P_2 \bullet T_1)} * V_1 \quad (2)$$

Where applicable the conversion factors are taken from *The Handbook of Chemistry and Physics, 60th edition*, R.C. Weast (Ed.), CRC Press Inc., Cleveland, Ohio.

5-2-2 Temperature Conversions

All temperature values involved in the exchange of data during communication are converted to/from the user specified temperature units. A list of supported temperature units is provided in Section 8-5. The user can change the temperature units to be used for all temperature conversions with Command #197.

6-1 Command # 0 Read Unique Identifier

Command used to retrieve the expanded device-type codes, revision levels and the device identification number from the specified device. The device type code will always be returned in the expanded three byte format (i.e. "254", manufacturer identification code, manufacturers device type code). The combination of the manufacturer identification code, manufacturer's device type code and device identification code make up the unique identifier for the extended frame format of the data link layer.

Request data bytes:

NONE

Response data bytes:

254	MFR. ID	MFR's DEVICE TYPE	NUMBER RQUEST PREAM	UNIV. CMD. REV.	TRANS. SPEC. REV.	SOFTW REV.	HARDW REV.	FLAGS	DEVICE ID NUM MSB	DEVICE ID NUM	DEVICE ID NUM
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Device type code for "expansion". Contains the code "254" (decimal).
1	8-bit unsigned integer	Manufacturer identification code. (Always 10).
2	8-bit unsigned integer	Manufacturers device type code. Refer to Section 9-2, Device type codes.
3	8-bit unsigned integer	Number of response preamble characters required for the request message from the master to the slave.
4	8-bit unsigned integer	Universal command revision level implemented by this device.
5	8-bit unsigned integer	Transmitter specific command revision level implemented by this device.
6	8-bit unsigned integer	Software revision level of the device.
7	8-bit unsigned integer	Hardware revision level of the electronics in the device. Format: xxxxx.yyyB x - Device hardware revision level, 5-bit unsigned integer, level 15 is reserved. y - Physical signalling code, 3-bit unsigned integer, refer to Section 9-8, Physical signalling codes.
8	8-bit unsigned integer	Flags. Refer to Section 9-10, Flag assignments.
9 - 11	24-bit unsigned integer	Device identification number.

6-1-1 Command #0 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-2 Command #1 Read Primary Variable

Read the primary variable. The primary variable is the flow rate of the device expressed in the selected flow units at the selected flow reference conditions. See Command #196 for information on setting Flow Units, and Flow Reference conditions.

Request data bytes:
NONE

Response data bytes:

SEL. FLOW UNIT	FLOW RATE MSB	FLOW RATE	FLOW RATE	FLOW RATE LSB
#0	#1	#2	#3	#4

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Primary variable unit code. Refer to Section 9-3, Flow rate unit and reference codes.
1 - 4	32-bit floating point, IEEE 754 format	Primary variable: flow rate.

6-2-1 Command #1 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-3 Command #2 Read Primary Variable Current and Percent Range

Read the primary variable, flow rate, as current or voltage and as a percent of the primary variable range. For Brooks GF40/GF80 Series S-protocol devices, the current/voltage field reports current in mAmps or voltage in volts depending upon the configuration of the output of the device.The current/voltage always matches the analog output of the device including alarm conditions and set values. Percent of range always follows the primary variable, even if the current is in an alarm condition or set to a value. Also, the percent of range is not limited to values between 0% and 100%, but tracks the primary variable to the sensor limits.

Request data bytes:

NONE

Response data bytes:

CURRENT/ VOLTAGE MSB	CURRENT/ VOLTAGE	CURRENT/ VOLTAGE	CURRENT/ VOLTAGE LSB	PV % RANGE MSB	PV % RANGE	PV % RANGE	PV % RANGE LSB
#0	#1	#2	#3	#4	#5	#6	#7

Data Byte #	**Type**	**Remarks**
0 - 3	32-bit floating point, IEEE 754 format	Analog output current or voltage [milliamperes or volts].
4 - 7	32-bit floating Point, IEEE 754 format	Primary variable: flow rate [% of range]

6-3-1 Command #2 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-4 Command #3 Read Current and all Dynamic Variable

Read the current and the dynamic variables. The current/voltage field reports current in mAmps or voltage in volts depending upon the configuration of the output of the device. The current/voltage always matches the analog output current/voltage of the device including alarm conditions and set values. For the GF40/GF80 Series S-Protocol devices, the dynamic variable assignments are as follows:

Variable #0: Flow Rate (Primary Variable)
Variable #1: Temperature (Secondary Variable)

Request data bytes:

NONE

Response data bytes:

CURRENT/ VOLTAGE MSB	CURRENT/ VOLTAGE	CURRENT/ VOLTAGE	CURRENT/ VOLTAGE LSB	PRIMARY VAR. UNITS	PRIMARY VAR.	PRIMARY VAR.	PRIMARY VAR.
#0	#1	#2	#3	#4	#5	#6	#7

PRIMARY VAR. LSB	SECOND. VAR. UNITS	SECOND. VAR. MSB	SECOND. VAR.	SECOND. VAR.	SECOND. VAR. LSB
#8	#9	#10	#11	#12	#13

Data Byte #	Type	Remarks
0 - 3	32-bit floating point, IEEE 754 format	Analog output current/ voltage [milliamperes or volts].
4	8-bit unsigned integer code.Refer to Section	Primary variable unit 9-3, Flow rate unit and reference codes.
5 - 8	32-bit floating point, IEEE 754 format	Primary variable: flow rate.

9	8-bit unsigned integer	Secondary variable unit code.Refer to Section 9-5, Temperature unit codes.
10 - 13	32-bit floating point, IEEE 754 format	Secondary variable: temperature.

6-4-1 Command #3 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-5 Command #6 Write Polling Address

This command writes the Polling Address (Short Frame Address) to the field device.

Request data bytes:

POLLING ADDRESS
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Polling Address: 0-15 16-255 Undefined

Response data bytes:

POLLING ADDRESS
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Polling Address: 0-15 16-255 Undefined

6-5-1 Command #6 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8-15	Undefined
16	Access restricted
17 -127	Undefined

6-6 Command #11 Read Unique Identifier associated with Tag

This command returns the expanded device-type codes, revision levels and the device identification number of a device containing the requested tag. It will be executed when either the appropriate long address or the broadcast long address, "00000" is received. The address field in the response message of this command always contains the address received in the request message. This command is unique in that no response is made unless the tag matches that of the device.

Request data bytes:

TAG	TAG	TAG	TAG	TAG	TAG
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	6(8-bit) byte packed ASCII	Device tag number

Response data bytes:

254	MFR. ID	MFR's DEVICE TYPE	NUMBER RQUEST PREAM	UNIV. CMD. REV.	TRANS. SPEC. REV.	SOFTW REV.	HARDW REV.	FLAGS	DEVICE ID NUM MSB	DEVICE ID NUM	DEVICE ID NUM
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Device type code for "expansion". Contains the code "254" (decimal).
1	8-bit unsigned integer	Manufacturer identification code. (Always 10).
2	8-bit unsigned integer	Manufacturers device type code. Refer to Section 9-2, Device type code.
3	8-bit unsigned integer	Number of response preamble characters required for the request message from the master to the slave.
4	8-bit unsigned integer	Universal command revision level implemented by this device.
5	8-bit unsigned integer	Transmitter specific command revision level implemented by this device.
6	8-bit unsigned integer	Software revision level of the device.
7	8-bit unsigned integer	Hardware revision level of the electronics in the device. Format: xxxxx.yyyB x- Device hardware revision level, 5-bit unsigned integer, level 15 is reserved. y- Physical signalling code, 3-bit unsigned integer, refer to Section 9-8, Physical signalling codes.
8	8-bit unsigned integer	Flags Refer to Section 9-10, Flag assignments.
9-11	24-bit unsigned integer	Device identification number.

6-6-1 Command #11 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-7 Command #12 Read Message

Read the 32 Character Message String contained within the device. The message string is a 32 character storage area that the user may use for any application related function desired. The message string is not used by the device.

Request data bytes:

NONE

Response data bytes:

MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE
#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23

Data Byte #	Type	Remarks
0-23	24(8-bit) byte packed ASCII	32 character message string.

6-7-1 Command #12 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-8 Command #13 Read tag, Descriptor, Date

Read the tag, descriptor and date contained within the device. The tag name is used to identify the device (See Command #11). The description and date fields can be utilized for any application specific function desired. The description and date fields are not used by the device.

Request data bytes:

NONE

Response data bytes:

TAG	TAG	TAG	TAG	TAG	TAG	DESCRIPT.	DESCRIPT.	DESCRIPT.	DESCRIPT.	DESCRIPT.	DESCRIPT.
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

DESCRIPT.	DESCRIPT.	DESCRIPT.	DESCRIPT.	DESCRIPT.	DESCRIPT.	DATE DAY	DATE MONTH	DATE MONTH
#12	#13	#14	#15	#16	#17	#18	#19	#20

Data Byte #	Type	Remarks
0-5	6(8-bit) byte packed ASCII	Device tag name.
6-17	12(8-bit) byte packed ASCII	Device descriptor. (16 character string)
18-20	3(8-bit) byte packed ASCII	Date.Respectively day, month, year - 1900.

6-8-1 Command #13 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-9 Command #14 Read Primary Variable Sensor Information

This command is intended to read primary variable sensor information.

Request data bytes:

NONE

Response data bytes:

SENSOR SERIAL NUM MSB	SENSOR SERIAL NUM	SENSOR SERIAL NUM LSB	LIMITS UNITS CODE	UPPER SENSOR LIMIT MSB	UPPER SENSOR LIMIT	UPPER SENSOR LIMIT	UPPER SENSOR LIMIT LSB	LOWER SENSOR LIMIT MSB	LOWER SENSOR LIMIT	LOWER SENSOR LIMIT	LOWER SENSOR LIMIT LSB
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

MIN SPAN MSB	MIN SPAN	MIN SPAN	MIN SPAN LSB
#12	#13	#14	#15

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Sensor serial number.
3	8-bit unsigned integer	Sensor limits/minimum span unit code.
4 - 7	32-bit floating point, IEEE 754 format	Upper sensor limit.
8 - 11	32-bit floating point, IEEE 754 format	Lower sensor limit.
12 – 15	32-bit floating point, IEEE 754 format	Minimum span.

6-9-1 Command #14 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-10 Command #15 Read Output Information

This command is intended to read the alarm selection code, transfer function, primary variable/range unit code, upper range value, lower range value, damping value (applied to the sensor, not the output), write protect code and private label distributor

Request data bytes:

NONE

Response data bytes:

#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
ALARM SELECT CODE	TRANSF. FUNCT. CODE	PV / RANGE UNITS CODE	UPPER RANGE MSB	UPPER RANGE	UPPER RANGE	UPPER RANGE MSB	LOWER RANGE MSB	LOWER RANGE	LOWER RANGE	LOWER VALUE MSB	DAMPING VALUE

#12	#13	#14	#15	#16
DAMPING VALUE	DAMPING VALUE	DAMPING VALUE LSB	WRITE PROTECT CODE	PVT LABEL DIST

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Alarm select code. Not implemented for the Brooks GF40/GF80 Series S-Protocol devices, the integer returned is a “Not-Used” or “250” (decimal).
1	8-bit unsigned integer	Transfer function code. Always returns LINEAR (0)
2	8-bit unsigned integer	Primary variable upper and lower range unit code.
3 - 6	32-bit floating point, IEEE 754 format	Upper range value.
7 - 10	32-bit floating point, IEEE 754 format	Lower range value.

Data Byte #	Type	Remarks
11 - 14	32-bit floating point, IEEE 754 format	Damping value. (Always 0.0)
15	8-bit unsigned integer	Write protect code. Not supported, returns Not Used (250 dec)
16	8-bit unsigned integer	Private label distributor. Returns Hart code for Brooks Instrument (10dec)

6-10-1 Command #15 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-11 Command #16 Read Final Assembly Number

This command is used to read the final assembly number associated with the device.

Request data bytes:

NONE

Response data bytes:

FINAL ASS. NUM MSB	FINAL ASS. NUM	FINAL ASS. NUM LSB
#0	#1	#2

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Final assembly number.

6-11-1 Command Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined

6-12 Command #17 Write Message

Write a 32 Character Message String into the device. See Command #12 for more information about the message string

Request data bytes:

MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE
#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23

Data Byte #	Type	Remarks
0 - 23	24 (8-bit) byte packed ASCII	32 Character message string.

Response data bytes:

MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE	MESSAGE
#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23

Data Byte #	Type	Remarks
0 - 23	24 (8-bit) byte packed ASCII	32 Character message string.

6-12-1 Command #17 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined
7	In write protect mode
8-127	Undefined

6-13 Command #18 Write Tag, Descriptor, Date

Write the tag, descriptor and date into the device. See Command #13 for more information.

Request data bytes:

TAG	TAG	TAG	TAG	TAG	TAG	DESCR.	DESCR.	DESCR.	DESCR.	DESCR.	DESCR.
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

DESCR.	DESCR.	DESCR.	DESCR.	DESCR.	DESCR.	DATE DAY	DATE MONTH	DATE YEAR
#12	#13	#14	#15	#16	#17	#18	#19	#20

Data Byte #	Type	Remarks
0 - 5	6 (8-bit) byte packed ASCII	Device tag number.
6 - 17	12 (8-bit) byte packed ASCII	Device descriptor. (16 character string)
18 - 20	3 (8-bit) unsigned integers	Date. Respectively day, month, year - 1900.

Response data bytes:

TAG	TAG	TAG	TAG	TAG	TAG	DESCR.	DESCR.	DESCR.	DESCR.	DESCR.	DESCR.
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

DESCR.	DESCR.	DESCR.	DESCR.	DESCR.	DESCR.	DATE DAY	DATE MONTH	DATE YEAR
#12	#13	#14	#15	#16	#17	#18	#19	#20

Data Byte #	Type	Remarks
0 - 5	6 (8-bit) byte packed ASCII	Device tag number.
6 - 17	12 (8-bit) byte packed ASCII	Device descriptor. (16 character string)
18 – 20	3 (8-bit) unsigned integers	Date. Respectively day, month, year - 1900.

6-13-1 Command #18 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined
7	In write protect mode
8-127	Undefined

6-14 Command #19 Write Final Assembly Number

Write the final assembly number into the device.

Request data bytes:

FINAL ASS. NUM MSB	FINAL ASS. NUM	FINAL ASS. NUM LSB
#0	#1	#2

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Final assembly number.

Response data bytes:

FINAL ASS. NUM MSB	FINAL ASS. NUM	FINAL ASS. NUM LSB
#0	#1	#2

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Final assembly number.

6-14-1 Command #19 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6 - 127	Undefined
7	In write protect mode
8-127	Undefined

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7-1 Command #37 Set Primary Variable Lower Range Value

This command generates a sensor zero action, the same function as pushing the zero button on the analog device. No flow should be applied to the device.

The command will return an error response code 9, “Applied process too high,” if flow output is greater than 2% when the command is received.

Request data bytes:

NONE

Response data bytes:

NONE

7-1-1 Command #37 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8	Undefined
9	Applied pressure too high
10-127	Undefined

7-2 Command #38 Reset Configuration Changed Flag

Resets the configuration changed response code, bit #6 of the transmitter status byte. Secondary master devices, address ‘0’should not issue this command. Primary master devices, address ‘1’, should only issue this command after the configuration changed response code has been detected and acted upon.

Request data bytes:

NONE

Response data bytes:

NONE

7-2-1 Command #38 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8-15	Undefined
16	Access restricted
17-127	Undefined

7-3 Command #39 EEPROM Control

This command is supported ONLY for backwards compatibilty with Brooks 5850S devices. The GF40/GF80 device automatically saves all changes made to non-volatile attributes in flash memory. It is not necessary to use this command to save data non-volatile memory.

Request data bytes:

EEPROM CONTROL CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	EEPROM control code 0 No change 1 No change 2-249 Undefined

Response data bytes:

EEPROM CONTROL CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	EEPROM control code 0 No change 1 No change 2-249 Undefined

7-4 Command #42 Perform Master Reset

Command used to reset the device's microprocessor. The device will respond first and then perform the master reset.

Request data bytes:

NONE

Response data bytes:

NONE

Command Specific Response Codes:

0	No command-specific errors
1-15	Undefined
16	Access restricted
17-127	Undefined

7-5 Command #48 Read Additional Transmitter Status

This command is used to retrieve additional transmitter status information.

Request data bytes:

NONE

Response data bytes:

ADD. STATUS BYTE#0	ADD. STATUS BYTE#1	ADD. STATUS BYTE#2	ADD. STATUS BYTE#3
#0	#1	#2	#3

Refer to Section 9-15 for a definition of the Additional Status Bytes.

7-5-1 Command #48 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6-127	Undefined

7-6 Command #50 Read Dynamic Variable Assignments

Read the assignment numbers for the dynamic variables. This command always returns Transmitter Variable #0 (flow rate) as the Primary Variable Transmitter Variable #1 (temperature) as the Secondary Variable, and Transmitter Variable #2 (pressure) as the Tertiary Variable. Note that the assignment of dynamic variables cannot be changed.

Transmitter variable codes **shall** be reported as defined in Section 9-9.

Request data bytes:
none

Response data bytes:

PV. XMITTER CODE	SV. XMITTER CODE	TV. XMITTER CODE	QV. XMITTER CODE
#0	#1	#2	#3

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Transmitter variable number assigned to the primary variable, flow rate
1	8-bit unsigned integer	Transmitter variable number assigned to the secondary variable, temperature
2	8-bit unsigned integer	Transmitter variable number assigned to the tertiary variable, not supported, returns Not Used (250 dec)
3	8-bit unsigned integer	Transmitter variable number assigned to the Quaternary variable, not supported, returns Not Used (250 dec)

7-6-1 Command #50 Specific Response Codes

0	No command specific errors
1 - 4	Undefined
5	Incorrect byte count
6 – 127	Undefined

7-7 Command #59 Write Number of Response Preambles

Set the minimum number of preambles to be sent by a device before the start of a response packet. This number includes the two preambles contained in the start of message. The value can vary from 2 to 15.

Request data bytes:

NUMBER RESP. PREAM.
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Number of response preambles to be sent with the response message from slave to master.

Response data bytes:

NUMBER RESP. PREAM.
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Number of response preambles to be sent with the response message from slave to master.

7-7-1 Command #59 Specific Response Codes

0	No command-specific errors
1 -2	Undefined
3	Passed parameter too large
4	Passed parameter too small
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8-15	Undefined
16	Access restricted
17	Undefined

7-8 Command #66 Enter/Exit Fixed Analog Output Mode

The device is placed in the Fixed Analog Output Mode with the analog output set to the value received. The value returned in the response data bytes is the value actually used by the device. A level of "Not-A-Number" (7F A0 00 00) with any unit code exits the fixed analog output mode. Fixed Analog Output Mode is also exited when the power is removed from the device. The Analog Output Code and the Analog Output Units must be compatible (i.e. current output and milliamps)
and the device must be configured for the type of output specified by the Analog Output Code or Response Code 12 or 15 will be returned.

Request data bytes:

ANALOG OUTPUT # CODE	ANALOG OUTPUT # UNIT	ANALOG OUT. LVL. MSB	ANALOG OUT. LVL.	ANALOG OUT. LVL.	ANALOG OUT. LVL. LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Analog output selection code. Refer to Section 9-11.
1	8-bit unsigned integer	Analog output units code. Refer to Section 9-19.
2-5	32-bit floating point, IEEE 754 format	Fixed analog output low or high level. Refer to Section 9-**1**.

Response data bytes:

ANALOG OUTPUT # CODE	ANALOG OUTPUT # UNIT	ANALOG OUT. LVL. MSB	ANALOG OUT. LVL.	ANALOG OUT. LVL.	ANALOG OUT. LVL. LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Analog output selection code. Refer to Section 9-11.
1	8-bit unsigned integer	Analog output units code. Refer to Section 9-19.
2-5	32-bit floating point, IEEE 754 format1	Fixed analog output low or high level. Refer to Section 9-**1**

7-8-1 Command #66 Specific Response Codes

0	No command-specific errors
1-2	Undefined
3	Passed parameter too large
4	Passed parameter too small
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8-11	Undefined
12	Invalid units code
13-14	Undefined
15	Invalid analog output number code
16	Access restricted
17-127	Undefined

Follow the sequence below to adjust the output:
1) Use command #66 to put the device in a fixed analog output mode with the low limit as the fixed value.
2) Use command #67 to adjust the low limit (zero offset).
3) Use command #67 to put the device in a fixed analog output mode with the high limit as the fixed value.
4) Use command #68 to adjust the high limit (span).
5) Use the command #42 to perform a master reset in order to store the new values in nonvolatile memory

7-9 Command #67 Trim Analog Output Zero

Trim the Zero of the selected analog output so that the connected meter reads the analog output lower endpoint value. The response data bytes contain the value from the request as used by the device. Command #66, Enter/Exit Fixed Analog Output Mode, should be used first to set the analog output exactly to the lower endpoint value before using this command. Response code #9, "Not in proper analog output mode" will be returned if the analog output involved has not been set to the fixed analog output mode.

Request data bytes:

ANALOG OUTPUT # CODE	ANALOG OUTPUT # UNIT	MEASURED OUT. LVL. MSB	MEASURED OUT. LVL.	MEASURED OUT. LVL.	MEASURED OUT. LVL. LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Analog output number code. Refer to Section 9-11, Analog Output Selection codes.
1	8-bit unsigned integer	Analog output units code. Refer to Section 9-19, Analog Output units codes.
2-5	32-bit floating point, IEEE 754 format	Externally measured analog output level.

Response data bytes:

ANALOG OUTPUT # CODE	ANALOG OUTPUT # UNIT	MEASURED OUT. LVL. MSB	MEASURED OUT. LVL.	MEASURED OUT. LVL.	MEASURED OUT. LVL. LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Analog output number code. Refer to Section 9-11, Analog Output Selection codes.
1	8-bit unsigned integer	Analog output units code. Refer to Section 9-19, Analog Output units codes.
2-5	32-bit floating point, IEEE 754 format1	Actual measured analog output level.

7-9-1 Command #67 Specific Response Codes

0	No command-specific errors
1-2	Undefined
3	Passed parameter too large
4	Passed parameter too small
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8	Undefined
9	Not in proper analog output mode
10-11	Undefined
12	Invalid units code
13-14	Undefined
15	Invalid analog output number code
16	Access restricted
17-127	Undefined

7-10 Command #68 Trim Analog Output Span

Trim the Span of the selected analog output so that the connected meter reads the analog output upper endpoint value. The response data bytes contain the value from the request as used by the device. Command #66, Enter/Exit Fixed Analog Output Mode, should be used first to set the analog output exactly to the upper endpoint value before using this command. Response code #9, "Not in proper analog output mode" will be returned if the analog output involved has not been set to the fixed analog output mode.

Request data bytes:

ANALOG OUTPUT # CODE	ANALOG OUTPUT # UNIT	MEASURED OUT. LVL. MSB	MEASURED OUT. LVL.	MEASURED OUT. LVL.	MEASURED OUT. LVL. LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Analog output number code. Refer to Section 9-11, Analog Output Selection codes.
1	8-bit unsigned integer	Analog output units code. Refer to Section 9-19, Analog Output units codes.
2-5	32-bit floating point, IEEE 754 format	Externally measured analog output level.

Response data bytes:

ANALOG OUTPUT # CODE	ANALOG OUTPUT # UNIT	MEASURED OUT. LVL. MSB	MEASURED OUT. LVL.	MEASURED OUT. LVL.	MEASURED OUT. LVL. LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Analog output number code. Refer to Section 9-11, Analog Output Selection codes.
1	8-bit unsigned integer	Analog output units code. Refer to Section 9-19, Analog Output units codes.
2-5	32-bit floating point, IEEE 754 format1	Actual measured analog output level.

7-10-1 Command #68 Specific Response Codes

0	No command-specific errors
1-2	Undefined
3	Passed parameter too large
4	Passed parameter too small
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8	Undefined
9	Not in proper analog output mode
10-11	Undefined
12	Invalid units code
13-14	Undefined
15	Invalid analog output number code
16	Access restricted
17-127	Undefined

7-11 Command #122 Write Device Identification Number (Non-Public)

Write the device indentification number into the device's memory. The response message will be made using the unique identifer (long frame address) as received in the request message. The devcie indentification number will not be incorporated in the unique identifer until the response message has been sent. The command is a Non-Public one, i.e. execution is protected by a three byte 'password' which has to be sent with the request message. This password should match the device's final assembly number in order to achieve a correct execution of the command. When they do not match, the "Command not implemented" response code will be returned. The coommand specific response codes will only be returned if the password and final assembly numbers have matched.

Request data bytes:

Password MSB	Password	Password LSB	Device I.D. # MSB	Device I.D. #	Device I.D. # LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Password
3 - 5	24-bit unsigned integer	Device indentification number

Response data bytes:

Device I.D. # MSB	Device I.D. #	Device I.D. # LSB
#0	#1	#2

Data Byte #	Type	Remarks
0 - 3	24-bit unsigned integer	Device indentification number

Command specific response codes:

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 15	Undefined
16	Access restricted
17 - 127	Undefined

7-12 Command #123 Select Baud Rate

Select the baud rate for S-protocol communications. The new baud rate setting will not take effect until the device is reset, (See Command #42) or power is cycled to the device.

Request data bytes:

Baud Rate
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Baud Rate 0 9600 1 19200 2 38400

Response data bytes:

Baud Rate
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Baud Rate

Command specific response codes:

0	No command-specific errors
1	Undefined
2	Invalid selection
3 - 4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

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8-1 Command #128 Enter/Exit Write Protect Mode (Non-Public)

This command is implemented to maintain compatibility with other Brooks Smart products, however, it is not required and has no effect. Write Protect mode is not supported by GF40/GF80 Series.

Request data bytes:

USER PASS-WORD	USER PASS-WORD	USER PASS-WORD	USER PASS-WORD	USER PASS-WORD	USER PASS-WORD	WRITE PROTECT MODE
#0	#1	#2	#3	#4	#5	#6

Data Byte #	Type	Remarks
0 - 5	6 (8-bit) byte packed ASCII	User password.
6	8-bit unsigned integer	Write protect code. Refer to Section 9-7, Write protect codes.

Response data bytes:

WRITE PROTECT MODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Write protect code. (Always returns 0). Refer to Section 9-7, Write protect codes.

8-1-1 Command #128 Specific Response Codes

0	No command-specific errors
1 - 4	Undefined
5	Incorrect bytecount
6-127	Undefined

8-2 Command #131 Read Brooks Serial Number

Read the Brooks order number from the device's memory. The Brooks order number is a 24-byte packed ASCII string (resulting in 32 total unpacked ASCII characters) indicating the serial number of the device. The number can be used for traceability purposes.

Request data bytes:
None

Response data bytes:

Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number	Brooks Serial Number
#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23

Data Byte #	Type	Remarks
0-23	24 (8-bit) packed ASCII	Brooks Serial Number

8-2-1 Command #131 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-3 Command #132 Read Model Number

Read the device Model number from the device's memory. The device Model number is a 24-byte packed ASCII string (resulting in 32 total unpacked ASCII characters).

Request data bytes:
None

Response data bytes:

Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number	Device Model Number
#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23

Data Byte #	Type	Remarks
0-23	24 (8-bit) packed ASCII	Brooks Serial Number

8-3-1 Command #132 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-4 Command #134 Read Software Revisions

Read the software revision from the device as an ASCII string of up to 8 characters. If the firmware revision string is less than 8 characters, the remaining bytes wil be 0.

Request data bytes:
None

Response data bytes:

FIRMWARE REVISION	FIRMWARE REVISION	FIRMWARE REVISION	FIRMWARE REVISION	FIRMWARE REVISION	FIRMWARE REVISION	FIRMWARE REVISION	FIRMWARE REVISION
#0	#1	#2	#3	#4	#5	#6	#7

Data Byte #	Type	Remarks
0 - 7	8 (8-bit) ASCII text	Firmware revision

8-4-1 Command #134 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-5 Command #150 Read Process Gas Type

Read the type of process gas specified by the gas selection code from the device's memory. The gas can be specified as a string of upper and lower case characters. The gases will in most cases be expressed by their chemical formula.

Request data bytes:

Gas Select Code
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Gas Selection Code (1-6)

Response data bytes:

Gas Select Code	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas	Process Gas
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Gas Selection Code (1-10)
1-12	12 (8-bit) ASCII text	Process Gas Type (null terminated string)

8-5-1 Command #150 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid Selection
3-4	Undefined
5	Incorrect Bytecount
6-127	Undefined

8-6 Command #151 Read Gas Density, Flow Reference and Flow Range

Read the density of the selected gas, the operational flow range and the reference temperature and pressure for the flow range. The flow range equals the volume flow in engineering units at 100% as calibrated. The reference temperature and pressure are the conditions at which the volume flow is specified.

Request data bytes:

Gas Select Code
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Gas Selection Code (1-6)

Response data bytes:

Gas Select Code	Density Unit Code	Density MSB	Density	Density	Density LSB
#0	#1	#2	#3	#4	#5

Ref. Temp. Unit	Ref. Temp. MSB	Ref. Temp.	Ref. Temp.	Ref. Temp. LSB	Ref. Press. Unit	Ref. Press. MSB	Ref. Press.	Ref. Press.	Ref. Press. LSB
#6	#7	#8	#9	#10	#11	#12	#13	#14	#15

Flow Unit Code	Flow Range MSB	Flow Range	Flow Range	Flow Range LSB
#16	#17	#18	#19	#20

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Gas selection Code (1-10)
1	8-bit unsigned integer	Density Unit Code (See Section 9-4)
2-5	32-bit floating point, IEEE 754 format	Process Gas Density
6	8-bit unsigned integer	Reference Temperature Unit Code (See Section 9-5)
7-10	32-bit floating point, IEEE 754 format	Reference Temperature Value
11	8-bit unsigned integer	Reference Pressure Unit Code (See Section 9-6)
12-15	32-bit floating point, IEEE 754 format	Reference Pressure Value
16	8-bit unsigned integer	Reference Flow Rate Unit Code (See Section 9-3)
17-20	32-bit floating point, IEEE 754 format	Reference Flow range Value

8-6-1 Command #151 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid Selection
3-4	Undefined
5	Incorrect Byte count
6-127	Undefined

8-7 Command #152 Read Full Scale Flow Range

Read the configured full scale flow range of the specified process gas page in the selected flow units (see Command 196).

Request data bytes:

GAS SELECT CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Gas selection code. Number between 1 and 6

Response data bytes:

SEL FLOW UNIT	FLOW RATE MSB	FLOW RATE	FLOW RATE	FLOW RATE LSB
#0	#1	#2	#3	#4

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Primary variable unit code. Refer to Section 9-3, Flow rate unit and reference codes.
1-4	32-bit floating point IEEE 754 format	Primary variable: flow rate

Command specific response codes:

0	No command-specific errors
1	Unidefined
2	Invalid selection
3 - 4	Unidefined
5	Incorrect bytecount
6 - 127	Unidefined

8-8 Command #190 Read Standard Temperature and Pressure

Write the standard temperature and pressure values into the device's memory. The standard temperature and pressure are reference values which can be set by the user and which are used in the conversion of flow units as defined in Section 5-2-1.

Request data bytes:
None

Response data bytes:

Temp. Unit Code	Std. Temp MSB	Std. Temp	Std. Temp	Std. Temp LSB	Press. Unit Code	Std. Press. MSB	Std. Press.	Std. Press.	Std. Press. LSB
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Temperature Unit Code (See Section 9-5)
1-4	32-bit floating point, IEEE 754 format	Standard Temperature Value
5	8-bit unsigned integer	Pressure Unit Code (See Section 9-6)
6-9	32-bit floating point, IEEE 754 format	Standard Pressure Value

8-8-1 Command #190 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-9 Command #191 Write Standard Temperature and Pressure

Write the standard temperature and pressure values into the device's memory. The standard temperature and pressure are reference values which can be set by the user and which are used in the conversion of flow units as defined in Section 5-2-1.

Request data bytes:

Temp. Unit Code	Std. Temp MSB	Std. Temp	Std. Temp	Std. Temp LSB	Press. Unit Code	Std. Press. MSB	Std. Press.	Std. Press.	Std. Press. LSB
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Temperature Unit Code (See Section 9-5)
1-4	32-bit floating point, IEEE 754 format	Standard Temperature Value
5	8-bit unsigned integer	Pressure Unit Code (See Section 9-6)
6-9	32-bit floating point, IEEE 754 format	Standard Pressure Value

Response data bytes:

Temp. Unit Code	Std. Temp MSB	Std. Temp	Std. Temp	Std. Temp LSB	Press. Unit Code	Std. Press. MSB	Std. Press.	Std. Press.	Std. Press. LSB
#0	#1	#2	#3	#4	#5	#6	#7	#8	#9

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Temperature Unit Code (See Section 9-5)
1-4	32-bit floating point, IEEE 754 format	Standard Temperature Value
5	8-bit unsigned integer	Pressure Unit Code (See Section 9-6)
6-9	32-bit floating point, IEEE 754 format	Standard Pressure Value

8-9-1 Command #191 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid Selection
3	Passed parameter too large
4	Passed parameter too small
5	Incorrect Byte count
6	Undefined
7	In write protect mode
8-15	Undefined
16	Access restricted
17-127	Undefined

8-10 Command #193 Read Operational Settings

Read the operational settings from the device. These settings consist of the selected gas number, the selected flow reference condition, the selected flow unit and the selected temperature unit.

Request data bytes:

None

Response data bytes:

SEL GAS NUMBER	SEL FLOW REF	SEL FLOW UNIT	SEL TEMP UNIT
#0	#1	#2	#3

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Selected gas number. Number between 1 and 6.
1	8-bit unsigned integer	Selected flow reference. Refer to Section 9-3, Flow rate unit and reference codes.
2	8-bit unsigned integer	Selected flow unit. Refer to Section 9-3, Flow rate unit and reference codes.
3	8-bit unsigned integer	Selected temperature unit. Refer to Section 9-5, Temperature unit codes.

8-10-1 Command #193 Specific Response Codes

0	No command-specific errors
1 - 127	Undefined

8-11 Command #195 Select Gas Calibration

Select a gas calibration from the available calibrations. Refer to the Product/Calibration Data Sheet(s) shipped with each device to determine the proper gas calibration number for the desired gas/flow conditions.

Request data bytes:

SEL CAL NUMBER
#0

Data Byte #	**Type**	**Remarks**
0	8-bit unsigned integer	Selected calibration number. Number between 1 and 6.

Response data bytes:

SEL CAL NUMBER
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Selected calibration number. Number between 1 and 6.

8-11-1 Command #195 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

8-12 Command #196 Select Flow Unit

Select a flow unit. Selecting a flow unit not only consists of selecting the flow unit, but also the reference condition. The selected flow unit will be used in the conversion from flow data. Flow data will be made available to the user in the selected flow unit and reference conditions.
(See Section 5-2-1.)

Request data bytes:

SEL FLOW REF	SEL FLOW UNIT
#0	#1

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Selected flow reference. Refer to Section 9-3, Flow rate unit and reference codes.
1	8-bit unsigned integer	Selected flow unit. Refer to Section 9-3, Flow rate unit and reference codes.

Response data bytes:

SEL FLOW REF	SEL FLOW UNIT
#0	#1

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Selected flow reference. Refer to Section 9-3, Flow rate unit and reference codes.
1	8-bit unsigned integer	Selected flow unit. Refer to Section 9-3, Flow rate unit and reference codes.

8-12-1 Command #196 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

8-13 Command #197 Select Temperature Unit

Select a temperature unit. The selected temperature unit will be used in the conversion of temperature data. Temperature data will be made available to the user in the selected temperature unit.

Request data bytes:

SEL TEMP REF
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Selected temperature unit. Refer to Section 9-5, Temperature unit codes.

Response data bytes:

SEL TEMP REF
#0

8-13-1 Command #197 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

8-14 Command #215 Read Setpoint Settings

Read the setpoint related settings from the device. The settings contain the setpoint source indication, i.e. analog 0 - 5 V / 0 - 10 V / 0 - 20 mA, analog 4 - 20 mA or digital, the type of softstart and the softstart ramp.

Request data bytes:

None

Response data bytes:

SETP SOURCE CODE	SETP SPAN MSB	SETP SPAN	SETP SPAN	SETP SPAN LSB	SETP OFFSET MSB	SETP OFFSET	SETP OFFSET
#0	#1	#2	#3	#4	#5	#6	#7

SETP OFFSET LSB	SOFT START CODE	S. START RAMP MSB	S. START RAMP	S. START RAMP	S. START RAMP LSB
#8	#9	#10	#11	#12	#13

Data Byte #	Type	Remarks
0	8 bit unsigned integer	Setpoint source selection code. Refer to Section 9-12, Setpoint source selection codes.
1 - 4	32-bit floating point, IEEE 754 format	Always returns 1.0

Data Byte #	Type	Remarks
5 - 8	32-bit floating point, IEEE 754 format	Always return 0.0.
9	8 bit unsigned integer	Softstart selection code. Refer to Section 9-13, Softstart selection codes.
10 - 13	32-bit floating point, IEEE 754 format	Softstart ramp value See command #218 for an explanation of the Softstart Ramp Value.

8-14-1 Command #215 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-15 Command #216 Select Setpoint Source

Select the setpoint source to be used as setpoint input. The setpoint source can be either analog 0 - 5 V / 0 - 10 V / 0 - 20 mA, analog 4 - 20 mA or digital (i.e. through communication). This command allows the user to select between analog setpoint and digital setpoint. To change the analog input and output type configured during production, e.g. 0 - 5 V, 0 - 10 V, 0 - 20 mA, or 4 - 20 mA use the setpoint source selection values 10, 11, 20, 21 refer to Section 9-12.

Request data bytes:

SETP SOURCE CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Setpoint source selection code. Refer to Section 9-12, Setpoint source codes.

Response data bytes:

SETP SOURCE CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Setpoint source selection code. Refer to Section 9-12, Setpoint source codes.

8-15-1 Command #216 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

8-16 Command #218 Select Softstart

Select the softstart type to be used by the device. The softstart mode can be set to either disabled or time. When Time is selected, then the Software Ramp value (see Command #219) will be the time required to ramp to a new setpoint expressed in seconds.

Request data bytes:

SOFT START CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Softstart selection code. Refer to Section 9-13, Softstart selection codes.

Response data bytes:

SOFT START CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Softstart selection code. Refer to Section 9-13, Softstart selection codes.

8-16-1 Command #218 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

8-17 Command #219 Write Linear Softstart Ramp Value

Write the linear softstart ramp value into the device's memory. The definition of the softstart ramp value is dependent upon the selected softstart ramp code. See command #218 for a description of the softstart ramp value.

Request data bytes:

S.START RAMP MSB	S.START RAMP	S.START RAMP	S.START RAMP LSB
#0	#1	#2	#3

Data Byte #	Type	Remarks
0 - 3	32-bit floating point, IEEE 754 format	Softstart ramp value [seconds]

Response data bytes:

S.START RAMP MSB	S.START RAMP	S.START RAMP	S.START RAMP LSB
#0	#1	#2	#3

Data Byte #	Type	Remarks
0 - 3	32-bit floating point, IEEE 754 format	Softstart ramp value [seconds]

8-17-1 Command #219 Specific Response Codes

0	No command-specific errors
1-2	Undefined
3	Parameter too small
4	Parameter too large
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefine

8-18 Command #220 Read PID Controller Values

Read the PID controller settings from the device. The controller setting consist of three parameters: the proportional part Kp, the integral part Ki and the differential part Kd. Kd is not used and therefore is set to 0.

Request data bytes:

NONE

Response data bytes:

#0	#1	#2	#3	#4	#5	#6	#7
KP MSB	KP	KP	KP LSB	KI MSB	KI	KI	KI LSB

#8	#9	#10	#11
KD MSB	KD	KD	KD LSB

Data Byte #	Type	Remarks
0 - 3	32-bit floating point, IEEE 754 format	Kp. Proportional part of PID controller.
4 - 7	32-bit floating point, IEEE 754 format	Ki. Integral part of PID controller.
8 - 11	32-bit floating point, IEEE 754 format	Kd. Differential part of PID controller.

8-18-1 Command #220 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-19 Command #221 Write PID Controller Values

Write the PID controller settings into the device. The controller setting consist of three parameters: the proportional part Kp, the integral part Ki and the differential part Kd.

Request data bytes:

KP MSB	KP	KP	KP LSB	KI MSB	KI	KI	KI LSB
#0	#1	#2	#3	#4	#5	#6	#7

KD MSB	KD	KD	KD LSB
#8	#9	#10	#11

Data Byte #	Type	Remarks
0 - 3	32-bit floating point, IEEE 754 format	Kp. Proportional part of PID controller.
4 - 7	32-bit floating point, IEEE 754 format	Ki. Integral part of PID controller.
8 - 11	32-bit floating point, IEEE 754 format	Kd. Differential part of PID controller.

Response data bytes:

KP MSB	KP	KP	KP LSB	KI MSB	KI	KI	KI LSB
#0	#1	#2	#3	#4	#5	#6	#7

KD MSB	KD	KD	KD LSB
#8	#9	#10	#11

Data Byte #	Type	Remarks
0 - 3	32-bit floating point, IEEE 754 format	Kp. Proportional part of PID controller.
4 - 7	32-bit floating point, IEEE 754 format	Ki. Integral part of PID controller.
8 - 11	32-bit floating point,	Kd.

8-19-1 Command #221 Specific Response Codes

0	No command-specific errors
1-4	Undefined
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8-127	Undefined

8-20 Command #222 Read Valve Range and Valve Offset

Read the Valve Range and Valve Offset values from the device. The settings are 24-bit unsigned integers used to fine tune the D/A converter for the valve control. The numbers are dimensionless and sized to the range of 0 to 62500. 100% flow is achieved with the number valve offset + valve range. Also, the sum of both should not be over 62500.

Request data bytes:

NONE

Response data bytes:

VALVE RANGE MSB	VALVE RANGE	VALVE RANGE LSB	VALVE OFFSET MSB	VALVE OFFSET	VALVE OFFSET LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Valve range - (Not used in GF40/GF80, always returns 0.) Dimensionless number in the range of 0 to 62500.
3 - 5	24-bit unsigned integer	Valve offset Dimensionless number in the range of 0 to 62500.

8-20-1 Command #222 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-21 Command #223 Write Valve Range and Valve Offset

Write the Valve Range and Valve Offset values into the device. The settings are 24-bit unsigned integers used to fine tune the D/A converter for the valve control. The numbers are dimensionless and sized to the range of 0 to 62500. 100% flow is achieved with the number valve offset + valve range. Also, the sum of both should not be over 62500.

Request data bytes:

VALVE RANGE MSB	VALVE RANGE	VALVE RANGE LSB	VALVE OFFSET MSB	VALVE OFFSET	VALVE OFFSET LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Valve range - (Not used in GF40/GF80, always write 0.) Dimensionless number in the range of 0 to 62500.
3 - 5	24-bit unsigned integer	Valve offset Dimensionless number in the range of 0 to 62500.

Response data bytes:

VALVE RANGE MSB	VALVE RANGE	VALVE RANGE	VALVE OFFSET MSB	VALVE OFFSET	VALVE OFFSET LSB
#0	#1	#2	#3	#4	#5

Data Byte #	Type	Remarks
0 - 2	24-bit unsigned integer	Valve range (Not used in GF40/GF80; always returns 0) Dimensionless number in the range of 0 to 62500.
3 - 5	24-bit unsigned integer	Valve offset Dimensionless number in the range of 0 to 62500.

8-21-1 Command #223 Specific Response Codes

0	No command-specific errors
1-2	Undefined
3	Parameter too small
4	Parameter too large
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8-127	Undefined

8-22 Command #226 Trim Setpoint Input

This command instructs the device to perform a trim of the Setpoint Input for the condition specified in the data section. Before issuing this command, the appropriate voltage or current must be applied to the Setpoint Input. For example, to trim the Setpoint Input when the device is configured for 0 - 5 Volt input, first apply 2 Volts to the input, then send command #226 with the data value of 1. Then apply 10 Volts to the input and send command #226 with data value of 2.
The new values will be stored in non-volatile memory when a master reset is performed using command #42.

Request data bytes:

CAL POINT
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	1 = Low scale point (2 volt 0 - 5 V / 0 - 10 V; 4 mA 0 - 20 mA; 4 mA 4 - 20 mA). 2 = High scale point (10 volt 0 - 5 V / 0 - 10 V; 20 mA 0 - 20 mA; 20 mA 4 - 20 mA). 0,3 - 225 = Undefined

Response data bytes:

CAL POINT
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	1 = Min scale point (ex. 2 Volts, 4 ma). 2 = Max scale point (ex. 10 Volts, 20 ma). 0,3 -225 = Undefined

8-22-1 Command #226 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6-127	Undefined

8-23 Command #230 Get Valve Override Status

Get the current valve override status from the device. The valve override status can be set to either OFF (No valve override), CLOSE, OPEN or MANUAL. The analog valve override input on the D-Connector of the device will take precedence over the digital command sent to the device via command #231. Therefore, the value reported with the Get Valve Override Status command may be different than the last value sent to the device using command #231.

Request data bytes:

None

.

Response data bytes:

VALVE OVERRIDE CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Valve override code. Refer to Section 9-14, Valve override codes.

8-23-1 Command Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-24 Command #231 Set Valve Override Status

Set the current valve override status. The valve override can be set to either OFF (No valve override), CLOSE or OPEN. The analog valve override input on the D-Connector of the device will take precedence over the digital command.

Request data bytes:

VALVE OVERRIDE CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Valve override code. Refer to Section 9-14, Valve override codes.

Response data bytes:

VALVE OVERRIDE CODE
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Valve override code. Refer to Section 9-14, Valve override codes.

8-24-1 Command #231 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-127	Undefined

8-25 Command #235 Read Setpoint in % and Selected Units

Read the current setpoint value in percent of full scale and in selected flow units. The setpoint in selected flow units compared to its full scale range should be the equivalent of the setpoint in percent.

Request data bytes:

NONE

Response data bytes:

PERCENT UNIT CODE	SETP PERCENT MSB	SETP PERCENT	SETP PERCENT	SETP PERCENT LSB	SETP FLOW UNIT	SETP UNITS MSB	SETP UNITS
#0	#1	#2	#3	#4	#5	#6	#7

SETP UNITS	SETP UNITS LSB
#8	#9

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Setpoint percent unit. Unit always reads 57 (decimal), percent.
1 - 4	32-bit floating point, IEEE 754 format	Setpoint in percent of full scale.
5	8-bit unsigned integer	Selected flow unit. Refer to Section 9-3, Flow rate unit and reference codes.
6- 9	32-bit floating point, IEEE 754 format	Setpoint in selected flow unit.

8-25-1 Command #235 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-26 Command #236 Write Setpoint in % or Selected Units

Write the current setpoint value in percent of full scale or in selected flow units to the device. If the setpoint unit code is set to percent (code 57) the setpoint value is assumed to be in percent. If the setpoint unit code is set to Not Used, the setpoint value is assumed to be in the selected flow unit. The return message is the same as the one of Command #235. The setpoint in selected flow units compared to its full scale range should be the equivalent of the setpoint in percent. When this command is received, the Setpoint Source will be set to digital automatically if not already in digital mode. The Setpoint Source will remain in digital mode until the user returns the Setpoint Source to analog mode via Command #216 or until the power to the device is cycled.

Request data bytes:

SETP UNIT CODE	SETP MSB	SETP	SETP	SETP LSB
#0	#1	#2	#3	#4

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Setpoint unit. 57 (decimal), “Percent” or 250 (decimal) “Not Used”.
1 - 4	32-bit floating point, IEEE 754	Setpoint value. In either percent of full scale or in selected flow units.

Response data bytes:

PERCENT UNIT CODE	SETP PERCENT MSB	SETP PERCENT	SETP PERCENT	SETP PERCENT LSB	SETP FLOW UNIT	SETP UNITS MSB	SETP UNITS
#0	#1	#2	#3	#4	#5	#6	#7

SETP UNITS	SETP UNITS LSB
#8	#9

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Setpoint percent unit. Unit always reads 57 (decimal), percent.
1 - 4	32-bit floating point, IEEE 754 format	Setpoint in percent of full scale.
5	8-bit unsigned integer	Select flow unit. Refer to Section 9-3, Flow rate unit and reference codes.
6-9	32-bit floating point, IEEE 754 format	Setpoint in selected flow unit.

8-26-1 Command #236 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3	Parameter too small
4	Parameter too large
5	Incorrect bytecount
6	Undefined
7	In write protect mode
8 - 127	Undefined

8-27 Command #237 Read Valve Control Value

Read the current valve control value. The valve control value is a dimensionless number in the range from 0 to 62500. It represents the value sent to the D/A-converter used to control the valve.

Request data bytes:

NONE

Response data bytes:

VALVE VALUE MSB	VALVE VALUE	VALVE VALUE LSB
#0	#1	#2

Data Byte #	Type	Remarks
0-2	24-bit unsigned integer	Valve control value. Dimensionless number between 0 and 62500.

8-27-1 Command #237 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-28 Command #240 Read Totalizer Status

Read the totalizer status. Both the totalizer status and the selected totalizer unit is returned.

Request data bytes:

NONE

Response data bytes:

TOT. STATUS	SEL. TOT. UNIT
#0	#1

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Totalizer status code. Refer to 9-16
1	8-bit unsigned integer	Totalizer unit. Refer to 9-17

8-28-1 Command #240 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-29 Command #241 Set Totalizer Control

Set the totalizer state. Use this command to start, stop or reset the totalizer. Actually, the totalizer has only two states; running and stopped. A totalizer reset will not effect the totalizer state.

Request data bytes:

TOT. CMD.
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Totalizer command code. Refer to Section 9-16, Totalizer command/status codes.

Response data bytes:

TOT. STATUS
#0

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Totalizer status code. Refer to Section 9-16, Totalizer command/status codes.

8-29-1 Command #241 Specific Response Codes

0	No command-specific errors
1	Undefined
2	Invalid selection
3-4	Undefined
5	Incorrect bytecount
6- 127	Undefined

8-30 Command #242 Read Totalizer Value and Unit

Read the totalizer counter and the totalizer unit. The totalizer unit is dependent on the selected flow unit and can not be selected separately.

Request data bytes:

NONE

Response data bytes:

SEL. TOT. UNITS	TOT. COUNT. MSB	TOT. COUNT.	TOT. COUNT.	TOT. COUNT. LSB
#0	#1	#2	#3	#4

Data Byte #	Type	Remarks
0	8-bit unsigned integer	Totalizer unit code. Refer to Section 9-17, Totalizer unit codes
1-4	32-bit floating point, IEEE 754 format	Totalizer counter value.

8-30-1 Command #242 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-31 Command #245 Read Alarm Enable Setting

Read the alarm enable settings. These alarm settings can be used to mask specific alarm sources.

Request data bytes:

NONE

Response data bytes:

ALARM-ENABLE BYTE 0	ALARM-ENABLE BYTE 1	ALARM-ENABLE BYTE 2	ALARM-ENABLE BYTE 3
#0	#1	#2	#3

Data Byte #	**Type**	**Remarks**
0	8-bit bit-field	Alarm mask byte 0
1	8-bit bit-field	Alarm mask byte 1
2	8-bit bit-field	Alarm mask byte 2
3	8-bit bit-field	Alarm mask byte 3 Refer to Section 9-15, Additional device status and masking

8-31-1 Command #245 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-32 Command #246 Write Alarm Enable Setting

Set the alarm enable settings. These alarm settings can be used to mask specific alarm sources.

Request data bytes:

ALARM-ENABLE BYTE 0	ALARM-ENABLE BYTE 1	ALARM-ENABLE BYTE 2	ALARM-ENABLE BYTE 3
#0	#1	#2	#3

Data Byte #	Type	Remarks
0	8-bit bit-field	Alarm mask byte 0
1	8-bit bit-field	Alarm mask byte 1
2	8-bit bit-field	Alarm mask byte 2
3	8-bit bit-field	Alarm mask byte 3
		Refer to 9-15, Additional device status and masking

Response data bytes:

ALARM-ENABLE BYTE 0	ALARM-ENABLE BYTE 1	ALARM-ENABLE BYTE 2	ALARM-ENABLE BYTE 3
#0	#1	#2	#3

Data Byte #	Type	Remarks
0	8-bit bit-field	Alarm mask byte 0
1	8-bit bit-field	Alarm mask byte 1
2	8-bit bit-field	Alarm mask byte 2
3	8-bit bit-field	Alarm mask byte 3
		Refer to 9-15

8-32-1 Command #246 Specific Response Codes

0	No command-specific errors
1-4	Undefined
5	Too few bytes received
6-127	Undefined

8-33 Command #247 Read High/Low Flow Alarm

Read the high/low flow alarm settings as a percent of device full scale. This command can be used to read the actual flow alarm limits.

Request data bytes:

NONE

Response data bytes:

LOW-LIMIT MSB	LOW-LIMIT	LOW-LIMIT	LOW-LIMIT LSB	HIGH-LIMIT MSB	HIGH-LIMIT	HIGH-LIMIT	HIGH-LIMIT LSB
#0	#1	#2	#3	#4	#5	#6	#7

Data Byte #	Type	Remarks
0-3	32-bit floating point, IEEE 754 format	Low-flow alarm limit (Percent of FS).
4-7	32-bit floating point, IEEE 754 format	High-flow alarm limit (Percent of FS).

8-33-1 Command #247 Specific Response Codes

0	No command-specific errors
1-127	Undefined

8-34 Command #248 Write High/Low Flow Alarm

Set the high/low flow alarm settings in percent of device full scale. This command can be used to configure the flow alarm limits. NOTE: Smart *II* Digital Series devices use Flow Alarm 1 for the Low Flow Alarm and Flow Alarm 2 for the High Flow Alarm.

Request data bytes:

LOW-LIMIT MSB	LOW-LIMIT	LOW-LIMIT	LOW-LIMIT LSB	HIGH-LIMIT MSB	HIGH-LIMIT	HIGH-LIMIT	HIGH-LIMIT LSB
#0	#1	#2	#3	#4	#5	#6	#7

Data Byte #	Type	Remarks
0-3	32-bit floating point, IEEE 754 format	Low-flow alarm limit (Percent of FS).
4-7	32-bit floating point, IEEE 754 format	High-flow alarm limit (Percent of FS).

Response data bytes:

LOW-LIMIT MSB	LOW-LIMIT	LOW-LIMIT	LOW-LIMIT LSB	HIGH-LIMIT MSB	HIGH-LIMIT	HIGH-LIMIT	HIGH-LIMIT LSB
#0	#1	#2	#3	#4	#5	#6	#7

Data Byte #	Type	Remarks
0-3	32-bit floating point, IEEE 754 format	Low-flow alarm limit.
4-7	32-bit floating point, IEEE 754 format	High-flow alarm limit.

8-34-1 Command #248 Specific Response Codes

0	No command-specific errors
1-2	Undefined
3	Passed parameter too large
4	Passed parameter too small
5	Too few bytes received
6-127	Undefined

8-35 Command #250 Change User Password

This command is implemented to maintain compatibility with other Brooks Smart products, however, it is not required and has no effect. Write Protect mode is not supported by Smart *II* Digital Series and therefore the device does not require a password.

Request data bytes:

#0	#1	#2	#3	#4	#5	#6	#7
OLD PASSW.	OLD PASSW.	OLD PASSW.	OLD PASSW.	OLD PASSW.	OLD PASSW.	NEW PASSW.	NEW PASSW.

#8	#9	#10	#11
NEW PASSW.	NEW PASSW.	NEW PASSW.	NEW PASSW.

Data Byte #	Type	Remarks
0 - 5	6 (8-bit) byte packed ASCII	Current password.
6 - 11	6 (8-bit) byte packed ASCII	New password.

Response data bytes:

NONE

8-35-1 Command #250 Specific Response Codes

0	No command-specific errors
1-4	Undefined
5	Incorrect bytecount
6-127	Undefined

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9-1 Transmitter Specific Tables

This Section lists all transmitter specific codes as used by the Brooks GF40/GF80 Series S-Protocol devices. The codes are commonly 8-bit unsigned integers, ranging from 0 to 255. In a number of cases these code tables are subsets of existing “Common Tables” provided by the HART communication specification.

9-2 Device Type Codes

The Device type code for all Brooks GF40/GF80 Series S-Protocol devices is 90.

9-3 Flow Rate Unit and Reference Codes

The flow rate unit codes are covered by two tables: the table with the reference condition codes and the table with the actual unit codes.

Code	Flow rate unit
0..16	Undefined
17	Litres/minute
18	Undefined
19	Cubic meters/hour
20..23	Undefined
24	Litres/second
25..27	Undefined
28	Cubic meters/second
29..56	Undefined
57	Percent of flow range
58..130	Undefined
131	Cubic meters/minute
132..137	Undefined
138	Liters/hour
139..169	Undefined
170	Millilitres/second
171	Millilitres/minute
172	Millilitres/hour
173..249	Undefined
250..255	Reserved

Code	Reference condition
0	Normal (273.15 Kelvin/1013.33 mBar)
1	Standard (User defined through separate command)
2	Calibration (As defined at calibration)
3..249	Undefined
250..255	Reserved

9-4 Density Unit Codes

The density units are always referenced at 273.15 Kelvin and 1013.33 mBar ('normal' conditions).

Code	Density unit
0..90	Undefined
91	Grams/cubic centimetre
92	Kilograms/cubic meters
93	Undefined
94	Pounds/cubic feet
95	Undefined
96	Kilograms/litre
97	Grams/Litre
98..249	Undefined
250..255	Reserved

9-5 Temperature Unit Codes

Code	Temperature unit
0..31	Undefined
32	Degrees Celsius
33	Degrees Fahrenheit
34	Undefined
35	Kelvin
36..249	Undefined
250..255	Reserved

9-6 Pressure Unit and Reference Codes

All pressure values can be expressed in the pressure units as given in the table below. In case the unit refers to the inlet and outlet pressure values, the pressure reference is also given.

Code	Pressure unit
0..5	Undefined
6	Pounds/square inch
7	Bar
8	Millibar
9-10	Undefined
11	Pascals
12	Kilopascals
13	Torricelli
14	Atmosphere
15..249	Undefined
250..255	Reserved

Code	Pressure reference
0	Absolute pressure
1	Effective pressure
2..249	Undefined
250..255	Reserved

9-7 Write Protect Codes

Write Protect Codes	
Code	**Material**
0	Not write protected
2..249	Undefined
250..255	Reserved

9-8 Physical Signalling Codes

The physical signalling codes indicate the physical layer that can be used for communication.

Physical Signalling Codes	
Code	**Physical signalling code**
0	RS-485
1..249	Undefined
250..255	Reserved

9-9 Transmitter Variable Codes

Definition of the transmitter variable codes.

Transmitter Variable Codes	
Code	**Variable**
0	Flow rate
1	Temperature
2	Pressure
3..249	Undefined
250..255	Reserved

9-10 Flag Assignments

The flag assignments indicate implementation facts of the device.

Flag Assignments	
Bit	**Indication**
#0	Multisensor device
#1	Undefined
#2	Undefined
#3	Undefined
#4	Undefined
#5	Undefined
#6	Undefined
#7	Reserved

9-11 Analog Output Selection Codes

Definition of the analog output selection codes.

Analog Output Selection Codes				
Analog Output Code	**Analog Output Code Description**	**Factory Configured Output Type**	**Analog Level Low**	**Analog Level High**
0	Current Output	0 - 20 mA[1]	4	20
		4 - 20 mA	4	20
1	Voltage Output	0 - 5 V	0	5
		0 - 10 V	0	10

[1] For output type 0 - 20 mA use command #216 to switch to 4 - 20 mA. Perform the output adjustment, master reset and use command #216 to switch back to 0 - 20 mA.

9-12 Setpoint Source Selection Codes

The codes define the possible sources for the setpoint signal.

Setpoint Source Selection Codes

Code	Setpoint source
0	Undefined
1..2	Analog Input
3	Digital Communication Input
4...9	Undefined
10	Sets Analog Input and Output 0-5 V
11	Sets Analog Input and Output 0-10 V
12..19	Undefined
20	Sets Analog Input and Output 0-20 mA
21	Sets Analog Input and Output 4-20 mA
22..249	Undefined
250..255	Reserved

Read command #215 will only return setpoint source selection codes 1, 2 and 3. Command #215 returns code 1 for analog input/output type 0-5 V, 0-10 V and 0-20 mA, and code 2 for input/output type 4-20 mA. Both codes 1 and 2 can be used for command #216 to change the setpoint source to analog, this will select the analog input/output type configured during production. Next to the values 1, 2 and 3 write command #216 will also accept setpoint source selection codes 10, 11, 20 and 21 to change the configured analog input and output type to 0-5 V, 0-10 V, 0-20 mA or 4-20 mA. Only use this in case the analog input and output type, configured during production, needs to change.

9-13 Softstart Selection Codes

The codes define the possible softstart types with changing setpoints.

Softstart Selection Codes

Code	Softstart type
0	Softstart disabled
1	Undefined
2	Undefined
3	Undefined
4	Linear up and down Softstart
5..249	Undefined
250..255	Reserved

9-14 Valve Override Codes

Note: These codes are all 'Undefined' for the meter models.

Valve Override Codes

Code	Valve override selection
0	Valve override off (normal operation)
1	Valve override open
2	Valve override close
3	Valve override manual (Read Only)
3..249	Undefined
250..255	Reserved

9-15 Totalizer Command/Status Codes

Totalizer command/status codes

Code	Totalizer command / status
0	Stop totalizer / stopped
1	Start totalizer / running
2	Reset totalizer counter / resetting

9-16 Totalizer Unit Codes

Totalizer unit codes

Code	Totalizer unit
41	l (liters)
43	m^3 (cubic meters)
60	g (gram)
61	kg (kilogram)
63	lb (pound)
175	ml (milliliter)

9-17 Analog Output Unit Codes

Analog Output Unit codes

Code	Analog Output Unit Codes
0..38	Undefined
39	Milliamperes
40..57	Undefined
58	Volts
59..249	Undefined
250..255	Reserved

9-18 Additional Device Status and Masking

Additional Device Status and Masking					
Byte #	**Bit #**	**Status bit description 0=no error, 1=specified error ccured):**	**Device status masking**		
			Mask bit: 0=disabled 1=enabled (*default)	**Mod LED Flash Code**	**Remarks**
0	0	Program memory corrupt	1	12	One always
	1	RAM test failure	1	12	One always
	2	Undefined	0		Zero always
	3	Non-volatile memory failure	1	12	One always
	4	Undefined	0		Zero always
	5	Internal power supply failure	1	6	One always
	6	Undefined	0		Zero always
	7	Undefined	0		Zero always
1	0	Undefined	0		Zero always
	1	Undefined	0		Zero always
	2	Undefined	0		Zero always
	3	Undefined	0		Zero always
	4	Undefined	0		Zero always
	5	Undefined	0		Zero always
	6	Setpoint deviation (controller error)	0 / 1*	8	
	7	Temperature out of limits (high/low)	0 */ 1	7	
2	0	Low flow alarm (flow alarm 1)	0* / 1	10	
	1	High flow alarm (flow alarm 2)	0* / 1	11	
	2	Totalizer overflow	0* / 1	7	
	3	Undefined	0		Zero always
	4	Undefined	0		Zero always
	5	Valve drive out of limits	0* / 1	3	
	6	Undefined	0		Zero always
	7	Device calibration due	0* / 1	2	
3	0	Device overhaul due	0* / 1	1	
	1	Undefined	0		Zero always
	2	No-flow indication	0/ 1*	9	
	3	Undefined	0		Zero always
	4	Undefined	0		Zero always
	5	Undefined	0		Zero always
	6	Undefined	0		Zero always
	7	Undefined	0		Zero always

LIMITED WARRANTY

Seller warrants that the Goods manufactured by Seller will be free from defects in materials or workmanship under normal use and service and that the Software will execute the programming instructions provided by Seller until the expiration of the earlier of twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller.

Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer.

All replacements or repairs necessitated by inadequate preventive maintenance, or by normal wear and usage, or by fault of Buyer, or by unsuitable power sources or by attack or deterioration under unsuitable environmental conditions, or by abuse, accident, alteration, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense.

Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Seller and can be amended only in a writing signed by an authorized representative of Seller.

BROOKS SERVICE AND SUPPORT

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required.
For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

CUSTOMER SEMINARS AND TRAINING

Brooks Instrument can provide customer seminars and dedicated training to engineers, end users and maintenance persons.

Please contact your nearest sales representative for more details.

HELP DESK

In case you need technical assistance:

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Germany	☎ +49 351 215 2040	China	☎ +86 21 5079 8828
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Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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