Installation and Operation Manual
X-SW-DDE-MFC-eng
Part Number 541C057AAG
January, 2013

Smart DDE Software

for use with Brooks Digital Mass Flow Meter/Controller Series

BROOKS® INSTRUMENT

Smart DDE Software

Essential Instructions
Read before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. These products must be properly installed, operated and maintained to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, operating and maintaining Brooks Instrument products.

- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.

⚠ **WARNING: Do not operate this instrument in excess of the specifications listed in the Instruction and Operation Manual. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.**

- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.
- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Operation: (1) Slowly initiate flow into the system. Open process valves slowly to avoid flow surges. (2) Check for leaks around the flow meter inlet and outlet connections. If no leaks are present, bring the system up to the operating pressure.
- Please make sure that the process line pressure is removed prior to service. When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place to prevent electrical shock and personal injury, except when maintenance is being performed by qualified persons.

⚠ **WARNING: For liquid flow devices, if the inlet and outlet valves adjacent to the devices are to be closed for any reason, the devices must be completely drained. Failure to do so may result in thermal expansion of the liquid that can rupture the device and may cause personal injury.**

European Pressure Equipment Directive (PED)

All pressure equipment with an internal pressure greater than 0.5 bar (g) and a size larger than 25mm or 1" (inch) falls under the Pressure Equipment Directive (PED).

- The Specifications Section of this manual contains instructions related to the PED directive.
- Meters described in this manual are in compliance with EN directive 97/23/EC.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Meters larger than 25mm or 1" (inch) are in compliance with PED category I, II or III.
- Meters of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

European Electromagnetic Compatibility (EMC)

The Brooks Instrument (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (2004/108/EC (EMC directive 89/336/EEC)).

Special attention however is required when selecting the signal cable to be used with CE marked equipment.

Quality of the signal cable, cable glands and connectors:

Brooks Instrument supplies high quality cable(s) which meets the specifications for CE certification.

If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.

"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screen clamping.

The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.

The shield should be terminated to an earth ground.

Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification.

The shield should be terminated to an earth ground.

For pin configuration : Please refer to the enclosed Instruction Manual.

ESD (Electrostatic Discharge)

⚠ **CAUTION: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.**

Handling Procedure:

1. Power to unit must be removed.
2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.
3. Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.

Comments

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

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Smart DDE Software

Dear Customer,

We appreciate this opportunity to service your flow measurement and control requirements with a Brooks Instrument device. Every day, flow customers all over the world turn to Brooks Instrument for solutions to their gas and liquid low-flow applications. Brooks provides an array of flow measurement and control products for various industries from biopharmaceuticals, oil and gas, fuel cell research and chemicals, to medical devices, analytical instrumentation, semiconductor manufacturing, and more.

The Brooks product you have just received is of the highest quality available, offering superior performance, reliability and value to the user. It is designed with the ever changing process conditions, accuracy requirements and hostile process environments in mind to provide you with a lifetime of dependable service.

We recommend that you read this manual in its entirety. Should you require any additional information concerning Brooks products and services, please contact your local Brooks Sales and Service Office listed on the back cover of this manual or visit www.BrooksInstrument.com

Yours sincerely,
Brooks Instrument

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Tables

Tables

1.1 General Information

Brooks Smart DDE software for Microsoft® Windows™ is a server application, making it easy to communicate with the Brooks Digital Mass Flow Meters/Controllers Models GF40/GF80, 48xxS, SLA58xxS, SLAMfxxS, 58xxS, & MfxxS, as well as the 0152/54 and 0254 secondary electronics devices through other Windows applications which support Dynamic Data Exchange (DDE). This enables you to communicate with one or more Brooks Digital Mass Flow Meters or Controllers, using common available Windows client applications (e.g. Microsoft Excel).

Smart DDE is designed to allow you to access the configuration data in the models, take measurement data from the models and — in case of the Mass Flow Controllers — send setpoint values, by using the Windows Dynamic Data Exchange facilities. The protocol used for the communication between the Mass Flow Meters and Controllers and the Smart DDE software is based on the Emerson HART™ protocol and can take place over either RS-232 or RS-485 (The Bell-202 as normally used with the true HART is NOT supported within the S-series).
Note that the GF40/GF80, 48xx and SLA device families only support the RS-485 interface, the 58xxS and MfxxS devices support both the RS-232 and RS-485 interfaces. The 0152/54 and 0254 secondary elctronics devices only support the RS-232 interface.

This manual explains how to use Smart DDE, in combination with other programs which support DDE, under the Microsoft Windows environment for PCs personal computers in conjunction with the Brooks Digital Mass Flow products.
The manual does not cover the functionality of the Brooks Mass Flow Meters and Controllers itself. These products are described in detail; please refer to the specific instruction manual for your device. For detailed protocol message structure refer to the Communication Instruction manual; Document 541-C-053-AAA.

NOTE: The reader is assumed to have knowledge on how to use the Microsoft Windows environment for PCs (personal computers).

1-2 Use of Smart DDE

The Brooks Digital Mass Flow products are equipped with analogue I/O, representing the mass flow and —in case of a controller— the setpoint. The information on these I/O ports are represented as a voltage signal ranging from 0 (1) to 5 Volt or as a current signal ranging from 0 (4) to 20 mA.

In addition, all models can be equipped with a communication piggyback board, providing access to the flow and setpoint information, either in a range from 0% to 100%, or in selectable engineering units. You also have access to the configuration parameters of the device.

Smart DDE Software

Smart DDE gives you the opportunity to communicate with one or more devices (equipped with communication piggyback board), which are hooked up to the host computer through a point to point or a multidrop network connection, using a personal computer with regular software, e.g. Excel or Word. Smart DDE enables other applications to perform tasks like:

- Visualising on line measurement data
- Control process settings
- Inspect or change configuration data
- Configuring operational settings
- Optimise the control parameters of the device for your process application
- Monitoring the process for diagnostic alarm conditions
- Communicate with a device from a remote computer using the Windows for Workgroups network DDE facilities.

With Smart DDE it is possible to make your own applications for communication with your device using data acquisition programs like LabVIEW® or Testpoint™, or SCADA programs like FIX DMACS™, without concerning about the details of the HART protocol. Also typical Windows programming languages like C(++), Pascal or even 4GL's work just fine with Smart DDE as the DDE server.

Smart DDE offers you the possibility to integrate Brooks Digital Mass Flow products in your own process control application.

2.1 Introduction

This section will deal with the installation of the Smart DDE software and setting up your system in order to establish communication with the Brooks Digital Mass Flow products. The system requirements will be discussed as well as the hardware connections which must be made between the device(s) and the host computer.
In addition, some basics about Dynamic Data Exchange are explained before the instruction on how to install the software. See the following sections for a more detailed description on how to use the program and making links between Smart DDE and other programs.

2.2 System Requirements

When using Smart DDE with RS-485, an additional RS-232 to RS-485 converter or RS-485 interface board is required. Smart DDE supports automatic and manual switching converters.
IMPORTANT NOTE: To support a wide range of RS-232 to RS-485 converters and RS-485 interface boards, Smart DDE allows the selection of both the direction control line (i.e. RTS or DTR) and the read- and write buffer logical levels (i.e. logical ‘1’ activating the write buffer and logical ‘0’ activating the read buffer, or logical ‘0’ activating the write buffer and logical ‘1’ activating the read buffer). Contact Brooks Instrument for available converters and interface boards.
Smart DDE is designed for the following platforms/operating systems:
1. Microsoft Windows 98 (SE)
2. Microsoft Windows 2000 (With SP4)
3. Microsoft Windows XP (With SP2)
4. Microsoft Windows Vista

2.3 Supported Brooks Devices

Models GF40/GF80, 48xxS, SLA58xxS, SLAMfxxS, 58xxS, MfxxS, 0152/54 and 0254 are supported. Refer to the instruction manuals available at the Brooks website (www.BrooksInstrument.com) Documentation & Downloads/Product Documentation link “Thermal Mass Flow Meters & Controllers, Digital, Gas” and/or "Secondary Electronics (Power Supplies & TMF Accessories)".

2.4 Interconnection Configurations

Models 58xxS and MfxxS both support RS-232 and RS-485 interface whereas Models GF40/GF80, 48xxS SLA58xxS and SLAMfxxS only support the RS-485 interface. The 0152/54 and 0254 secondary electronics devices only support the RS-232 interface.

2.4 .1 Digital Mass Flow Products

The RS-232 is essentially a point-to-point connection, i.e. one host computer and one Digital Mass Flow Meter/Controller model. The standard cable supplied by Brooks (part number 124Z893ZZZ, 124Z894ZZZ or 124Z895ZZZ) is a split cable, suited for RS-232 communication: the communication part of the cable can directly be connected to the serial COM-port of any PC or PC with USB to RS-232 converter. The other part of the cable can be connected to the Brooks Model 0152/0154 or 0154

secondary electronics. These models provide power to the Digital Mass Flow Meter and Controller models and perform local read out and display of the analog output signals. Figure 2.1 shows the interconnection diagram of the RS-232 configuration. The pin assignment on the DTE (Data Terminal Equipment), which represents the PC, is standard for RS-232.

Table 2.1 D-Connector Communication Pins

D-connector pin number	RS-232	RS-485
Pin #9	Ground	Not Used
Pin #14	Receiver Input	A-
Pin #15	Transmitter Output	A+

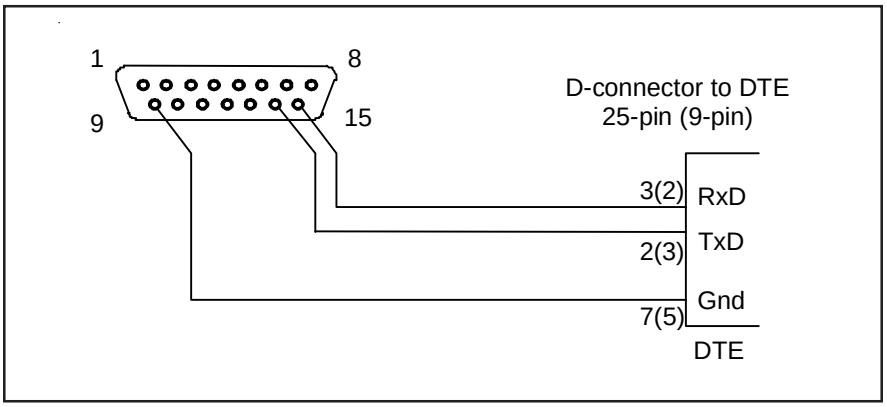

Figure 2.1 RS-232 Interconnection with DMFC and PC

Important Note: When you provide your own cable assembly, please refer to Brooks Documents 541-C-051 AAG (Elastomer Seal) or (Metal Seal/UHP) Document Number 541-C-067.

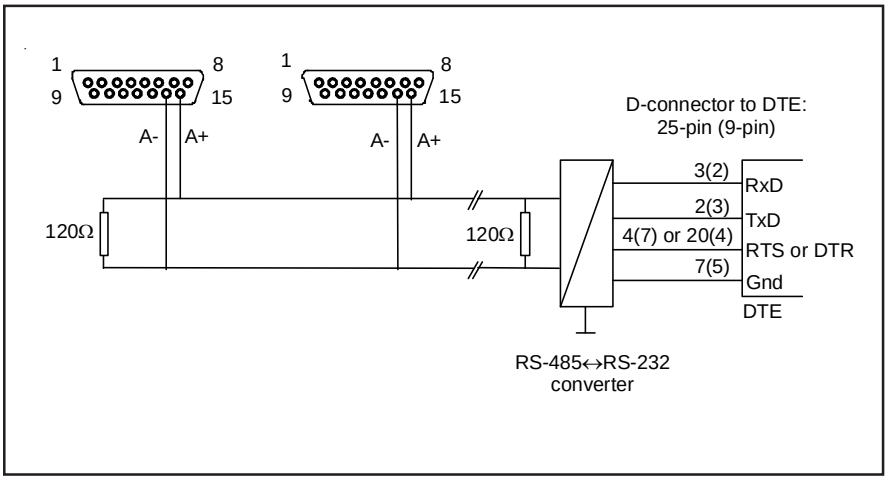

Figure 2.2 Multidrop Interconnection with DMFC's and PC

The Break out cable with part number S-124-Z-905-ZZZ can be used if the device is already connected via a power cable. The power cable needs to be disconnected and can be reconnected once the break out cable is connected onto the device.

The RS-485 is essentially a multidrop connection. It allows connection of max. 32 devices to a computer system. PC's are **not** standard equipped with RS-485 ports, thus requiring a RS-232 to RS-485 or USB to RS-485 convertor. Figure 2.2 shows the interconnection diagram of two DMFC's, via RS-485 and a RS-485 to RS-232 converter, to a PC. The RS-485 bus requires two matching resistors of 120 Ohm, one at the end of the bus and one at the beginning, near (or sometimes already in) the converter.

NOTE: In a RS-485 connection some converters require a control line from the PC to the converter in order to control the data direction of the RS-485 buffers. To support a wide range of RS-232 to RS-485 converters, Smart DDE makes it possible to select both the direction control line (i.e. RTS or DTR) and the read- and write buffer logical levels (i.e. logical '1' activating the write buffer and logical '0' activating the read buffer, or logical '0' activating the write buffer and logical '1' activating the read buffer). Many RS-232/RS-485 converters are automatically switching and do not require a switch line.

2.4.2 Secondary Electronics

In addition to digital mass flow products, the Smart DDE application also works with the Models 0152/54 and 0254 secondary electronics. An RS-232 cable is needed for communication. This cable needs to be connected between the RS-232 port on the secondary electronics and the serial-com port of the PC or PC with USB to RS-232 converter. Note that the communication cable is specific for each model. Refer to the specific secondary electronics instruction manuals for details. The instruction manuals are available at the Brooks website (www.BrooksInstrument.com) Documentation & Product Documentation "Secondary Electronics (Power Supplies & TMF Accessories)".

2.5 Concept of DDE

Smart DDE offers all the functions you need to access the information from the Brooks Digital Mass Flow Controller/Meter. Dynamic Data Exchange (DDE) is a form of communication using shared memory in order to exchange data between application programs. Applications can use DDE for one-time data transfers and for ongoing exchanges in which the programs send updates to one another as new data becomes available.

Dynamic Data Exchange differs from the clipboard data-transfer mechanism which is also part of the Windows operating system. One difference is that the clipboard is used as a one-time response to a specific action by the user—such as choosing the Cut/Paste command from a menu. Although DDE may also be initiated by a user, it typically continues without the user's further involvement.

The principles of Dynamic Data Exchange are based on a conversation between two applications, a client and a server:

Client The application requesting information or initiating an action.

Server The application providing the information requested by the client or executing an action (i.e. Smart DDE).

A client requests the server to provide a service. There are several types of server requests:

Request The client asks the server for a single piece of information ('cold' link)

Advise (special request) A continuous form of information transfer from the server to the client, initiated by the client ('hot'/'warm' link).

Poke The client asks the server to change a data item and therefor sends the information to the server.

Execute The server is asked by the client to execute a command.

A conversation service is set up by the client application using the three-level hierarchy of service, topic and item names. Each service is uniquely identified by the service name and the topic name, which can not be changed during the existence of the conversation. The information, exchanged within a conversation between two applications, is identified with the usage of item names. It is possible to transfer several different items using the same conversation.

2.6 Installing Smart DDE

The Smart DDE software is available on the Smart CD part number 535-F-002 and on the Smart DDE CD part number 535-F-003.

Both the Smart CD and the Smart DDE CD are programmed with the auto run feature, which means that the installation menu should be shown automatically after inserting the CD. If this doesn't happen, the executable in the root of the CD folder structure should be started manually, e.g. select the 'Browse' button in the 'Start->Run' window, navigate to the root of the CD folder and select the executable.

Select Smart DDE in the menu, at the right side of the installation window a radio button will be shown indicating Smart DDE, which needs to be selected prior to activating the install button.

The install wizard will show a welcome screen once the install button is activated. After clicking the next button the user has to select the 'I accept the terms in the license agreement' radio button and click the next button. In the last screen the user is given the option to launch Smart DDE after the installation is finished.

Once the installation is finished, the Smart DDE application can be started via the 'Start->All Programs->Brooks Instrument->Smart DDE->Smart DDE' menu option.

2.7 Running Smart DDE

Smart DDE is a translation program (driver), which translates the HART based communication protocol, used to communicate with one or more Brooks Digital Mass Flow Meters/Controllers, to the Windows Dynamic Data Exchange mechanism. Because Smart DDE is a DDE-driver for other applications, the program is not useful as a stand-alone program, i.e. **it will not show you the DMFC data**.

To perform the function as DDE-driver, Smart DDE needs to be active (mostly running in background) in combination with your application. To get Smart DDE running, there are two possibilities:

1. Start Smart DDE from the Program Manager and setup one or more DMFC-connections using the Smart DDE user interface (refer to section 3).
2. Start Smart DDE and setup the DMFC-connections from your own application without intervention of the Smart DDE user interface (refer to section 5)

3.1 Introduction

The Smart DDE must be considered as a communication interface between the Digital Mass Flow Controller/Meter and other applications supporting DDE and is of no use as stand alone application. Most of the time the Smart DDE program operates in the background, serving other applications. Therefor, all functions within Smart DDE, necessary for setting up, maintaining and changing DDE-links can be called from a client application using the DDE mechanism.
The Smart DDE user interface provides you several utilities, for example manually setting up communication links, visualizing existing conversation links and showing error messages. This section explains the functions of the Smart DDE user interface.

3.2 Main Window

Figure 3.1 shows an example of the main window of Smart DDE with several communication links established between DMFC's and other applications.

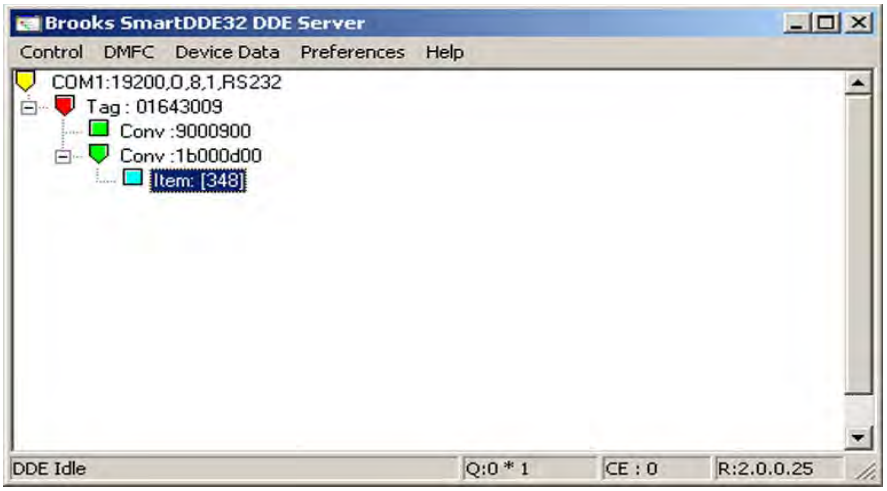

Figure 3.1 Smart DDE Main Window

The main window shows the status of all links with other resources in Windows, using the following icons:

1. COM (Yellow) Communication ports
2. Tag (Red) DMFC's
3. Conv (Green) Conversations with client applications
4. Item (Blue) Advise links

NOTE: The icons can take three different shapes which reflect the hierarchical structure; the , the and the . The last shape indicates the end of a branch in the hierarchical tree. You can toggle between the and the . Just double click with the left mouse button on the involved line. This allows you to show/hide portions of the hierarchical tree.

The bottom row displays a status bar showing information on the status of the communication links.

3.2.1 Communications Ports

'COM' icons indicate open communication ports along with their matching communication settings.

EXAMPLE: Figure 3.1 shows one open communication port, i.e. COM1 which is configured to RS-232.

NOTE: Communication ports used by Smart DDE (all communication ports displayed in the main window) are exclusively in use by Smart DDE and can not be accessed by other applications.

3.2.2 DMFC's

'Tag' icons indicate open Digital Mass Flow Controllers/Meters (DMFC) or Secondary Electronics (SE). The information behind the icon shows the tag number of the DMFC or SE, which is necessary to set up the connection.

EXAMPLE: 1. "Figure 3.1 shows one DMFC with tag number 01643009 opened on COM1.

NOTE: The tag number of a DMFC should have eight (8) digits.

3.2.3 Conversations

Conversation links to other applications are displayed behind the 'Conv' icons. A conversation row shows the conversation handle (this is a number, in hexadecimal format, identifying the conversation) and the topic used to open the conversation.

NOTE: This window does not display links with the system topic (section 4.1.3 explains the system topic).

3.2.4 Advise Links

The 'Item' icons represent 'warm/hot' links, used for continuous data transfer. A conversation can hold more than one advise link. Behind the icon of an Advise link is(are) the itemnumber(s) displayed which were used when the advise link was opened.

NOTE: The displayed item numbers are not refreshed when changing advise link items using the 'Device data' menu (refer to section 5.8, Changing advise link items, for more information).

3.2.5 Status Bar

The status bar (displayed below in the User Interface, see Figure 3.1: Smart DDE main window) shows multiple information. The left message indicates the status of Smart DDE. This can be one of the following:

Idle
Smart DDE is in the idle state, waiting to get a command from any DDE-link, the User Interface or an Advise link timer signal.

Requesting items
Smart DDE asks a DMFC to provide information as a result of a DDE request.

Writing items
Smart DDE issues the command to change a value within a DMFC as a result of a poke request.

Executing command
Smart DDE issues the command to perform a function within a DMFC.

Requesting items (Advise loop)
Smart DDE asks a DMFC to provide information to update an Advise link as a result of an Advise link timer signal.

Initializing
Smart DDE is copying all readable parameters from a DMFC into its internal database.

Communication time-out
Smart DDE is waiting for a response from a DMFC but the device does not react within the time-out period.

No available timer. Updating stopped
There is no timer available for use within Smart DDE, making it impossible to update the information within an Advise link.

The middle message (Q:) indicates the number of requests waiting to be processed. In case the rate of issuing requests exceeds the rate at which Smart DDE can handle them, the queue number will increase. In this case one should decrease the refresh rate in Smart DDE

The right message (CE:) indicates the number of communication errors occurred since Smart DDE was started. A communication error occurs after three retries of one command. The request being processed will be skipped when a communication occurs and the next request will be executed.

3.3 Control

The control menu (see Figure 3.2) allows you to open or close a communication port, connect a new or a previously opened DMFC or close an opened DMFC. The ‘copy DDE-link’ menu item provides you a tool for copying link information, necessary for setting up a request, to other applications.

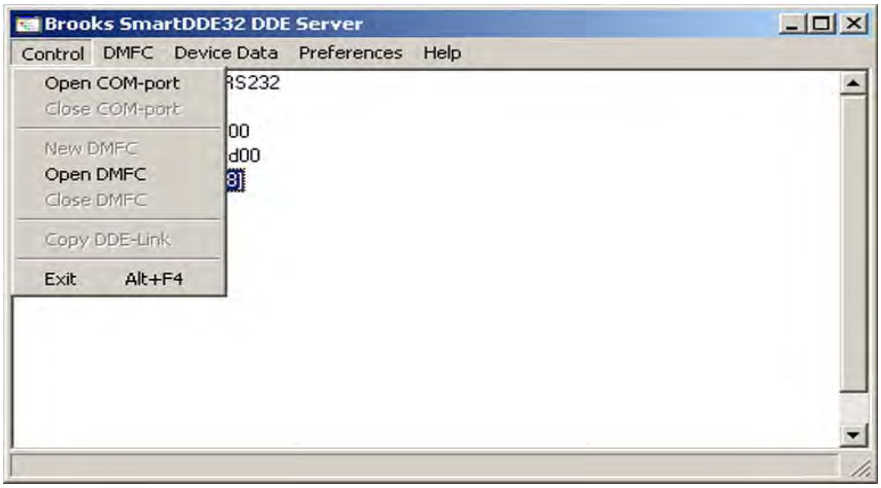

Figure 3.2 The Control Menu

Most of the items in this menu, except the ‘Open COM-port’ and ‘Exit’ option, are only available when a particular row is selected (high-lighted) in the main windows. For example, the ‘New DMFC’ option is only available when a ‘COM’ row is selected by clicking on it with the left mouse button.

3.3.1 Opening A Communication Port

Selecting the **Control|Open COM-port** option pops up the ‘Open communication port’ window, see Figure 3.3. You can open a new (not already opened) communication port using this dialog.

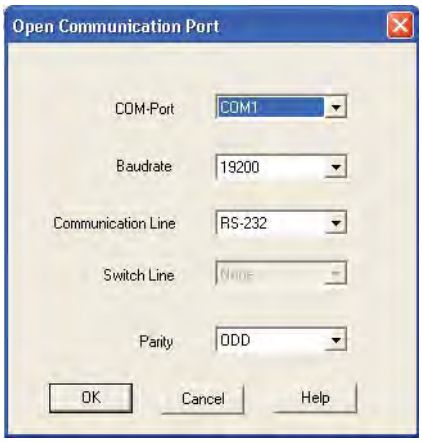

Figure 3.3 Open Communication Port Window

From this window you can enter the communication settings.

1. COM-port: The communication port to open. The list indicates all **available** COM-ports (between COM1 and COM9). Already opened communication ports are not displayed in the COM-port list.
2. Baudrate: The baudrate of communication with the DMFC(s) you connect to this communication port. The options are: 1200, 2400, 4800, 9600, 19200 and 38400.
3. Communication line: The type of communication Smart DDE should use to communicate with the DMFC(s) connected to the selected communication port: RS-232 or RS-485. When selecting RS-485, you also need to select a switch line. Otherwise, when1. RS-232 is selected, no switch line is needed and the switch line box will not be available.
4. Switch line: Selection of the switch line, used for controlling the data direction of the RS-232 to RS-485 converter buffers (only available when the communication line is set to RS-485). Smart DDE supports the following switch lines:
   RTS: The RTS line is **set** when writing and **reset** when waiting for response.
   DTR: The DTR line is **set** when writing and **reset** when waiting for response.
   !RTS: The RTS line is **reset** when writing and **set** when waiting for response.
   !DTR: The DTR line is **reset** when writing and **set** when waiting for response.

In case a Model 0152 or 0154 is connected a baud rate of 9600 baud, RS-232 communication line and ODD parity should be selected. In case a Model 0254 is connected a baud rate of 9600 baud, RS-232 communication line and parity none should be selected. See Figures 3.4 and 3.5.

Figure 3.4 Open Communication Port Window for 0152/54

Clicking the **OK** button opens the communication port using the entered settings and represents this in the main window using the 'COM' icon.

Figure 3.5 Open Communication Port Window for 0254

3.3.2 Closing A Communication Port

In order to close a communication port, click with the left mouse button on the communication port row in the Smart DDE main window, thus identifying the port you wish to close. Then select the **Control|Close COM-port** option. Note that this menu option is only available when a communication port has been selected in the Smart DDE window. When selecting the option, the communication port will be closed immediately if no DMFC(s) are open on the COM-port. Otherwise Smart DDE will report an error message, indicating that the communication port can not be closed.

If the communication port is successfully closed, Smart DDE will save the communication settings to the WIN.INI file, making the settings available when opening the communication port a next time.

3.3.3 Opening A New DMFC

Opening a new DMFC can be realized as follows. Click with the left mouse button on the communication port row in the Smart DDE main window, identifying the port on which the DMFC is connected to. Choose the **Control|New DMFC** option from the menu (Note that this menu option is only available when there is a communication port selected in the Smart DDE window). This pops up the 'New DMFC' window, see Figure 3.6.

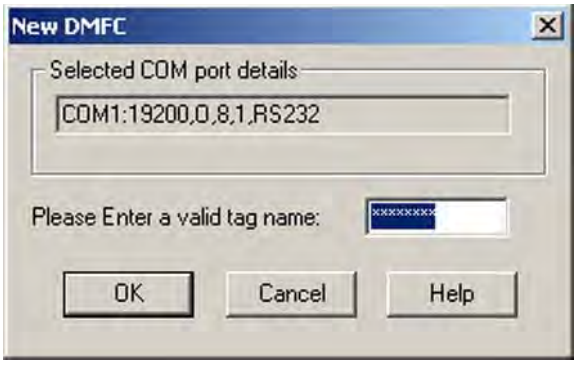

Figure 3.6 Open a New DMFC Window

The window requests you to fill in a tag number.

- Tag: An **8 character** long tag number, used for making the first identification to the DMFC to open.

1."Fill in the tag number or "xxxxxxxx" for automatic search and press the OK button. Note that the automatic search works only in the single drop mode, meaning that there is only one (1) device connected per serial port.

Smart DDE tries to establish communication with the DMFC and represents this in the main window using the 'Tag' icon. When communication is established and if the DMFC was never opened before (i.e. the tag number can not be found in the WIN.INI file), Smart DDE will request all readable data from the DMFC, thus initializing its internal data buffers. Otherwise, when the program recognizes the DMFC as opened before, the internal data buffers will be filled with information from disk. The status bar informs you with information about the actions taken.

The tag number of the Brooks Digital MFCs/MFMs consists of the last 8 characters of the device serial number (remove the forward slash "/" in case present in the serial number). In case of a 0152/54 Read Out device the tag number consists of the string "CHANNEL" followed by the channel number [1..4], e.g. "CHANNEL 2" for selecting channel 2. The automatic search is not supported for the 0152/54 Read Out device. (Note that it's possible to change these tag names within the 0152/54 Read Out, using a software application called 'Read Out Tagwriter'. This software application is available in the 'Smart DDE' folder of the CD.)

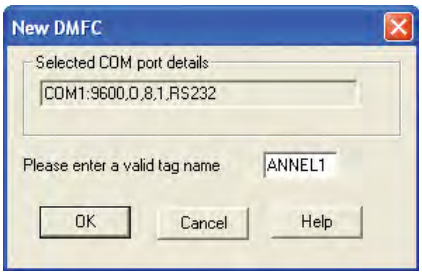

Figure 3.7 Open a new DMFC Window for 0152/54 Read Out

In case a 0254 Read Out device is connected the user will be prompted with a different screen in which a channel number needs to be selected. The tag number will be automatically read from the device and shown in the main screen once the 'OK' button is pushed. The first 6 characters of the tag name is a unique identification per Read Out, the last character

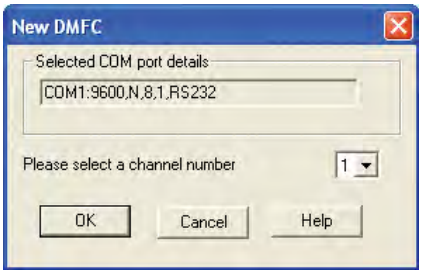

Figure 3.8 Open a new DMFC Window for 0254 Read Out

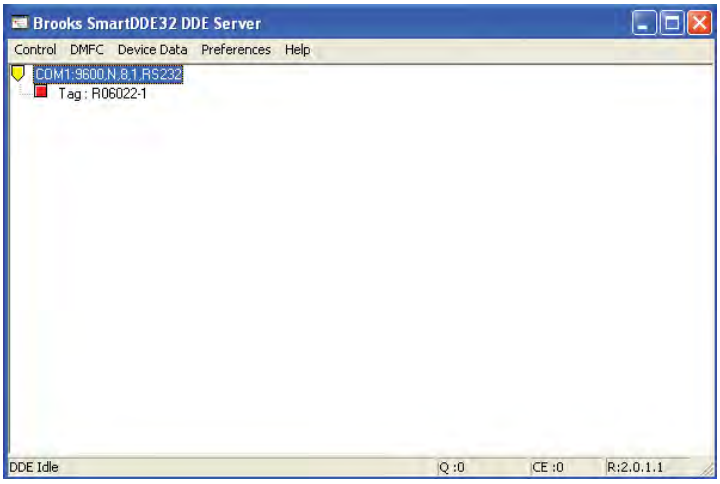

Figure 3.9 Main Window Showing the Tag Number of a 0254 Read Out

3.3.4 Opening An Existing DMFC

By using the ‘Open DMFC’ option, **previously** opened DMFC’s can be opened again: Select the communication port in the Smart DDE main window, identifying the port to which the DMFC is connected. Select the **Control|Open DMFC** option from the menu (note that this menu option is only available when there is a communication port selected in the Smart DDE window). This pops up the ‘Open DMFC’ window, see Figure 3.10.

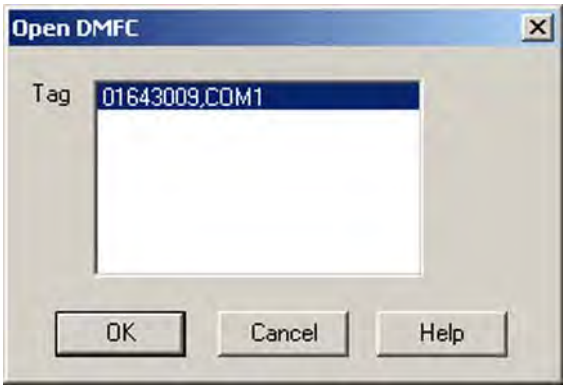

Figure 3.10 Open DMFC Window

The window shows a list of tag numbers along with their COM-ports.

- Tag: The tag number identifies the DMFC. The COM-port indicates the former communication port on which the DMFC was opened.

From the list, select one or more of the available tag numbers. Then press the **OK** button. Smart DDE opens the DMFC(s) with the selected tag(s) on the currently selected communication port (which can differ from the indicated COM-port).

3.3.5 Closing A DMFC

To close a connection to a DMFC, select the DMFC row, indicated by the 'Tag' icon. Then select the **Control|Close DMFC** option from the menu. Smart DDE will disconnect the communication with the DMFC immediately, on condition that no open links are established. If there are any open DDE-links to the DMFC, the program displays a message, informing you that the connection with the DMFC can not be closed because of open DDE-links to other applications, which depends on this links.

When Smart DDE closes a connection to a DMFC, the data necessary for communication with the DMFC is stored in a DMF-file on disk. The name of the DMF-file is the same as the tag number of the DMFC, with the extension ".DMF". Smart DDE uses this file the next time you open the DMFC again.

3.3.6 Copying DDE-Link Information

Smart DDE supports the possibility to copy link information to the clipboard, using the ‘Copy DDE-link’ option. This will be explained in section 5.4.

3.3.7 Exit Smart DDE

Using the **Control|Exit** option from the menu or by simultaneously pressing the Alt-F4 keys on the keyboard, you can quit the Smart DDE program. Another possibility to quit the program is double click the left mouse button on the application control box in the upper left corner of the Smart DDE main window. Exiting the program with open DDE-links results in a confirmation window, asking if you really want to quit the program (Figure 3.11).

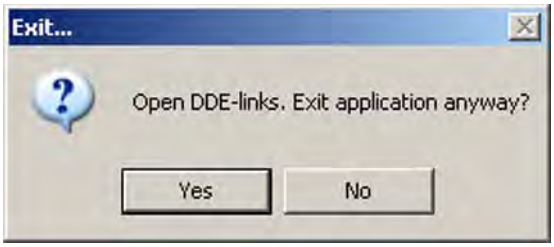

Figure 3.11 Exit Confirmation Window

3.4 DMFC

The ‘DMFC’ menu (see Figure 3.12) is divided in two categories. The first category provides options causing certain actions to be executed by the DMFC. The second category provides options used for updating or saving the internal program buffers associated with a DMFC.

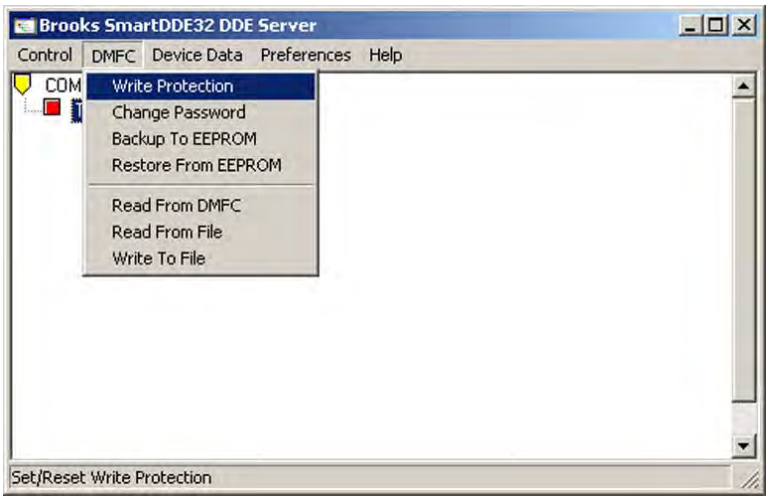

Figure 3.12 The DMFC Menu

All the items in this menu are related to an open DMFC. Therefore, the items only are available when a DMFC is selected (high-lighted) in the main windows by clicking with the left mouse button on a DMFC row, indicated with the ‘Tag’ icon.

3.4.1 Write Protection

After power up of a DMFC, the device is write-protected preventing unauthorized users from changing the internal configuration. Therefor, a password needs to be entered to turn off the protection, prior to changing the configuration.

First select the DMFC from the main window. Then choose the **DMFC|Write protection** option. This pops up the ‘Write protection’ window, see Figure 3.13.

Figure 3.13 Write Protect Window

3.4.2 Changing The Password

Selecting the **DMFC|Change password** option from the menu pops up the 'Change password' window, see Figure 3.14 (note that this option is only available when a DMFC is selected from the Smart DDE main window).

Figure 3.14 Change Password Window

This window allows you to edit the password in the DMFC, used for changing the write-protect status of the DMFC (see section 3.4.1, Write protection). Changing the password requires filling in three fields. First enter the actual (old) password. Then enter the new one twice. Re-entering the password prevents you from typing mistakes. Then press **OK** to change the password in the currently selected DMFC.

NOTE: When changing the password, use visible characters, but do not use the '(', ')' and ',' characters

3.4.3 Backup to EEPROM

Changes made to parameter settings in the DMFC database will be stored in the volatile memory of the device. These settings will be used until there is a power-down or a master reset of the device. A power up or a master reset results in an initialization of the internal settings, meaning that the configurable parameters are copied from the backup-database into the working memory of the DMFC (the backup database resides in non-volatile memory on the DMFC).

To save the changes made, use the **DMFC|Backup to EEPROM** option from the menu. Note that this option is only available when you first select a DMFC from the main window. Using this option, Smart DDE sends a command to the currently selected DMFC which causes the parameters in the volatile SRAM memory to be copied to the non-volatile EEPROM memory on the DMFC. This way, the current settings will be maintained also after a power down or a master reset.

3.4.4 Restore from EEPROM

Using the ‘Restore from EEPROM’ option gives you the possibility to send a command to a DMFC causing replacement of the current settings in the volatile working memory with the database parameters stored in the non-volatile backup memory (EEPROM) on the DMFC. This command is very useful when the DMFC is not working properly as a result of changes you have made to the configurable settings in the working memory. Issuing this command will **discard all the changes** you made after the last backup command.

Perform this function by selecting the DMFC in the main window. Next select the **DMFC|Restore from EEPROM** option from the menu (note that this option is only available when a DMFC is selected). After this action, Smart DDE directly sends a command to the currently selected DMFC, which causes a restore of all the configurable settings out of the non-volatile backup-memory to the working memory of the DMFC. The restored settings will take effect immediately.

3.4.5 Read from DMFC

For each open DMFC, Smart DDE needs to make a copy of all the readable DMFC parameters to its internal data buffers, prior to establish communication. When opening a DMFC, Smart DDE will try to find a DMF-file that holds the readable settings. This file should have a name, equal to the tag number with the extension “.DMF”. When this file is found, the internal buffer is filled with the information from the file. Otherwise, when there is no file found, Smart DDE reads all the settings out of the DMFC in order to fill its internal buffers.

Suppose you want to open a DMFC with the same tag number as another previously opened DMFC. Due to the previously opened DMFC, there is a DMF-file stored on disk with a name that is equal to the tag number of the DMFC you want to open now. This causes Smart DDE to fill its internal data buffers with the settings belonging to the wrong DMFC. As a result of an inaccurate internal buffer, the communication can not be set up.

Communication problems due to differences between the internal Smart DDE buffers and the actual DMFC parameters, as mentioned in the example above, can be handled using the **DMFC|Read from DMFC** option from the menu. When you select this option (note that this option is only available when you first select a DMFC from the main window), Smart DDE starts filling its internal data buffer, belonging to the actual selected DMFC, with all readable parameters out of the device.

3.4.6 Read from File

With the option **DMFC|Read from File** (first select a DMFC from the main window to enable this option), Smart DDE will try to find a DMF-file on disk with the same name as the tag number of the selected DMFC, with the extension ".DMF". A DMF-file holds all readable settings from one DMFC. When this file can be read from disk, all the settings from the DMF-file will be copied to the internal data buffer belonging to the currently selected DMFC.

3.4.7 Write to File

For each open DMFC, Smart DDE contains a copy of all the readable DMFC parameters in its internal data buffers. Normally, when the connection to a DMFC is closed, Smart DDE will store the readable parameters, belonging to the DMFC, to disk. The name of the stored file will be the same as the tag number of the closed DMFC, with the extension ".DMF". Using the 'Write to File' option, you will be able to store the readable parameters belonging to a DMFC to disk during the open connection of a DMFC. This option can be performed by selecting a DMFC from the main window, followed by selecting the **DMFC|Write to File** option from the menu (note that this option is only available when a DMFC is selected). Smart DDE will store the parameters immediately to disk after selecting the option. The name of the stored file will be the same as the tag number of the selected DMFC with the extension ".DMF". In case a file with the same name already exists, this file will be overwritten.

3.5 Device Data

Selecting **Device Data** pops up a pull-down menu with eight options, see Figure 3.15. The options in the pull-down menu are only available when a DMFC (indicated with a 'Tag' icon) or an Advise-link (indicated with a 'Item' icon) row is selected in the main window by highlighting the row with the left mouse button.

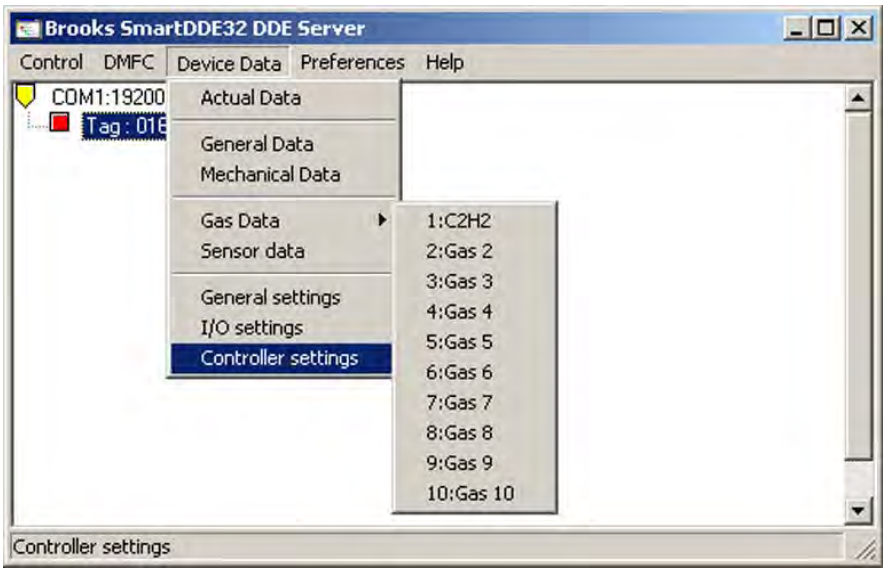

Figure 3.15 The Device Data Menu

Selecting one of these options pops up a window with a list of checkboxes.

IMPORTANT NOTE: The user interface 'Device data' menu option is a feature making it easy to set up or change DDE links in order to access DMFC data. This function does not display the data itself.

Setting or resetting a checkbox, by clicking on it with the left mouse button, gives you the possibility to perform two kind of functions. The performed function depends on the row active, when selecting this menu option:

1. **A DMFC ('Tag') row is selected:**
   When a DMFC-row is selected, the 'Device data' menu provides the function of copying link information to the clipboard. This link-information on the clipboard can then be pasted into other applications and used for setting up a request. This function will be explained in section 5.7 (Copying a link using the clipboard).

2. **An Advise-link ('Item') row is selected:**
   When an Advise-link-row is selected, the 'Device data' menu provides the function of changing the information (identified by the item number) passed through an DDE Advise link. This will be further explained in section 5.8 (Changing advise link items).

The following sections briefly explain the meaning of the parameters, listed in each device data option window, within the DMFC.

3.5.1 Actual Data

The actual data window appears when the **Device Data|Actual data** menu option is selected. This window contains a list of checkboxes related to the actual data parameters of the currently selected DMFC (see Figure 3.16).

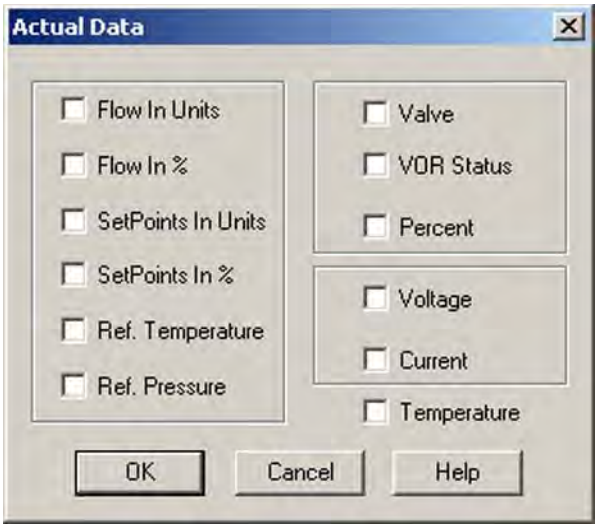

Figure 3.16 Actual Data Window

The parameters on top of the list represent the currently measured flow and setpoint (controller model only) in engineering units or percentages of full scale (at reference conditions). The measured temperature is used to perform compensation.

The *valve* parameters represent a valve *value* and the *Valve OverRide status*.

The parameters in the *Analogue output* box represents the output of the DMFC in percentage of full scale, voltages and current.

3.5.2 General Data

When selecting the **Device Data|General data** menu option, a general data window appears (see Figure 3.17). This window contains a list of checkboxes related to the general data parameters of the DMFC.

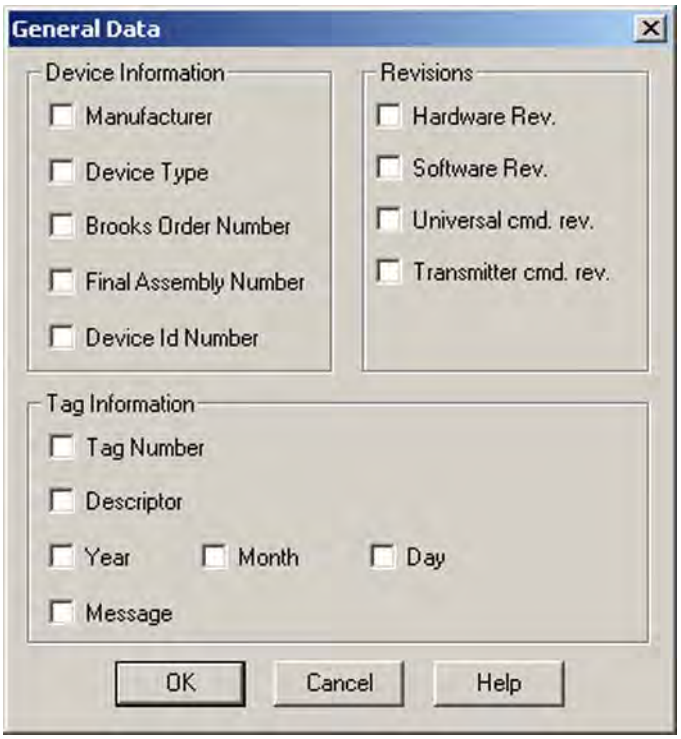

Figure 3.17 General Data Window

The parameters in the general data window are divided into three groups. The *Device information* box contains parameters used for identification of the device. The *Manufacturer* parameter represents the name of the manufacturer. The *Device type* parameter represents the model code of the device.

The *Brooks order number* parameter contains a string, indicating the order number used during the original order handling at Brooks Instrument. This number is our reference on the device and should be used when contacting Brooks Instrument for service issues. The *Final assembly* parameter contains a string which is for internal use with Brooks Instrument only. The *Device id number* parameter contains a number which is normally set by Brooks Instrument to a unique number. The HART-protocol used for communication with a DMFC specifies the device number as a part of the address. Therefore, it needs some attention in case you intend to change this number; always make sure that the device ID to be changed remains unique on the communication link, i.e. that no another device with the same type and manufacturer and with the same device ID number is present on the bus. Be sure that you assign an *unique*, positive number between 0 and 16777215.

The *Revisions* box contains a set of four parameters. The left parameters refer to the revision of the printed circuit board and the control software used on the DMFC. The right parameters refer to the revisions used for the communication protocol (Rosemount HART protocol).

The *Tag information* contains the *tag number*, which is necessary when establishing the communication to a DMFC using the RS-485 configuration with several devices hooked up to the same communication port. In this configuration, the tag number of the device needs to be unique within the communication link. There are five more parameters related to the tag number: a *Descriptor*, three date parameters and a *Message*, which can be used to give some extra information concerning the device.

3.5.3 Mechanical Data

When selecting the **Device Data|Mechanical data** menu option, a mechanical data window appears. This window contains a list of checkboxes related to the mechanical data parameters of the DMFC.

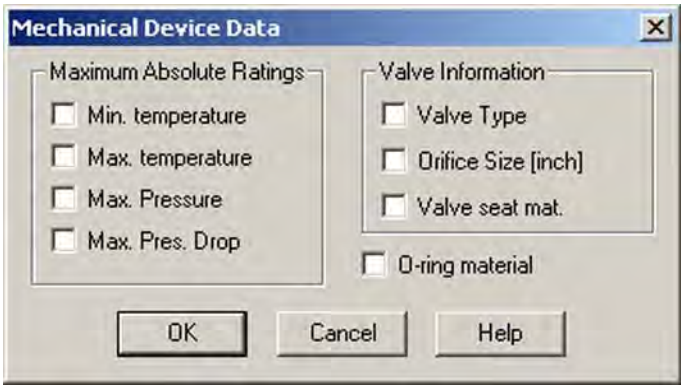

Figure 3.18 Mechanical Data Window

The *Maximum absolute ratings* parameters contain information about minimum and maximum operating temperatures and maximum operating pressure. The maximum pressure drop indicates the maximum difference between the pressure at the inlet and the pressure at the outlet of the DMFC. For controller models, the maximum pressure drop depends on the orifice selection and is determined by the device itself.

The *O-ring material* parameter contains the material of the O-ring used. The *Valve information* includes the *Valve type* (Normally Open or Normally Closed), the *Orifice size* and the *Valve seat material*. These valve parameters are only available when the device is a controller model.

3.5.4 Gas Data

Selecting the **Device Data|Gas data** menu option pops up a second menu. This menu gives you the possibility to select one out of 10 gases. The DMFC can be calibrated for 10 different gases. Selecting a gas pops up a gas data window, containing a list of checkboxes related to the gas data parameters.

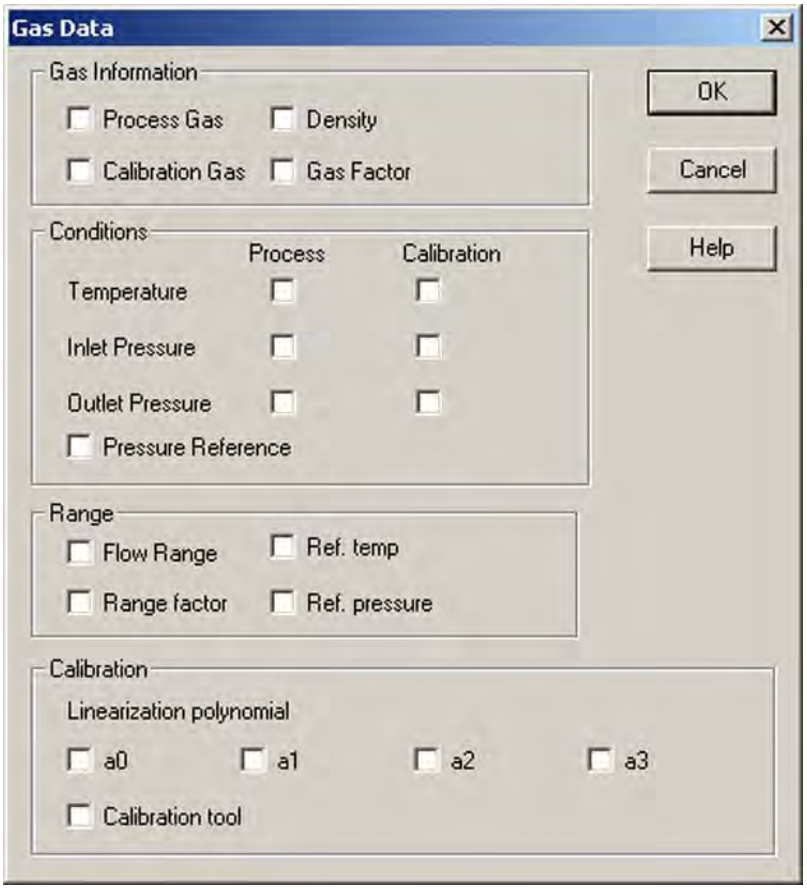

Figure 3.19 Gas Data Window

The gas data parameters contains all the calibration data necessary for the selected gas. The *Gas information* box contains parameters providing general information about the *Process* and *Calibration gas* name, the *Density* and the *Gas factor*. The gas factor is used as a scale factor in the calculating of the linearization polynomial during calibration. It is only stored in the DMFC for information purpose. The density however is used by the DMFC to convert the measured flow from volumetric units to mass units.

The *Conditions* parameters contain information about the gas temperature and pressure under process and calibration conditions. The *Pressure reference* parameter can either be set to absolute or effective (gauge).

The parameters in the *Range* box represent the full scale *Flow range* of the device, its reference conditions which are used at calibration and the *Range factor*.

The *Calibration* box contains the coefficients of the flow sensor *Linearization polynomial* and an identification of the *Calibration tool*. The linearization polynomial coefficients are used internally in the DMFC as a correction formula for the sensor signal. The linearization polynomial coefficients are represented as a_0 through a_3.

$$\text{Flow} = a_0 + a_1 * (\text{Sensor}) + a_2 * (\text{Sensor})^2 + a_3 * (\text{Sensor})^3$$

This formula calculates the corrected flow using the sensor signal as input.

3.5.5 Sensor Data

When selecting the **Device Data|Sensor data** menu option, a sensor data window appears. This window contains a list of checkboxes related to the sensor data parameters of the DMFC.

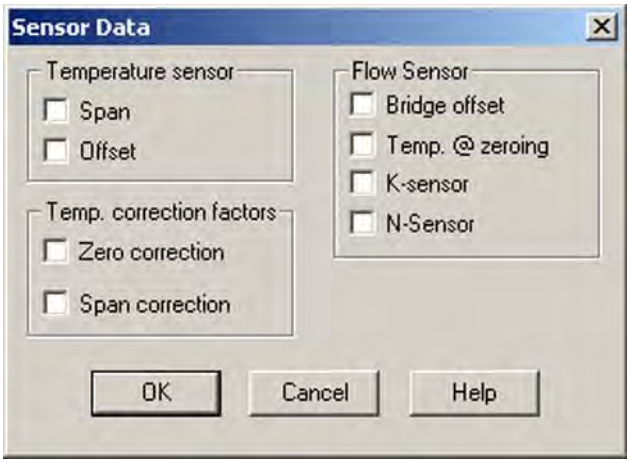

Figure 3.20 Sensor Data Window

The sensor data parameters are used within the DMFC to correct signals from the sensors or eliminate deviations from the sensor signal due to temperature changes.

The flow sensor *Bridge offset* parameter contains a value which reflects the full scale residual offset, determined during a zero-action (a zero-action can be performed using the DDE-execute service, see section 4.3.4).

The temperature at the sensor, measured during the zero-action is stored as the *Temp. @ zeroing* parameter and is used within the DMFC to correct the temperature sensor offset shift due to temperature changes.

The two parameters *K-sensor* and *N-sensor* are used to correct the signal from the flow sensor in relation with its frequency characteristics (i.e. the response of the sensor to a flow change is optimized using these parameters).

The *Temperature sensor* box contains two parameters, used to calibrate the signal from the on board temperature sensor.

The *Temp. correction factors* are two parameters used to correct the measured flow value for the temperature difference between the actual measured temperature and the temperature at calibration. These factors should be considered as the rate of change per Kelvin.

3.5.6 General Settings

When selecting the **Device Data|General settings** menu option, a general settings window appears. This window contains a list of checkboxes related to the general settings parameters of the DMFC.

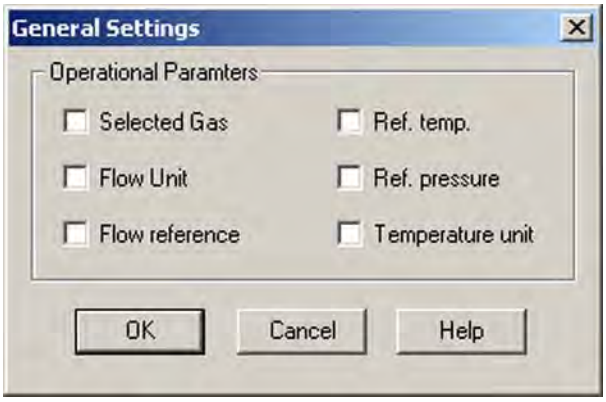

Figure 3.21 General Settings Window

The *Selected gas* parameter specifies which one of 10 gases is operational. The *Flow unit* parameter allows the user to select the preferred read out unit for the flow. The *Flow reference* parameter can be set to normal (273.15 Kelvin and 1013.33 mbar), standard or calibration. In case standard is selected, the reference temperature and pressure need to be specified using the *Ref. temp.* and the *Ref. pressure* parameters. When the calibration flow reference is selected, the reference conditions specified at calibration are used.

The *Temperature unit* parameter provides the option to select a user preferred temperature unit.

3.5.7 I/O Settings

When selecting the **Device Data|I/O settings** menu option, an I/O settings window appears. This window contains a list of checkboxes related the I/O settings parameters of the DMFC.

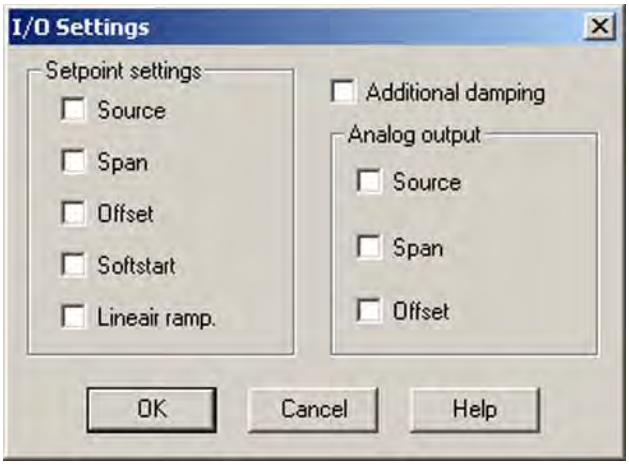

Figure 3.22 I/O Settings Window

The *Setpoint settings* box contains several parameters which are used to set and calibrate the input of a Brooks Digital Mass Flow Controller (these parameters are therefore not available when a device is a meter model). The *Source* parameter indicates the source of the setpoint to be used by the DMFC (e.g. analogue or through communication). It can be set to communication, 0-5V/0-20mA or 1-5V/4-20mA. When the communication source is selected, the setpoint can be provided to the device through communication via RS-232 or RS-485. The *Span* and *Offset* parameters are used to calibrate an analogue input. In case re-calibration of an analogue input is required, refer to 'Appendix E: Analogue I/O calibration'.

With the *Softstart* parameters, you are able to set the controller device to a state in which it will react slower to setpoint changes. This can be used in control situations where fast response is not desired. This feature includes the following options:

1. No softstart.
2. Traditional softstart ("traditional" with respect to the former 5850E/i series Mass Flow Controllers). Using this option, a setpoint change from level *a* to *b* at time *t = 0* , results in an internal setpoint reacting according to the following formula:

   Internal setpoint = $b-(b-a)\cdot e^{-\frac{t}{\tau}}$ (t = 4 seconds)
3. Linear ramp up. A setpoint change from a lower level *a* to a higher level *b* results in an internal setpoint which changes from level a to level *b* using a *Linear ramp* (this parameter is expressed in percentage per second). A decreasing setpoint change will not be delayed.
4. Linear ramp down. This is the opposite action mentioned in option 3.
5. Linear ramp, the combination of option 3 and 4.

The *Additional damping* parameter is applied in order to provide a stable flow output. The amount of damping is expressed in units of seconds and can be set to a value between 0.0 sec. (no damping at all) and 10.0 sec. (maximum damping). After changing the value in the DMFC, the damping will be active immediately.

The *Analogue output* box contains several parameters which are used to set and adjust the analogue output of the DMFC. The *Source* parameter can be set to either 0-5V/0-20mA or 1-5V/4-20mA. The *Span* and *Offset* parameters are used to calibrate an analogue output. Refer to 'Appendix E: Analogue I/O calibration' in case re-calibration of the analogue output is required.

3.5.8 Controller Settings

When selecting the **Device Data|Controller settings** menu option, a controller settings window appears. This window contains a list of checkboxes with all the controller settings parameters of the DMFC.

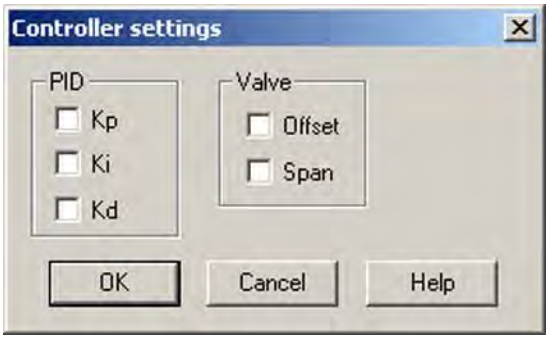

Figure 3.23 Controller Settings Window

The *PID* box refers to three parameters which are only available in case the device is a Brooks Digital Mass Flow Controller model. The behaviour of the controller on board can be set by determining the three PID parameters, the proportional (*Kp*), the integral (*Ki*) and the differential (*Kd*) parameter. The default values of the PID parameters are **Kp**=0.65, **Ki**=3.5 and **Kd**=0.0 respectively.

NOTE: It is advised to keep the differential part of the controller to Kd=0.0 at all times. Setting the differential controller to a non-zero value would make the system faster, but also more susceptible to fast disturbances, thus creating a "nervous", over reacting control system. Therefore only the settings of the proportional and integral parameters are discussed here.

In most cases, tuning the device for the desired control is merely a matter of selecting the right valve settings, rather then tuning the PID parameters. The PID parameters however can very well be used for fine tuning in the end.

The response to changed parameters should be monitored if possible on a fast flow or pressure measuring device down stream of the Mass Flow Controller to be adjusted. This method is preferred over just examining the output signal of the device itself, because the true control is found to be faster then the output signal.

Changing the proportional Kp parameter influences the control response the most. Care should be taken when increasing or decreasing this number. Increasing the Kp will speed up the response, but it will also increase the short term overshoot, e.g. increasing the Kp from 0.65 to 0.8 will cause overshoots of 40% and more. Increasing Kp too much will cause fast oscillations. Decreasing the Kp will slow down the response, i.e. the response will take longer to reach the end value. The ideal Kp value is determined around 0.5 to 0.6, depending on the environmental parameters (inlet pressure, outlet pressure etc.), and as such depending on your system.

Changing the integral Ki parameter will have a lesser influence on the response, e.g. increasing the Ki from 3.8 to 4.5 will cause a long term overshoot (approximately 10%) which slowly fades away, depending on your system. It will not change the response time significantly, and a Ki which is set too large will cause (slow) oscillations. Setting the Ki to a value which is too low (e.g. 2.0) will cause a slow responding system, which however will be less prone to fast disturbances in the system and the environment. In general you can tune the Ki value between 3.4 and 4.0 in order to get the right response. Again this should be verified using a fast measuring device down stream of the device under test.

The *Offset* and *Span* parameters in the *Valve* box are used within the device (Controller models only) to define the signal range where the controller can vary to control the gas flow between 0 and 100%. The offset defines the start point and the span defines the control range of the valve signal. The offset and the span are represented using numbers related to the D/A-converter used to set the current through the valve. Both numbers are dimensionless and can be set in the range of 0 to 62500.

During normal control the output signal of the PID control is mapped on to the control range of the valve. A PID controlling 0.0% flow, results in a valve setting equal to the valve offset. Controlling 100% flow results in a valve setting around the sum of the valve offset and the span. It will be clear that determining these two values greatly influences the control behaviour of the total device. Therefore care should be taken when selecting these values. A valve offset, which is too high will cause a leaking valve (remember that the valve used is a control valve, not a positive shutoff valve).

3.6 Preference

The ‘Preference’ option from the menu gives you the possibility to select one of two items; refresh rate and communication settings. The last item is only available when a communication port row is selected in the Smart DDE main window.

3.6.1 Refresh Rate

Selecting the **Preference|Refresh rate** option pops up a window (see Figure 3.24) which lets you change the refresh rate for advise links. This refresh rate implies the time between the last item(s) and the next item(s) send through an advise (hot) link.

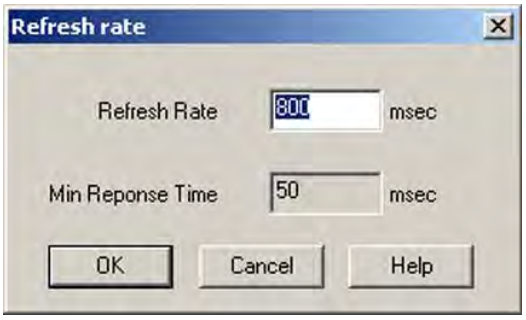

Figure 3.24 Refresh Rate Selection

The refresh rate window brings the following two items:

1. Refresh rate: The actual refresh rate used by Smart DDE to update advise links is displayed and you are able to change this value. The refresh rate is expressed in msec.

2. Minimum response time: This item displays the minimum time that Smart DDE required at the last update of an advise link. Changing the refresh rate to a lower value than the value displayed by this item leads to a real refresh rate that is around the minimum response time.

NOTE: Windows updates its internal clock with steps of approximately 50 msec. Decreasing the refresh rate below 50 msec is therefore not effective and the real refresh rate will be at least 50 msec.

Refresh Rate for 0254 Read Out: Due to speed limitations of the 0254 Read Out the refresh rate should be specified as per the following calculation:
Refresh Rate = Number of advise links * 500msec
EXAMPLE: If there are advise links for 5 items for 0254 Read Out; Refresh rate should be 2500msec (5*500msec = 2500 msec).

The entered refresh rate will be active immediately for all open advise links. Upon closing Smart DDE, the refresh rate is stored in the WIN.INI file. The next time Smart DDE is started, the last used refresh rate will be set.

3.6.2 Communication Settings

The ‘Communication settings’ option allows you to change the current communication settings. Therefor, first select the communication port by highlighting the communication port row (indicated with a ‘COM’ icon) using the left mouse button. Then select the **Preference|Communication settings** option from the menu. The window pops up on the screen. See Figure 3.25.

Figure 3.25 Communication Settings Window

From this window you are able to change the baudrate, the type of communication and if necessary, the switch line used in case of communication through RS-485.

1. Baudrate: The current baudrate setting of the selected communication port is displayed and can be changed: 1200, 2400, 4800, 9600, 19200 or 38400.
2. Communication line: The actual type of communication on the selected COM-port is shown. RS-232 and RS-485 are available options. In case RS-485 is selected, you also need to select a switch line if the hardware converter does not support automatic switch line selection. If RS-232 is selected, no switch line is needed and the switch line box will not be available.
3. Switch line: Selection of the switch line, used for controlling the data direction of the RS-232 to RS-485 converter buffers (only available

RTS: The RTS line is **set** when writing and **reset** when waiting for response.

DTR: The DTR line is **set** when writing and **reset** when waiting for response.

!RTS: The RTS line is **reset** when writing and **set** when waiting for response.

!DTR: The DTR line is **reset** when writing and **set** when waiting for response.

3.7 Main Window Pop Up Menus

The main window of Smart DDE shows the status of all links with other resources in Windows. Click with the right mouse button on such a link-status-row gives you a quick access to some of the above mentioned menu-options. The options which are available depends on the type of link-status-row you click on, see the following sections.

3.7.1 Communication Pop Up Menu

Pressing with the right mouse button on a communication port row (indicated with a 'COM' icon) in the Smart DDE main window, pops up the communication pop up menu (see Figure 3.21).

Figure 3.26 The Communication Pop Up Menu

Using this pop up menu, you have quick access to the following COM-port related functions:

- Close COM-port
- Communication settings
- New DMFC
- Open DMFC

3.7.2 DMFC Pop Up Menu

The DMFC pop up menu (Figure 3.22) will be displayed when the right mouse button is pressed on a DMFC row (indicated with a 'Tag' icon) in the main window.

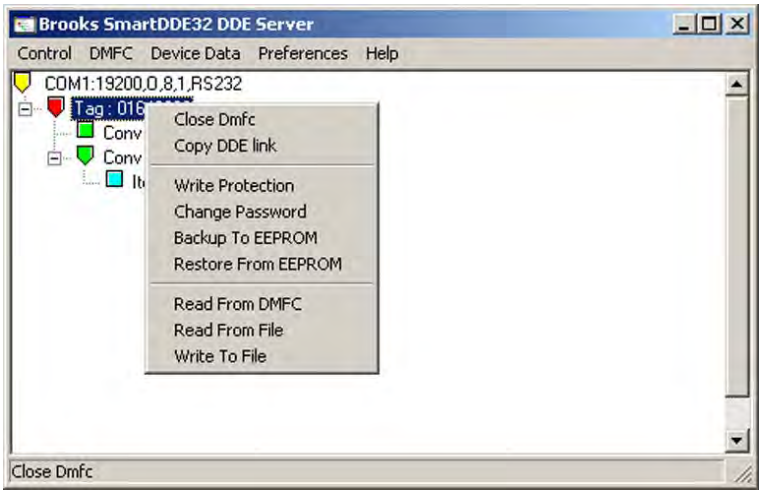

Figure 3.27 The DMFC Pop Up Menu

Using this pop up menu, you have quick access to the following DMFC related functions:

- Close DMFC
- Copy DDE-link
- Write protection
- Change password
- Backup to EEPROM
- Restore from EEPROM
- Read from DMFC
- Read from File
- Write to File

For an explanation of these functions, refer to previous sections.

3.7.3 Advise Pop Up Menu

Pressing with the right mouse button on an advise-link row (indicated with a 'Item' icon) in the Smart DDE main window, pops up the advise link pop up menu, see Figure 3.23.

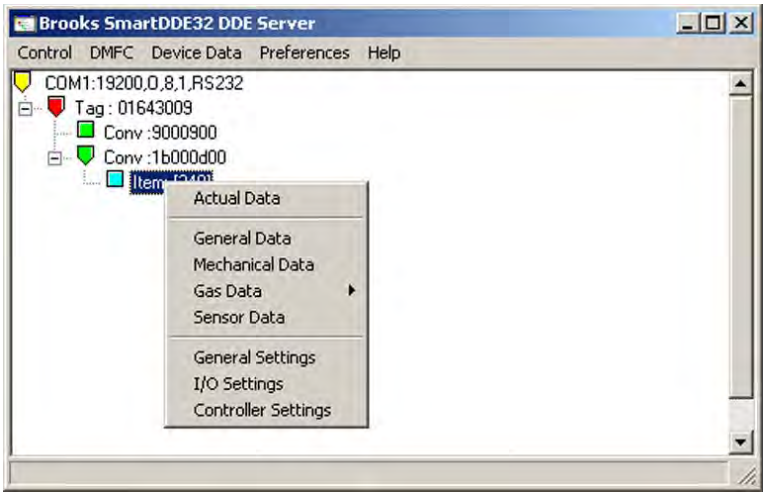

Figure 3.28 The Advise Link Pop Up Menu

Using this pop up menu, you have quick access to the following advise link related functions:

- Actual data
- General data
- Mechanical data
- Gas data
- Sensor data
- General settings
- I/O settings
- Controller settings

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4.1 Smart DDE Conversation Principles

In a conversation between Smart DDE and another application, using the Dynamic Data Exchange mechanism, Smart DDE acts as the server. The other application can be considered as the client.

A conversation is initiated by the client application. Using this conversation, the client application can request the server (i.e. Smart DDE) to provide a service. There are several types of server requests:

Request

The client application requests a single piece of information from Smart DDE. The client includes the item name as a part of the request, thus specifying which information is required. In most cases, the information needs to be achieved from the DMFC. Therefor, Smart DDE translates the request to a HART protocol based command, requesting the DMFC to provide the information. As soon as the DMFC returns the information in a HART protocol based format, Smart DDE translates this to a DDE based format and returns this to the client application.
Because Smart DDE returns the information once, as a result of the request from the client, this conversation is called a ‘cold’ link.

Advise (special request)

An advise link is a continuous form of information transfer from the Smart DDE to the client application. An advise link is initiated by the client using an advise request, specifying which information is required. As soon as the advise link is active, Smart DDE sends an update of the required information to the client application every time a specified period of time has elapsed. This period of time can be defined by the refresh rate. For each update, Smart DDE sends a HART protocol based command to the DMFC, requesting the DMFC to provide the information. As soon as the DMFC returns the information in a HART protocol based format, Smart DDE translates this to a DDE based format and sends this to the client application.
Because Smart DDE updates the information to the client application continuously (based on his own timer), this conversation is called a ‘hot’/’warm’ link.

Poke

The client application requests Smart DDE to change a data item within the DMFC. The client includes the item name and the new value as a part of the poke request, specifying the information which needs to be changed. Smart DDE translates the poke request into a HART protocol

based command, giving the DMFC the instruction to change the parameter value. The DMFC performs the actions required to change the parameter value and returns status information. This status information can be requested by the client application and can be used in order to check if the poke instruction has been processed without problems.

Execute

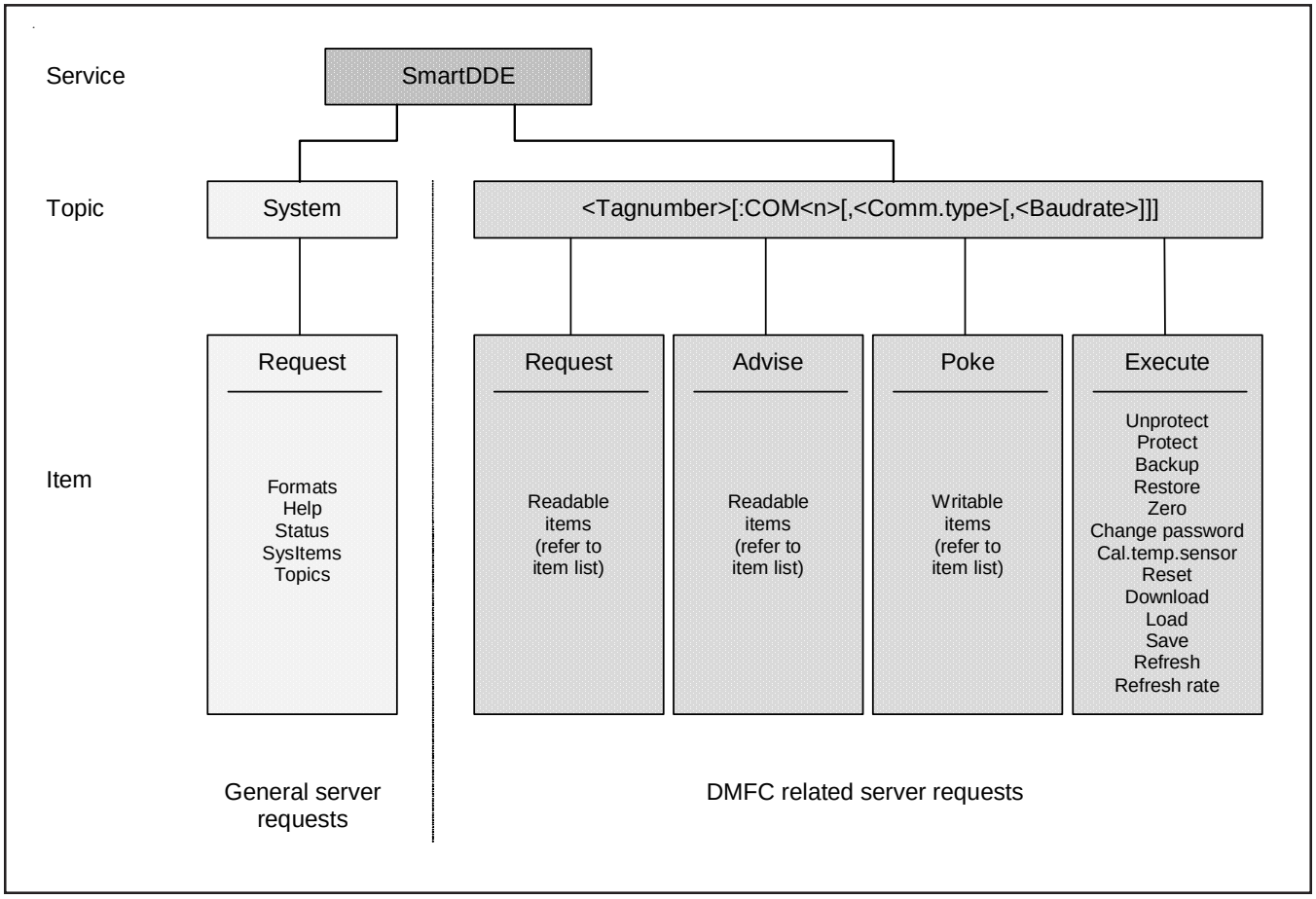
The client application requests Smart DDE to perform a specific action. An action can be performed within Smart DDE or within the DMFC. In the last mentioned type of execute request, Smart DDE translates the execute request into a HART protocol based command, giving the DMFC the instruction to perform the specified action. The DMFC performs the actions required and returns status information. This status information can be requested by the client application and can be used in order to check if the execute instruction has been processed without problems.

To manage all conversations between different applications, the DDE mechanism requires a particular identification of a DDE-link. This identification is built up using a three-level hierarchy of **service**, **topic**, and **item** names.

- Each DDE conversation is uniquely defined by the service name and the topic name. In a conversation between an application and Smart DDE, the DDE service name should always be equal to '***SmartDDE***'.
- The DDE topic name is a general classification of the data which may be discussed (exchanged) during the conversation. In Smart DDE, this can be a **tag number topic** or the **system topic**. The service name and topic name identifying a conversation cannot be changed during the course of the conversation.
- A DDE data **item** name identifies the information which is exchanged through a DDE-link between two applications. This information can be passed from the server to the client, or from the client to the server.

Figure 4.1 shows an overview of the Smart DDE supported service, topic and item names.

Figure 4.1 Three-Level Conversation Identification Hiearchy



The following sections explain the service, topic and item names supported by Smart DDE.

4.1.1 Service Names

A server request to Smart DDE is identified with the service name ***SmartDDE***. This is the only service name Smart DDE supports.

4.1.2 Topic Names

Smart DDE supports two types of topics. The **system topic,** used to request general information about Smart DDE, and the **tag number topic** which is related to a DMFC. The tag number topic name always starts with a tag number, which identifies the related DMFC, and can be followed by additional information on the communication port settings.
All valid Smart DDE topic names are listed below.

System

Through a conversation which is built up —and identified— using the system topic, the client application can request some general information about Smart DDE (e.g. help text). All topics not equal to **System** will be treated as a Tag number topic.

<Tag number>

When setting up a conversation using this topic name, Smart DDE will try to open the DMFC with tag <*Tag number*>. The DMFC with this tag number must have been opened in a previous session, otherwise Smart DDE will not know on which communication port it should be opened.

<Tag number>:<COM>

Setting up a conversation using this topic name, Smart DDE will open the DMFC with tag <*Tag number*> on the specified communication port. Valid communication port id's are:

- COM1
- COM2

.. up to ..

- COM9

If this communication port is not already open, Smart DDE will try to read previous communication settings from the WIN.INI file. When the communication settings are not specified in this file, the port is opened using as default the RS-232 setting with a baudrate of 19200.

<Tag number>:<COM>,<Communication Type>

Setting up a conversation using this topic name, the DMFC with tag <*Tag number*> will be opened on the specified communication port. If the communication port is not already open, the port will be opened using the <C*ommunication type*> setting. The baudrate is set to 19200, unless a previous baudrate setting of the opened port is found in the WIN.INI file. Valid <*Communication type*> settings are:

- RS232
- RTS
- DTR
- !RTS
- !DTR

Selecting (!)RTS or (!)DTR implies RS-485 communication, using the RTS or DTR-line (switch line) for controlling the data direction through the RS-485 data buffers.

IMPORTANT NOTE: To support a wide range of RS-232 to RS-485 converters and RS-485 interface boards, Smart DDE makes it possible to select both the direction control line and the read- and write buffer logical levels, i.e.:

RTS:	The RTS line is **set** when writing and **reset** when waiting for response.
DTR:	The DTR line is **set** when writing and **reset** when waiting for response.
!RTS:	The RTS line is **reset** when writing and **set** when waiting for response.
!DTR:	The DTR line is **reset** when writing and **set** when waiting for response.

<Tag number>:<COM>,<Communication Type>,<Baudrate>

With this type of tag number topic the baudrate that shall be used to open the COM port is specified.

- 1200
- 2400
- 4800
- 9600
- 19200
- 38400

<Tag number>:<Communication Type>,<Baudrate>,<Parity>

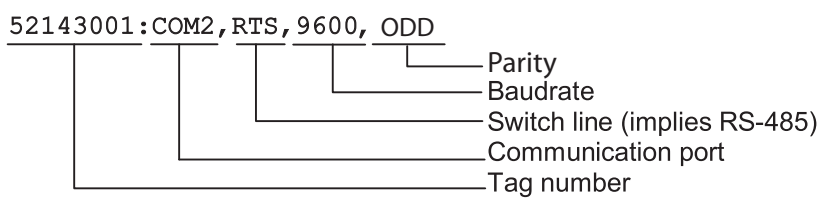
With this type of tag number topic, all parameters used, to establish communication with a device, are set. Usually, this topic name syntax is only used when the communication port is opened for the first time for the 0254 Read Out. Theparity can be set to:

- ODD
- NO

For all DMFCs except for 0254 Read Out, the parity is to be specified as ODD. For 0254 Read Out the parity is to be specified as NO.

EXAMPLE: To set up a conversation link between an application and Smart DDE, with the intention to communicate with a DMFC, connected to communication port COM2. The DMFC communicates through a RS-485 configuration, using a converter (RTS switch line; a logical ‘1’ activates the write buffer and a logical ‘0’ activates the read buffer) to adapt the RS-485 signals to RS-232. The baudrate of the DMFC is set to 9600 baud.

The topic name for setting up this conversation link needs to be as follows:



4.1.3 Item Names

As mentioned before, the DDE topic name is a general classification of the data which can be exchanged through a conversation link. Therefore, Smart DDE offers two different types of items. One type is related to the system topic, the other type is related to the tag number topic.

SYSTEM ITEMS

The following items are supported in combination with the system topic. If more than one value is returned to the client, the values will be separated by the <tab> - character.

Formats
Request Smart DDE to return the supported clipboard formats. The only format Smart DDE supports is CF_TEXT (Smart DDE will return TEXT an a result of this request).

Help
Request Smart DDE to return a short description of the supported topics and items.

Status
Request Smart DDE to return the current status information. This is the same information as is displayed in the Smart DDE User Interface status bar (for a detailed description of the status information, refer to section 3.2.5, Status bar).

Systems
Request Smart DDE to return the list of items Smart DDE supports in combination with the system topic.

Topics
Request Smart DDE to return all the supported topics; i.e. all known tags (which are stored in the WIN.INI file) and the system topic.

The system items only support one type of server request: the cold link ***Request*** service. This means it is only possible for the application to request Smart DDE to provide information.

EXAMPLE: When requesting general information using the Help item, Smart DDE returns the following text:

Smart DDE for Windows

Topics:
System: System topic
<tag>: Valid tag of a DMFC

System items:
Formats: Supported clipboard formats
Help: This help text
Status: Current server status
SysItems: Supported items under the system topic
Topics: Current supported topics

See manual for more information about supported DDE messages

4.2 Tag Number Related Server Requests

As mentioned before, the DDE topic name is a general classification of the data which can be exchanged through a conversation link. Therefore, Smart DDE offers twA server request, related to a tag number topic, and thus related to a DMFC, can be classified into four different types; request, advise, poke and execute commands. The item names for these server requests can be built up using an item number or an execute command in combination with a data-part (if necessary) and format codes (optional).

IMPORTANT NOTE: The number format Smart DDE uses to interpret numerical data from or translate data to a DDE-link depends on the Windows International settings. For an explanation, see section 4.4; Data formatting.

Request

Request Smart DDE to read one or more item values from the DMFC and return these to the client application.

Advise (special request)

Request Smart DDE to create an ‘hot’/’warm’ link through which item values are continuously sent (frequency of updating the information depends on the refresh rate in Smart DDE) from the DMFC to the client.

Poke

Request Smart DDE to change one or more item values in the DMFC. The new value(s) are sent to Smart DDE within the request.

Execute

Request Smart DDE to execute one or more commands. A command can imply an instruction within Smart DDE or within the DMFC.

4.2.1 Request

This server request can be used within a DDE-conversation in order to get information from a DMFC. The client needs to specify which parameter Smart DDE must obtain from the DMFC. All parameters in the DMFC are identified with an item number (the appendix in section 8 gives an overview of all item numbers).
When Smart DDE receives the request, it tries to read the value(s) of the specified item(s) as soon as possible from the DMFC and sends the value back to the client. The item numbers in a request **must be passed through the DDE-conversation between square brackets ([and]), and when more items are requested simultaneously they must be separated using a comma**.

EXAMPLE: To request the flow in percentage, the following item must be sent in combination with the correct tag number topic: [338]

EXAMPLE: To request both the setpoint and the flow in percentages, the following item must be sent in combination with the correct tag number topic: [337,338]

As a result of a request, Smart DDE returns the value of the specified item. Using a format letter in combination with an item number, it is possible to request additional information on an item. Supported format letters are:

A Smart DDE returns only the value of the requested item (default; the same as using no format letter)
B Smart DDE returns the value of the requested item and the value of the unit belonging to the item (if any)
C Smart DDE returns the value of the requested item and the status* of the item
D Smart DDE returns the value of the requested item, the value of the unit belonging to the item and the status* of the item
E Smart DDE returns only the status* of the requested item

* Refer to section 5.2, Item status, for detailed information on how to interpret the status information bytes.

In case a format letter is used within a request, the letter must be placed between square brackets ([and]), written in upper case and entered before the item(s).

EXAMPLE: To request both the setpoint and the flow in percentages, along with both their units and status, the following item must be sent in combination with the correct tag number topic: [D][337,338]

EXAMPLE: To request the status of the last zero command, it's possible to use the item 365 in the following request: [E][365]

4.2.2 Advise

The advise request can be used within a DDE-conversation in order to set up an advise link. An advise link is used for a continuous transfer of information from the sever to the client. Once an advise link is built up and active, Smart DDE continues to send updated information from the DMFC to the client application every time a specified period of time has elapsed (this period can be specified using the refresh rate, refer to section 3.6.1, Refresh rate, and section 4.3.4, Execute).
To set up an advise link using the advise request, the client needs to specify which parameters (items) should be transferred through the advise link (refer to Appendix A: Item list, for an overview of all item numbers).
The item numbers in an advise request **must be passed through the DDE-conversation between square brackets ([and]), and when more items are requested simultaneously they must be separated using a comma**.

EXAMPLE: To setup an advise link for the flow in percentage, send an advise request to Smart DDE using the following item name: [338]
EXAMPLE: To setup an advise link for both the setpoint and the flow in percentages, send an advise request to Smart DDE using the following item name: [337,338]

When using an advise request, it is possible to specify a format letter, requesting Smart DDE to return additional item information during an advise link information update. The same format letters are supported in an advise request as in the normal request.

4.2.3 Poke

Poke is a server request used to change a value in the working database of the DMFC. For example, a common used poke instruction is changing the setpoint of a Brooks Mass Flow Controller. To perform this server request, the client needs to specify the parameter Smart DDE has to change, by using the item number (refer to Appendix A: Item list) between square brackets ([and]). The new value must be included as a data part to the poke instruction (this value must be sent in the CF_TEXT format). **Smart DDE allows enclosing the value in square brackets ([and]), but this is only mandatory in case more data values are sent to change more than one item using one poke request. In the latter mentioned option, the item numbers and the data values needs to be separated using a comma**.

EXAMPLE: To change the setpoint of a controller to 60%, send a poke request to Smart DDE with the following item name and data part:

Item name	[337]
Data part	60

EXAMPLE: To change the calibration date of a DMFC to march 7, 1996, send a poke request to Smart DDE with the following item name and data part:

Item name	[33,34,35]
Data part	[96,3,7]

The Windows DDE mechanism does not allow the client application to wait until the poke instruction is processed by the server application (i.e. Smart DDE). It is not possible for Smart DDE to return the poke status as a result of the poke instruction. Smart DDE however provides another way to check if the poke instruction has been processed correctly: use the request command —with the same item number as used in the poke command— in combination with the E format. As a result of such a request command, Smart DDE returns the status information on the poke instruction (refer to section 5.2, Item status, for detailed information on how to interpret the status information bytes).

EXAMPLE: After setting a new setpoint (item 337) using the poke request, the status of this command will be returned immediately using the following request:

[E][337]

NOTE: In case a DMFC is in the busy state as a result of either a ZERO, BACKUP, RESTORE, RESET or CALTEMPSENSOR execute command, the device can not perform poke and execute type commands (except for the PROTECT/UNPROTECT execute command). If a poke or execute command is sent to the DMFC, the device returns a command error indicating the busy status. Requesting data (and the PROTECT/ UNPROTECT execute command) however can continue without problems.

4.2.4 Execute

Execute is a server request used to give Smart DDE the command to execute an instruction. An execute command can be used to perform a function within Smart DDE or to request Smart DDE to send the command to the DMFC to perform a function.

An execute command sent to Smart DDE **must be placed between square brackets ([and]) and written in upper case**, otherwise the command will not be recognized. The following execute commands are available.

UNPROTECT (<password>)

Request Smart DDE to send the command to the DMFC to disable the write protection. The DMFC only performs this function if the correct password of the DMFC is sent in combination with the instruction (replace *<password>* by the DMFC-password; default: Brooks). This same function is performed by using the **DMFC|Write protection** option from the Smart DDE user interface (see section 3.4.1; Write protection).

PROTECT(<password>)

Request Smart DDE to send the command to the DMFC to enable the write protection. The DMFC only performs this function if the correct password of the DMFC is sent in combination with the instruction (replace *<password>* by the DMFC-password; default: Brooks). This same function is performed by using the **DMFC|Write protection** option from the Smart DDE user interface (see section 3.4.1; Write protection).

BACKUP

Request Smart DDE to send the command to the DMFC to make a backup of the internal database, stored in the volatile RAM memory, to the non-volatile EEPROM memory in the DMFC. This same function is performed by using the **DMFC|Backup to EEPROM** option from the Smart DDE user interface (see section 3.4.3; Backup to EEPROM).

RESTORE

Request Smart DDE to send the command to the DMFC to restore all the settings from the EEPROM database memory, into the working RAM memory. This same function is performed by using the **DMFC|Restore from EEPROM** option from the Smart DDE user interface (see section 3.4.4; Restore from EEPROM).

ZERO

Request Smart DDE to send the zero-command to the DMFC. This commands the DMFC micro-processor to balance the flow sensor bridge.

CHANGEPASSWORD(<old password>,<new password>)

Request Smart DDE to send the command to the DMFC to change the password from the *<old password>* into the *<new password>*. This

same function is performed by using the **DMFC|Change password** option from the Smart DDE user interface (see section 3.4.2; Changing the password).

NOTE: When changing the password, use visible characters, but do not use the '(', ')' and ',' characters.

CALTEMPSENSOR(<ambient temperature>)

Request Smart DDE to send the command to the DMFC to perform a temperature sensor calibration action. Therefor, the DMFC needs to know the actual <*ambient temperature*>, which must be sent as a part of the execute request (in **Kelvin** only).

RESET

Request Smart DDE to send the command to the DMFC to perform a master reset. This command implies a reset of the on board micro-processor which results in an initialization of the DMFC. The settings of the DMFC database are restored from the backup database in the DMFC EEPROM memory.

DOWNLOAD

Request Smart DDE to download all readable settings from the working database of the DMFC to the internal Smart DDE buffers. This same function is performed by using the **DMFC|Read from DMFC** option from the Smart DDE user interface (see section 3.4.5; Read from DMFC).

LOAD

Request Smart DDE to load all readable settings, according to the DMFC, from the ".DMF" file into the internal Smart DDE buffers. This same function is performed by using the **DMFC|Read from File** option from the Smart DDE user interface (see section 3.4.6; Read from File).

SAVE

Request Smart DDE to store all readable settings, according to the DMFC, from the internal Smart DDE buffers to a ".DMF" file on disk. This same function is performed by using the **DMFC|Write to File** option from the Smart DDE user interface (see section 3.4.7; Write to File).

REFRESH

Request Smart DDE to update all advise links immediately, i.e. the advise-link items are read from the DMFC(s) and sent to the client through the DDE-conversation .

REFRESHRATE(<msec>)

Request Smart DDE to change the refresh rate used to update advise links. This same function is performed by using the **Preference|Refresh rate** option from the Smart DDE user interface (see section 3.6.1; Refresh rate). The new refresh rate must be set as part of the execute command (replace <*msec*> by the new refresh rate, expressed in milli-seconds).

It is possible to send more than one command to Smart DDE in the same execute request string.

EXAMPLE: To zero the DMFC, to following execute command can be sent:
[ZERO]

EXAMPLE: To unprotect, zero and protect the DMFC, the following execute command can be sent:

[UNPROTECT(brooks)][ZERO][PROTECT(brooks)]

In case of an execute request which sends a command to the DMFC to perform an action, Smart DDE provides the possibility to check if it the execute command has been received correctly: use the request command with a special item number (refer to Appendix B: Execute commands) in combination with the E format. As a result of such a request command, Smart DDE returns the status information on the execute instruction (refer to section 5.2, Item status, for detailed information on how to interpret the status information bytes).

EXAMPLE: To change configurable parameters within a DMFC, it is necessary to turn off the write protection of the device. The following execute request can be used to send a command to the DMFC, turning off the write protection: [UNPROTECT(brooks)]
To check if the unprotect command is received correctly by the DMFC, use the following request:
[E][11]

NOTE: In case a DMFC is in the busy state as a result of either a ZERO, BACKUP, RESTORE, RESET or CALTEMPSENSOR execute command, the device can not perform poke and execute type commands (except for the PROTECT/UNPROTECT execute command). If a poke or execute command is sent to the DMFC, the device returns a command error indicating the busy status. Requesting data (and the PROTECT/ UNPROTECT execute command) however can continue without problems.

4.3 Data Formatting

The data passed trough a DDE link requires a specific format to ensure that both applications speak the same language. The number format (i.e. which characters are used as decimal and 1000 separator) used by Smart DDE depends on the ‘International settings’ of your Windows environment. Therefor make sure your application uses the same settings; i.e. your application also uses the International settings or the international settings are equal to the settings used by your application (refer to your Windows documentation on how to change the International settings).

4.4 Setting Up a Conversation Link

There are several methods to start Smart DDE and setup a conversation link between your application and a DMFC. First, you can start Smart DDE manually from the program manager and set up the connection to the DMFC from the Smart DDE user interface prior to start a conversation link from your application.
A second method is to start Smart DDE fully automatic from your application without the intervention of the Smart DDE user interface. This gives you the opportunity to program your application in such a way, the 'end-user' does not need to have the knowledge on any Smart DDE characteristic behavior. When the latter mentioned method is used, you need to be aware of the following:

- If you want to make a connection to a DMFC which is not opened previously, specify the communication settings in the topic name (see section 4.2.2).
- If you want to make a connection to a DMFC which is opened before, it is not necessary to specify the communication settings, because Smart DDE uses the settings which were previously stored to the WIN.INI file.

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5.1 Item Status

Using the format letters (C, D or E) in combination with a request command, enables you to get status information on item numbers (see also sections 4.3.1 up to 4.3.4). The item status returned by Smart DDE consists of two bytes. These two bytes contain error and status information from the DMFC, updated during the last item related request.

The first byte indicates if any error has occurred during reception or translation of the command by the DMFC. In case all bits in the first status byte are false (0), no error has occurred. Otherwise, when one or more bits are true (1), a communication or command error has occurred. The type of error can be determined by checking bit 7 of the first status byte. When this bit is false (0), the first item status byte indicates a command error. Otherwise, when bit 7 is true (1), the item status indicates a communication error, i.e. the command sent to the DMFC was not properly received.

The second byte provides information on the status of the DMFC at the moment the HART command, sent to the DMFC as a result of a server request, is executed by the DMFC.

Table 5.1 Item Status Bytes

First byte (Command/communication errors)										Second byte (device status information)								
	Bit#									Bit #								
Error type	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Description**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Description**
No command or communication error	0	0	0	0	0	0	0	0	The command is received and executed o.k. by the DMFC	0	0	0	0	0	0	0	0	No device status available
										x	x	x	x	x	x	x	1	Primary variable out of range
										x	x	x	x	x	x	1	x	Non-primary variable out of range
Command errors (bit# 6 .. 0 of first byte are non-bitmapped)	0	2							Invalid selection									
		3							Passed parameter too large	x	x	x	x	x	1	x	x	Primary variable analogue output saturated
		4							Passed parameter too small									
		5							Incorrect byte count	x	x	x	x	1	x	x	x	Primary variable analogue output fixed
		6							Transm. spec. command err.									
		7							In write-protect mode	x	x	x	1	x	x	x	x	More status available; use item [330], [331], [332] or [333] to request additional status info
		8 - 15*							Command specific error									
		16							Access restricted									
		32							Device is busy	x	x	1	x	x	x	x	x	Cold start
		64							Command not implemented	x	1	x	x	x	x	x	x	Configuration changed
		other values							Undefined	1	x	x	x	x	x	x	x	Device malfunction
Communication errors	1	x	x	x	x	x	x	1	Undefined	All zero								The second status byte does not contain status information in case a communication error is occurred.
		x	x	x	x	x	1	x	Rx buffer overflow									
		x	x	x	x	1	x	x	Reserved									
		x	x	x	1	x	x	x	Checksum error									
		x	x	1	x	x	x	x	Framing error									
		x	1	x	x	x	x	x	Overrun error									
		1	x	x	x	x	x	x	Parity error									

* For detailed description of command specific codes, refer to document 541-C-053-AAA.

Note: The 'X' stands for 'Don't Care' and applies to one or more communication errors or device status information bits which can be active simultaneously.

EXAMPLE A: A DMFC is configured to accept to the setpoint from the analogue input (i.e. 0..20mA). This configuration should be changed, making it possible to control the setpoint of the DMFC through digital communication. Therefor, a poke request is sent to Smart DDE in order to change the 'Setpoint source selection' parameter (item [319], refer to Appendix A: Item list) to code 3. To check if the setpoint source selection parameter has been changed correctly within the DMFC, the status of item [319] is requested using the following request: [E][319]

As a result of this request, Smart DDE returns the following two status bytes, separated by the tab-character: 7<tab>0

These status bytes should be translated as follows (refer to Table 5.1):

- First status byte: 7 decimal « 00000111 binair
  This implies a command error has occurred (bit 7 = 0)
- In this case (bit# 6..0: 0000111 binair « 7 decimal), the poke instruction failed because the DMFC is in the write protect mode.
- The second status byte is equal to zero: no device status information available

EXAMPLE B: The setpoint source of the DMFC described in *example A*, is configured for digital communication properly after the write protection has been turned off. A poke request is sent to Smart DDE in order to change the setpoint in percentage of full scale from 0% to 90% (item [337], refer to Appendix A: Item list). After this setpoint change, the flow in percentage of full scale (item [338], refer to Appendix A: Item list) is requested using the following command: [C][338]

As a result of this request, Smart DDE returns the actual measured flow in percentage of full scale together with two status bytes, each separated by the tab-character: 0<tab>0<tab>80

The first value implies that the DMFC does not measure flow actually, although the setpoint is set to 90%. Translating the status bytes explains what has happened:

- The first status byte is equal to zero: no command or communication errors occurred.
- Second status byte: 80 decimal « 01010000 binair; which means (refer to Table 5.1):

1. bit# 6 set — Configuration changed (the configuration of the device has been changed; the setpoint source is altered from analogue to digital)
2. bit# 4 set — More status available. One or more additional device status bytes (item [330], [331], [332] or [333]) contain additional status information.

Requesting the additional device status information notifies: valve-out-of-range. Probable cause of this behavior: no gas applied to the inlet of the DMFC.

5.2 Command Line Parameters

The following command line syntax can be used in order to start up Smart DDE:

SMARTDDE [<tag number>.DMF] [/M]

Description optional parameters:

[<tag number>.DMF]	In case Smart DDE is started using the <tag number> parameter, it will try to open the connection to the DMFC, indicated by the <tag number>, immediately.
[/M]	The command line parameter '/m' (minimized) makes it possible to start up Smart DDE automatically in background, avoiding the Smart DDE user interface popping up on top of your application window. This optional parameter is not necessary in all cases, because many applications support starting up another program in background by their own.

5.3 Starting Smart DDE Form Out of Another Windows Application

A windows application can be invoked in source code by calling one of the following APIs

1) ShellExecute or ShellExecuteEx

2) CreateProcess

3) WinExec

4) LoadModule

Any windows application which is using these APIs can invoke SmartDDE.

Command line parameters can be supplied through these API calls while invoking SmartDDE. However the 'CreateProcess' API wont be able to start the new application in minimized mode. Instead, it starts the new application in the normal mode.

5.4 Setting Up A Connection Using A DMF-File

Smart DDE supports the following features for quick set up of a connection to a DMFC, using the DMF-file which has been generated during a previous connection to the same DMFC:

1. Using the optional command line parameter;
   In case Smart DDE is not running, it is possible to use the [<tag number>.DMF] command line option (also refer to section 5.4, Command line parameters) in order to command Smart DDE to set up the connection the DMFC immediately after start up.

2. Using the Windows File Manager program;
   In case Smart DDE is already running, it is possible to use the File Manager in order to set up the connection to the DMFC. Just drag and drop the DMF-file from the File Manager into the Smart DDE main window.

5.5 Copying A Link Using The Clipboard

Smart DDE supports the possibility to copy link information to the clipboard, making it possible to create a DDE link between Smart DDE and other applications without typing anything. Here is a step by step description on how to create a DDE link to an opened DMFC using the 'Copy DDE-link' option.

1. Select the DMFC in the Smart DDE window
2. Select the **Device data** option from the Smart DDE menu bar
3. Select one of the options from the Device data pop up menu
4. Select one or more items from the opened window by clicking the checkbox
5. Close the window using the **OK** button

Possibly repeat step 2 through 5 one or several times to select more items.

6. Select the **Control** option from the menu bar
7. Select the **Copy DDE-link** option from the 'Control' pull down menu

At this point the DDE link information is stored in the clipboard and can be pasted into any program that supports pasting DDE links, e.g. Excel. See the manual of the application you are using to find out how to paste the DDE link information.

EXAMPLE: To display the actual measured flow in percentage of full scale, using Microsoft Excel for Windows, the following actions should be taken in order to setup the conversation link between Smart DDE and Excel:

1. Set up a connection to a DMFC using the Smart DDE user interface (refer to section 3, Smart DDE user interface, for a detailed description)
2. Select (highlight) the DMFC in the Smart DDE user interface main window.
3. Select the **Device data|Actual data** option from the menu bar and click with the left mouse button on the **Flow in %** check box (see Figure 5.1). Press the OK button to accept the selection made.

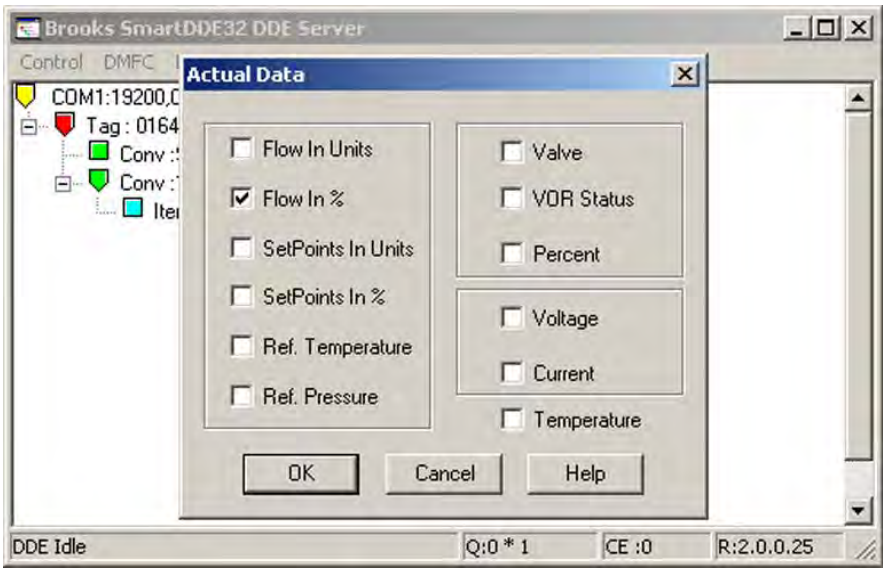


Figure 5.1 Select the Desired Item Using the Actual Data Window

4. Select the **Control|Copy DDE-link** option in order to copy the link information to the clipboard.
5. Start up Excel, open a new sheet and select a cell. Then select the **Edit|Paste Special...** option. The ‘Paste Special’ window pops up the screen, see Figure 5.2.
6. Select the **Paste Link** bullet and press the **OK** button in the ‘Paste Special’ window.

Excel copies the link information from the clipboard to the selected cell and starts the conversation with Smart DDE. An advise link is built up and Excel displays the actual measured flow in percentage of full-scale in the selected cell, see Figure 5.3. The frequency of updating of the flow data depends on the refresh rate setting in Smart DDE (refer to 3.6.1; Refresh rate).

Excel provides many features displaying the flow data, e.g. using a graphical chart. More Excel examples can be found in folder "SmartDDE\Examples" on the CD.

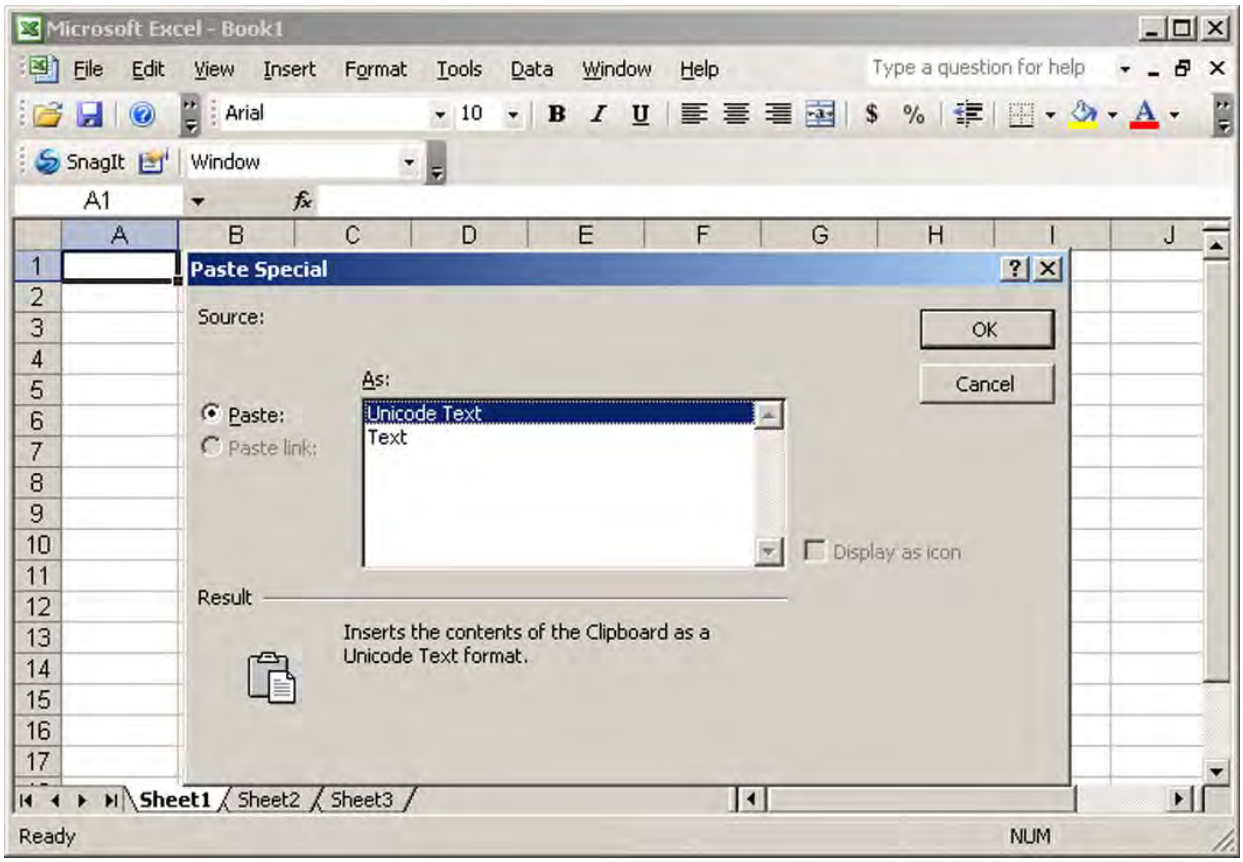


Figure 5.2 Microsoft Excel 5.0 Special Paste Window

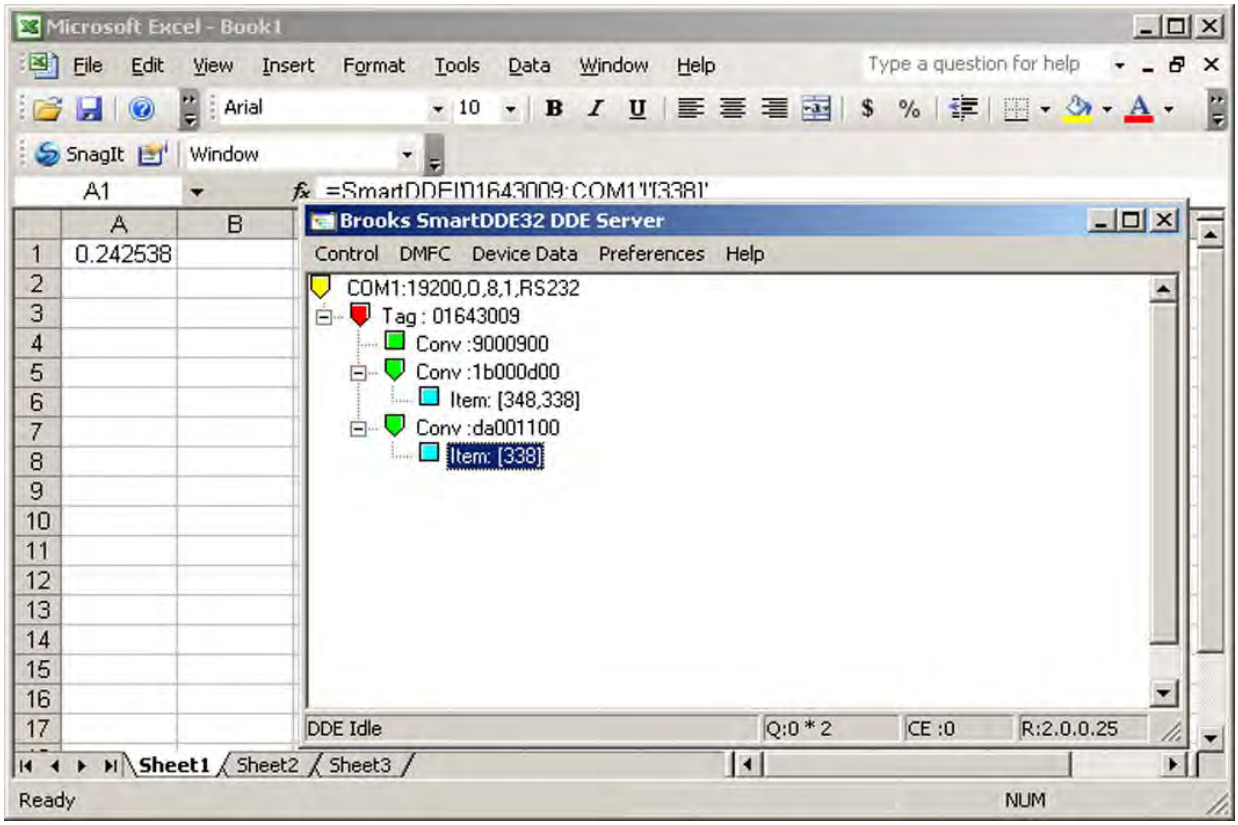


Figure 5.3 Microsoft Excel 5.0 Displaying the Actual Measured Flow from the DMFC

5.6 Changing Advise Link Items

Smart DDE supports the possibility to change the items sent through an open DDE advise link (It is not possible to create directly a new advise link). Here is a step by step description on how to change the item(s) sent through a DDE advise link.

1. Select an Advise link in the Smart DDE window
2. Select the **Device data** option from the Smart DDE menu bar
3. Select one of the options from the Device data pop up menu

A window appears, showing you a list of checkboxes (refer to section 3.5 for a description). Items actually passed through the selected advise link are indicated.

4. Deselect/Select one or more items from the opened window
5. Close the window using the **OK** button

At this point the DDE Advise link information is changed. From now on the new item values are passed through the advise link.

5.7 Related DMFC Parameters

A number of parameters in the DMFC are related to each other. In order to change these parameters (items) within the DMFC using the poke request, it is necessary to be aware of this relationship, because related parameters are sent to the DMFC within one and the same HART command. Refer to Table 8.29, Related DMFC parameters (Appendix A: Item list), for a summarized overview of the relation between item numbers.

To explain the impact of a relation between items, the following example is given.

EXAMPLE: A DMFC is configured as follows:

Orifice size = 0.048 inch (max. pressure drop = 6 bar)

Process/Cal. pressure reference	= Absolute	(gas #1)
Process pressure unit	= mbar	(gas #1)
Process inlet pressure	= 5000	(gas #1)
Process outlet pressure	= 1000	(gas #1)

In order to change the process/calibration pressure unit from *milli bar* to *bar*, the following poke request is sent to Smart DDE:

Item name	[51]
Data part	7

As a result of this, Smart DDE sends the HART command to the DMFC in order change the pressure unit to bar. This command also includes the inlet and outlet pressure, which are still expressed in milli bar (i.e. 5000 and 1000). When checking the command validity, the DMFC will interpret the pressure figures as being expressed in *bar*, and thus resulting in a (theoretical) pressure drop of 4000 bar. This value exceeds the maximum allowed pressure drop of 6 bar and therefor a command error is generated. As a result of this, the DMFC does not alter the pressure unit and reflects the 'Parameter to large' command error to Smart DDE.

In order to change the pressure unit without problems, the following poke instruction needs to be sent to Smart DDE:

Item name	[51,54,55]
Data part	[7,5,1]

In order to perform a poke within Windows Excel a macro needs to be written, below an example of an excel macro is shown which will change DDE items 319 and 337

```
Sub Using_DDEPoke()

    ' Dimension the variables.
    Dim Chan As Integer
    Dim RequestItems As Variant
    Dim RetVal As Integer
    Dim TagNr As String

  TagNr = Sheets("Sheet1").Range("A4")

    ' Start a channel to Word using the System topic.
    Chan = DDEInitiate("SmartDDE", TagNr)


  DDEExecute Chan, "[UNPROTECT(brooks)]"
  DDEPoke Chan, "[319]", Sheets("Sheet1").Range("B7")
  DDEExecute Chan, "[PROTECT(brooks)]"
  DDEPoke Chan, "[337]", Sheets("Sheet1").Range("B6")


    ' Terminate the DDE channel.
    DDETerminate Chan


End Sub
```

5.8 WIN.INI Settings

During setup and normal operation of Smart DDE, Smart DDE adds or changes some settings in the WIN.INI file in the windows directory. Here a list of Smart DDE related WIN.INI file settings.

[Extensions]

DMF=SmartDDE.exe ^.dmf (added by setup)

This line enables you to open Smart DDE automatically by clicking on a ".DMF" file in the File Manager. The DMFC related to this file will be opened directly at Smart DDE startup.

[SmartDDE]

window=<*x*> <*y*> <*w*> <*h*>

This line holds the coordinates (*x*, *y*, *w* and *h*) of the Smart DDE main window when it was closed the last time. When Smart DDE is opened, the main window will pop up using these dimensions.

dir=<*path*> (added by setup)

This line holds the path to the installation directory. This directory is also used to store the ".DMF" file. Do not alter this line.

Refreshrate=<*msec*>

Last refresh rate in msec. The refresh rate is used to update DDE advise links. If this line is not found, Smart DDE uses the default refresh rate, equal to 2500 msec.

TimeOut=<*msec*>

Time out in msec. If a DMFC does not respond to a command within this time frame, Smart DDE re-sends the command to the DMFC (with a maximum of 3 re-sends). In the default situation, this line is not present in the WIN.INI file and Smart DDE uses a time out of 500 msec. The only way to change the time out setting is to add this line manually to the WIN.INI file.

NrOfDMFC=<*number*>

Total number of DMFC's stored in the WIN.INI file.

Dmfc<*X*>=<*tag number*>,COM<*n*>

These lines indicate previously opened DMFC's. The following parameters are used within this line:

- *X* sequential number
- *tag number* identification of the DMFC
- *n* communication port number on which the DMFC was opened

COM<*n*>=<*baudrate*> <*communication line*> <*switch line*>

This line holds information on the communication port settings. The following parameters are used within this line:

- *n* communication port number
- *baudrate*
  - 1 = 1200
  - 2 = 2400
  - 3 = 4800
  - 4 = 9600
  - 5 = 19200
  - 6 = 38400
- *communication line*
  - 0 = RS-232
  - 1 = RS-485
- *switch line*
  - 0 = None
  - 1 = RTS
  - 2 = DTR
  - 3 = !RTS
  - 4 = !DTR

EXAMPLE: Smart DDE is used for communication with a DMFC with tag number 00000000, connected to COM2, and communicating through RS-232 with a baudrate of 19200. The WIN.INI file contains the following Smart DDE related setting:

```
[Extensions]
..
dmf=SmartDDE.exe ^.dmf
..

[SmartDDE]
TimeOut=700
window=555 494 427 200
dir=C:\SMARTDDE
Refreshrate=1000
NrOfDMFC=1
Dmfc1=00000000,COM2
COM2=5 0 0
```

6.1 Introduction

This section provides a summarized overview of problems which can occur when using Smart DDE. The problems are divided into three classifications: general, DDE link related and DMFC related problems. Troubleshooting is provided on these problems; the possible cause of the problem is discussed and suggestions for corrective actions are given.

6.2 General Problems

The summarized information on troubleshooting general problems is shown in Table 6.1.

Table 6.1 General Troubleshooting

General Troubleshooting		
Problem	**Possible cause**	**Corrective action**
Smart DDE can not be started automatically from another application	The Smart DDE program is not visible for other applications.	Add the actual Smart DDE path settings to the PATH statement in the AUTOEXEC.BAT file.
Windows reports a DDE error with the following message: *An application using DDE did not respond to the system's exit command*.	An application is closed while DDE links are still active. Most applications remove their DDE-links before closing, but some do not, resulting in a Windows error.	Prevent closing the application while DDE links are established.
Number of queued items is increasing continuously	Other Windows applications take to much processor time, causing Smart DDE to be unable to handle a request before the following request is received	Close other processor time consuming applications or decrease the number of requests to Smart DDE (decrease refresh rate in Smart DDE or decrease frequency of issuing requests in your application)
PC does not respond anymore	Due to communication errors, the number of queued requests exceeds the limit.	Restart computer. In order to prevent occurring this problem, stop issuing requests from the client application and stop active advise links when the number of queued requests exceeds a certain limit (e.g. > 500). Checking the number of queued requests can be implemented in the client application using the system topic status request.
It is not possible to open a specific COM-port	1. The COM-port is already open 2. The COM-port is in use with another program	1. It is not useful to open the COM-port again 2. Close the COM-port in the other program before opening the COM-port in Smart DDE or select another COM-port

The summarized information on troubleshooting DDE link related problems is shown in Table 6.2

Table 6.2 DDE Link Troubleshooting

DDE Link Troubleshooting		
Problem	**Possible cause**	**Corrective action**
No data provided via DDE link	1. Smart DDE not running	1. Start Smart DDE using the user interface or from out the application
	2. No open DMFC	2. Open a DMFC on a COM-port using the user interface or from out the application. In case the latter mentioned option is used in order to open the DMFC, be aware that the communication setting needs to be specified in case the DMFC was never opened before (i.e. no DMFC related setting are available in the WIN.INI file)
	3. No communication between Smart DDE and DMFC 1. The data in the Smart DDE internal buffers does not correspondent with the settings in the DMFC 2. Hardware related communication problems	3. 1. Use the Read from DMFC option from the user interface, or use the Download execute command via the DDE link 2. Refer to Table 7.3: DMFC troubleshooting
	4. No communication via DDE link between Smart DDE and client application	4. Check Windows International settings. Check your application for DDE link related settings. Use one of the demonstration programs in order to check if data exchange between Smart DDE and a client application is possible
Information from DDE link disrupted	Difference of data formatting between Smart DDE and client application.	Smart DDE uses the number format settings specified in the Windows 'International Settings'. Check your application on the used number format and make sure both the client application and Smart DDE use the same settings
A request sent to Smart DDE is not processed immediately	Smart DDE does not have enough time to handle the server request. As a result of this, the number of queued requests is increasing.	Decrease the frequency of issuing requests to Smart DDE. In case of active advise links, decrease the refresh rate.

The summarized information on troubleshooting DMFC related problems is shown in Table 6.3.

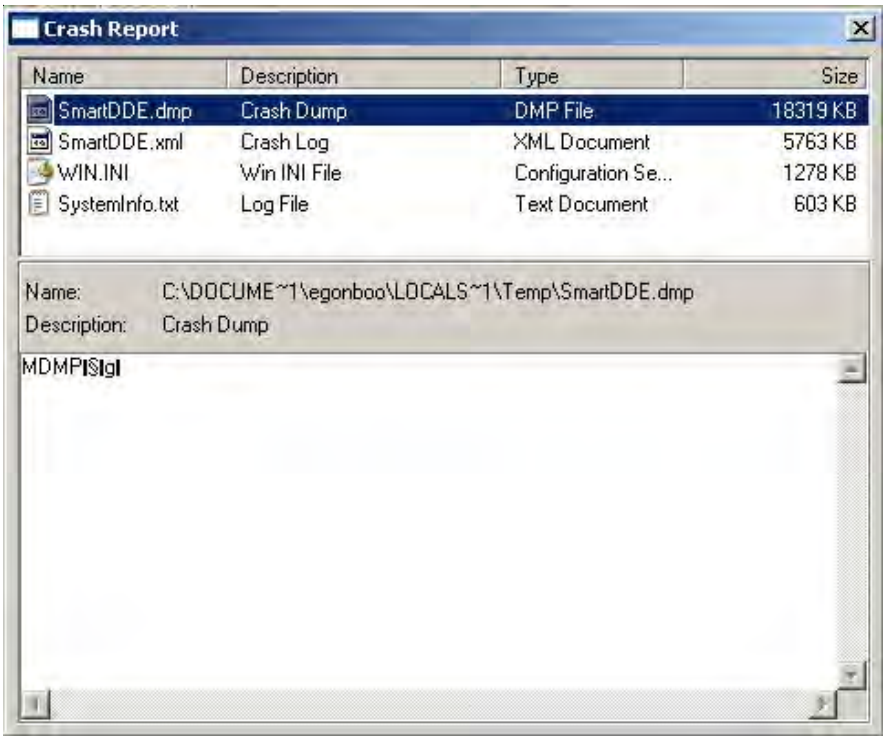
Table 6.3 DMFC Troubleshooting

DMFC Troubleshooting		
Problem	**Possible cause**	**Corrective action**
No communication with DMFC	1. No power supply to DMFC 2. Communication cable between DMFC and PC not connected 3. No communication piggyback installed 4. Difference between hardware and software (i.e. Smart DDE) communication settings	1. Check power supply cable 2. Check communication cable between DMFC and PC. Check the used COM port 3. Check if communication piggyback is installed 4. Check if communication settings in Smart DDE correspond to dipswitch settings on the communication piggyback
Smart DDE displays 'Communication Time-out' in the status bar and the communication error counter does not increase	The DMFC does not respond within the specified time out period. The time out period defined is to short (possible reason for this is a low baudrate setting).	Increase the time out period using the *TimeOut* parameter in the WIN.INI file.
Can not alter a specific parameter (item) within the DMFC.	1. DMFC is in the write protect mode 2. Item is related to one or more other items. 3. New value is not valid	1. Turn off the DMFC write protection 2. Specify all related item in the poke request. Refer to section 5.9, Changing related DMFC parameters. 3. Check item list (refer to Appendix A: Item list) for valid values

6.3 Application Crash

When the SmartDDE application crashes the following window will be shown. This window enables the user to save the Crash Report file and provide Brooks with detailed information about the circumstances of the crash. The user needs to contact Brooks and email the zipped Crash Report File

If the ‘click here’ button is clicked, the following window will be shown which lists the files that are present in the zip file, which will be saved upon clicking the ‘Save’ Button in the first window.



The database within a Digital Mass Flow Controller/Meter consists of more than 350 parameters. To provide access to these parameters using Smart DDE, each parameter can be referenced using an item number. This section lists all parameters (items) in a number of tables. Each table provides the following information: the description (name) of an item, the number used to access the item through DDE, the accessibility (Read, Write and/or Protected) of an item, the availability of an item (for Controllers and Meters (M/C) or for Controllers (C) only), the item type, a description of the valid item values and a reference to the unit (if applicable) related to the item.

NOTE: The help file, which is accessible using the Smart DDE user interface, also includes a number of tables, listing all item numbers.

NOTE: The accessibility of an item can be read-only (R), write-only (W) or random (R/W; readable as well as writable). Most writable items are protected. To change (poke) such items, first turn off the write protection.

Table A.1 Item List System Parameters

Item list system parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Manufacturer's id #	1	R	M/C	Byte	10 for Brooks Instrument	-
Manufact. device type #.	2	R/W/P	M/C	Byte	*Table A.11: Device type codes*	-
Device unique id #.	3	R/W/P	M/C	Long word	0 - 16777215	-
Universal command rev.	4	R	M/C	Byte	0 - 255	-
Transm. spec. command rev	5	R	M/C	Byte	0 - 255	-
Software revision #.	6	R	M/C	Byte	0 - 255	-
Hardware revision #.	7	R/W/P	M/C	Byte	xxxxx.yyy (binary) xxxxx (0-32) = Hardw.rev. yyy (0-7) = phys.sign.code	-
Brooks order #.	8	R/W/P	M/C	Char., 12	12 character string	-
Final assembly #.	9	R/W/P	M/C	Long word	0 - 16777215	-
Tag #	12	R/W/P	M/C	Char., 8	8 character string	-
Descriptor (associated with tag number)	13	R/W/P	M/C	Char., 16	16 character string	-
Date - Year (associated with tag number)	14	R/W/P	M/C	Byte	00 - 99	-
Date - Month (associated with tag number)	15	R/W/P	M/C	Byte	00 - 12	-
Date - Day (associated with tag number)	16	R/W/P	M/C	Byte	00 - 28, 29, 30 or 31	-
Message (associated with tag number)	17	R/W/P	M/C	Char., 32	32 character string	-

Table A.2 Item List Configuration Parameters

Item list configuration parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Temperature unit for maximum temperature range	18	R/W/P	M/C	Byte	*Table A.15: Temperature unit codes*	-
Absolute min. temperature	19	R/W/P	M/C	Float	Minimum 273.15 K	Temp. unit (Item 18)
Absolute max. temperature	20	R/W/P	M/C	Float	Maximum 343.15 K or 373.15 K (with remote electr.)	Temp. unit (Item 18)
Pressure unit for maximum absolute pressure	21	R/W/P	M/C	Byte	*Table A.16: Pressure unit codes*	-
Absolute maximum pressure	22	R/W/P	M/C	Float	100 bar (a)	Press. unit (Item 21)
Valve type installed	23	R/W/P	C	Byte	*Table A.23: Valve type codes*	-
Orifice size	24	R/W/P	C	Byte	*Table A.28: Orifice size codes*	-
Valve seat material	25	R/W/P	C	Byte	*Table A.12: Materials codes*	-
O-ring material	26	R/W/P	M/C	Byte	*Table A.12: Materials codes*	-
Absolute maximum pressure drop	27	R	M/C	Float	*Table A.28: Orifice size codes*	Press. unit (Item 21)

Table A.3 Item List Calibration Parameters

Item list calibration parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Calibrator's name	32	R/W/P	M/C	Char., 12	12 character string	-
Last calibration date - Year	33	R/W/P	M/C	Byte	00 - 99	-
Last calibration date - Month	34	R/W/P	M/C	Byte	00 - 12	-
Last calibration date - Day	35	R/W/P	M/C	Byte	00 - 28, 29, 30 or 31	-

Table A.4 Item List Gas Parameters

Item list gas parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Process gas name	Refer to Table 8.5	R/W/P	M/C	Char., 12	12 character string	-
Density unit		R/W/P	M/C	Byte	*Table A.13: Density unit codes*	-
Density value		R/W/P	M/C	Float	0 .. 20	Density unit
Flow unit		R/W/P	M/C	Byte	*Table A.14: Flow unit codes*	-
Reference temp. unit		R/W/P	M/C	Byte	*Table A.15: Temperature unit codes*	-
Reference temperature		R/W/P	M/C	Float	Temperature value typically 0 .. 20ºC	Ref. temp. unit
Reference press. unit		R/W/P	M/C	Byte	*Table A.16: Pressure unit codes*	-
Reference pressure		R/W/P	M/C	Float	Pressure value typically 1013.33 mbar or 1 atm	Ref. press. unit
Flow range		R/W/P	M/C	Float	5850S/5860S: 0.003 .. 30 ltr/min 5851S/5861S: 20 .. 100 ltr/min 5853S/5863S: 100 .. 1000 ltr/min 5864S: 18 .. 2160 m³/hr	Flow unit
Re-range factor for flow range		R/W/P	M/C	Float	0.8 .. 1.2	-
Linearization coefficient - 1		R/W/P	M/C	Float	typically -0.00xxx .. 0.00xxx	-
Linearization coefficient - 2		R/W/P	M/C	Float	typically 0.8 .. 5.0	-
Linearization coefficient - 3		R/W/P	M/C	Float	typically -0.5 .. 0.5	-
Linearization coefficient - 4		R/W/P	M/C	Float	typically -0.5 .. 0.5	-
Process/Cal. temperature unit		R/W/P	M/C	Byte	*Table A.15: Temperature unit codes*	-
Process/Cal. pressure unit		R/W/P	M/C	Byte	*Table A.16: Pressure unit codes*	-
Process/Cal. pressure reference		R/W/P	M/C	Byte	*Table A.20: Pressure reference codes*	-
Process temperature		R/W/P	M/C	Float	max.: 343.15 K or 373.15 K (with remote electronics) min.: 273.15 K	Process temp. unit
Process inlet pressure		R/W/P	M/C	Float	Maximum depends on model: 100 bar (a) for controllers 300 bar (a) for meters Mininum 0.8 bar (a)	Process press. unit
Process outlet pressure		R/W/P	M/C	Float	Maximun depends on max. pressure drop for controllers. 0 bar (a) for meter models	Process press. unit
Calibration gas name		R/W/P	M/C	Char., 12	12 character string	-
Calibration tool #		R/W/P	M/C	Char., 12	12 character string	-
Calibration temperature		R/W/P	M/C	Float	max.: 343.15 K or 373.15 K (with remote electronics) min.: 273.15 K	Process temp. unit
Calibration inlet pressure		R/W/P	M/C	Float	Maximum depends on model: 100 bar (a) for controllers 300 bar (a) for meters Mininum 0.8 bar (a)	Process press. unit
Calibration outlet pressure		R/W/P	M/C	Float	Maximun depends on max. pressure drop for controllers. 0 bar (a) for meter models	Process press. unit
Calibration gas factor		R/W/P	M/C	Float	Ratio between molar heat capacity of calibration gas and molar heat capacity of process gas	-

Table A.5 Item Numbers Gas Parameters

Item numbers gas parameters										
	Gas #									
Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Process gas name	36	62	88	114	140	166	192	218	244	270
Density unit	37	63	89	115	141	167	193	219	245	271
Density value	38	64	90	116	142	168	194	220	246	272
Flow unit	39	65	91	117	143	169	195	221	247	273
Reference temp. unit	40	66	92	118	144	170	196	222	248	274
Reference temperature	41	67	93	119	145	171	197	223	249	275
Reference press. unit	42	68	94	120	146	172	198	224	250	276
Reference pressure	43	69	95	121	147	173	199	225	251	277
Flow range	44	70	96	122	148	174	200	226	252	278
Re-range factor for flow range	45	71	97	123	149	175	201	227	253	279
Linearization coefficient - 1	46	72	98	124	150	176	202	228	254	280
Linearization coefficient - 2	47	73	99	125	151	177	203	229	255	281
Linearization coefficient - 3	48	74	100	126	152	178	204	230	256	282
Linearization coefficient - 4	49	75	101	127	153	179	205	231	257	283
Process temperature unit	50	76	102	128	154	180	206	232	258	284
Process pressure unit	51	77	103	129	155	181	207	233	259	285
Process pressure reference	52	78	104	130	156	182	208	234	260	286
Process temperature	53	79	105	131	157	183	209	235	261	287
Process inlet pressure	54	80	106	132	158	184	210	236	262	288
Process outlet pressure	55	81	107	133	159	185	211	237	263	289
Calibration gas name	56	82	108	134	160	186	212	238	264	290
Calibration tool #	57	83	109	135	161	187	213	239	265	291
Calibration temperature	58	84	110	136	162	188	214	240	266	292
Calibration inlet pressure	59	85	111	137	163	189	215	241	267	293
Calibration outlet pressure	60	86	112	138	164	190	216	242	268	294
Calibration gas factor	61	87	113	139	165	191	217	243	269	295

Table A.6 Item List Sensor Parameters

Item list sensor parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Temp. sensor offset correction (used to calculate temperature from temperature sensor signal)	296	R/W/P	M/C	Float	250.0 .. 270.0	-
Temp. sensor span correction (used to calculate temperature from temperature sensor signal)	297	R/W/P	M/C	Float	typically 96.0	-
Flow sensor bridge residual offset (determined through a zero command)	298	R/W/P	M/C	Float	0 (before zero command) 1 .. 5 % (after zero command)	-
Flow sensor bridge calibration temperature (temp. at execution of the zero command)	299	R	M/C	Float	max.: 343.15 K or 373.15 K (with remote electronics) min.: 273.15 K	[K]
Flow sensor bridge zero correction factor for temperature	300	R/W/P	M/C	Float	0.0 .. 0.05	-
Flow sensor bridge span correction factor for temperature	301	R/W/P	M/C	Float	0.0 .. 0.04	-

Table A.7 Item List Operation Parameters

Item list operation parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Standard temperature unit	302	R/W/P	M/C	Byte	*Table A.15: Temperature unit codes*	-
Standard temperature	303	R/W/P	M/C	Float	min.: 273.15 K	Standard temp. unit (item 302)
Standard pressure unit	304	R/W/P	M/C	Byte	*Table 8.20: Pressure reference codes*	-
Standard pressure	305	R/W/P	M/C	Float	min.: 0 bar	Standard pressure unit (item 304)
Selected gas #	306	R/W/P	M/C	Byte	0 .. 10 (1 out 10 gasses)	-
Selected flow unit	307	R/W/P	M/C	Byte	*Table A.14: Flow unit codes*	-
Selected flow reference	308	R/W/P	M/C	Byte	*Table A.17: Flow reference codes*	-
Selected temperature unit	309	R/W/P	M/C	Byte	*Table A.15: Temperature unit codes*	-
Additional output damping	310	R/W/P	M/C	Float	0.0 .. 10.0	[sec]
Analogue output selection	311	R/W/P	M/C	Byte	*Table A.22: Analogue range codes*	-
Analogue output span	312	R/W/P	M/C	Float	0.8 .. 1.2	-
Analogue output offset	313	R/W/P	M/C	Float	-10.0 .. 10.0	[% of full scale]
K-sensor	317	R/W/P	M/C	Float	4.0 .. 6.0	[sec]
N-sensor	318	R/W/P	M/C	Float	0.7 .. 4.0	[sec]
Setpoint source selection	319	R/W/P	C	Byte	*Table A.18: Setpoint source codes*	-
Analogue setpoint span correction	320	R/W/P	C	Float	0.8 .. 1.2	-
Analogue setpoint offset correction	321	R/W/P	C	Float	-10.0 .. 10.0	[% of full scale]
Softstart enable	322	R/W/P	C	Byte	*Table A.19: Softstart selection codes*	-
Softstart time ramp	323	R/W/P	C	Float	0.5 .. 200 (only valid when lineair softstart selected)	[%/sec]

Table A.8 Item List Controller Parameters

Item list controller parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Proportional control (P)	324	R/W/P	C	Float	Typically: 0.3 .. 1.0	-
Proportional control (I)	325	R/W/P	C	Float	Typically: 3.0 .. 7.0	-
Proportional control (D)	326	R/W/P	C	Float	0.0 in most cases	-
Valve range	327	R/W/P	C	Long word	Typically: 1000 .. 6000 Minimum: 0 Maximum: 62500	-
Valve offset	328	R/W/P	C	Long word	Typically: 10000 ..25000 Minimum: 0 Maximum: 62500	-

Table A.9 Item Actual Parameters

Item list actual parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Additional device status - 0	330	R	M/C	Byte	Refer to	-
Additional device status - 1	331	R	M/C	Byte		-
Additional device status - 2	332	R	M/C	Byte	*Table A.27*	-
Additional device status - 3	333	R	M/C	Byte	*Additional device status and masking*	-
Valve override	335	R/W	C	Byte	*Table A.21: Valve override codes*	-
Setpoint in selected units	336	R/W	C	Float	Depends on the selected flow rate at calibration	Setpoint unit (item 352)
Setpoint in % of full scale	337	R/W	C	Float	0 .. 100	Flow unit: Percentage [%]
Actual flow in % of full scale	338	R	M/C	Float	0 .. 100	Flow unit: Percentage [%]
Actual flow in selected units	339	R	M/C	Float	Depends on the selected flow rate at calibration	Selected flow unit (item 307)
Actual temperature	340	R	M/C	Float	max.: 343.15 K or 373.15 K (with remote electronics) min.: 273.15 K	Selected temp. unit (item 309)
Valve control value	341	R	C	Long word	0 .. 62500	-
Analogue output: in percentage of full scale	342	R	M/C	Float	0 .. 105 (0..5 V or 0..20 mA) 20 .. 105 (1..5 V or 4..20 mA)	[%]
Analogue output: in volts	343	R/W*/P	M/C	Float	0 .. 5.25 (0..5 V) 1 .. 5.25 (1..5 V)	[V]
Analogue output: in current	344	R/W*/P	M/C	Float	0 .. 21 (0..20 mA) 4 .. 21 (4..20 mA)	[mA]

* Analogue output fixed mode: Item [343] and [344] can be used to force the analogue output into a fixed mode. Therefor, use the poke request in order to set the output to a certain voltage (item [343]) or current (item [344]) value. To disable the fixed output mode, use the poke request to write a voltage or current value greater than 5 V, respectively 20 mA, to the DMFC.

Table A.10 Item List Additional DMFC Revision E Parameters

Item list additional DMFC Revision E parameters						
Description	**Item#**	**Access**	**Available**	**Type**	**Valid values**	**Unit**
Flow totalizer mode	347	R/W/P	M/C	Byte	*Table A.25: Totalizer function codes*	-
Flow totalizer counter	348	R	M/C	Float	0 ..26214300 [%min] (i.e. totalizer overrun will occur after approx. 182 days at continuous full scale flow	Selected totalizer unit (item 349)
Selected totalizer unit	349	R	M/C	Byte	*Table A.26: Totalizer unit codes* Depends on the selected flow unit (item 307)	-
Adaptive control mode	350	R/W/P	C	Byte	*Table A.24: Adaptive control codes*	-
Additional status enable/disable-0	351	R/W/P	M/C	Byte	*Refer to*	-
Additional status enable/disable-1	352	R/W/P	M/C	Byte		-
Additional status enable/disable-2	353	R/W/P	M/C	Byte	*Table A.27,*	-
Additional status enable/disable-3	354	R/W/P	M/C	Byte	*Additional device status and masking*	-
Low flow alarm limit	355	R/W/P	M/C	Float	0 .. 100	[%]
High flow alarm limit	356	R/W/P	M/C	Float	0 .. 100	[%]

IMPORTANT NOTE: The items described in the above table (Table 8.10) are implemented in the DMFC 831-A-001 Rev. E firmware and are not present in previous firmware revisions.

Table A.11 Device Type Codes

Device type codes	
Code	**Description**
1	Tri-20
2	3809
3	Quantim
4	Quantim
40	5850SM Mass Flow Controller
41	5851SM Mass Flow Controller
45	5964S Mass Flow Controller
46	5965S Mass Flow Controller
50	5850S Mass Flow Controller/SLA Series
51	5851S Mass Flow Controller
53	5853S Mass Flow Controller
60	5860S Mass Flow Meter
61	5861S Mass Flow Meter
63	5863S Mass Flow Meter
64	5864S Mass Flow Meter
70	4800 Series
90	GF40/GF80
154	0152/4 Read Out
254	0254 Read Out

Table A.12 Material Codes

Materials codes	
Code	**Material**
2	316 Stainless steel
10	PTFE (Teflon®)
11	Viton
12	Buna-N
22	Kalrez®
253	“Special”

Table A.13 Density Unit Codes

Density unit codes	
Code	**Density unit**
91	Grams/cubic centimeter
92	Kilograms/cubic meters
94	Pounds/cubic feet
96	Kilograms/liter
97	Grams/liter

Table A.14 Flow Unit Codes

Flow unit codes	
Code	**Flow unit**
17	Liters/minute
19	Cubic meters/hour
24	Liters/second
28	Cubic meters/second
57	Percentage of flow range
70	Grams/second
71	Grams/minute
72	Grams/hour
73	Kilograms/second
74	Kilograms/minute
75	Kilograms/hour
80	Pounds/second
81	Pounds/minute
82	Pounds/hour
131	Cubic meters/minute
138	Liters/hour
170	Milliliters/second
171	Milliliters/minute
172	Milliliters/hour

Table A.15 Temperature Unit Codes

Temperature unit codes	
Code	**Temperature unit**
32	Degrees Celsius
33	Degrees Fahrenheit
35	Kelvin

Table A.16 Pressure Unit Codes

Pressure unit codes	
Code	**Pressure unit**
6	Pounds/square inch
7	Bar
8	Millibar
10	Kilograms/square centimeters
11	Pascals
12	Kilopascals
13	Torr
14	Atmosphere

Table A.17 Flow Reference Codes

Flow reference codes	
Code	**Flow reference**
0	Normal (273.15 Kelvin/1013.33mBar)
1	Standard (User defined through separate command)
2	Calibration (As defined at calibration)

Table A.18 Setpoint Source Codes

Setpoint source codes	
Code	**Setpoint source**
1	0 .. 5 volt or 0 .. 20 mA input
2	1 .. 5 volt or 4 .. 20 mA input
3	Communication input

Table A.19 Softstart Selection Codes

Softstart selection codes	
Code	**Softstart**
0	Softstart disabled
1	Non-linear softstart
2	Linear up only softstart
3	Linear down only softstart
4	Linear up and down softstart

Table A.20 Pressure Reference Codes

Pressure reference codes	
Code	**Pressure reference**
0	Absolute pressure
1	Effective pressure (Gauge pressure)

Table A.21 Valve Override Codes

Valve override codes	
Code	**Valve override**
0	Valve override off (normal operation)
1	Valve override open
2	Valve override close
5	Valve override fixed

Table A.22 Analog Range Codes

Analogue range codes	
Code	**Analogue range**
0	Analogue output off
1	Analogue output 0 - 5 volt (0 - 20 mA)
2	Analogue output 1 - 5 volt (4 - 20 mA)

Table A.23 Valve Type Codes

Valve type codes	
Code	**Valve type**
0	Meter only (valve not used)
1	Normally closed valve
2	Normally open valve

Table A.24 Adaptive Control Codes

Adaptive control codes	
Code	**Adaptive control mode**
0	Adaptive control off
1	Track offset only
2	Track offset and span
3	Find offset only
4	Find offset and span

Table A.25 Totalizer Function Codes

Totalizer function codes	
Code	**Totalizer function**
0	Stop totalizer
1	Start totalizer
2	Reset totalizer counter

Table A.26 Totalizer Unit Codes

Totalizer unit codes	
Code	**Flow unit**
41	Liters
43	Cubic meters
60	Grams
61	Kilograms
63	Pounds
175	Milliliters

Table A.27.1 Additional Device Status and Masking for 58xxS and MfxxS Models

Additional device status and masking				
Byte #	**Bit #**	**Status bit description 0=no error 1=specified error occurred**	**Device status masking**	
			Mask bit 0=disabled 1=enabled (* default)	**Remarks**
0	0	EPROM corrupt	1	One always
	1	RAM corrupt	1	One always
	2	Database corrupt	1	One always
	3	EEPROM corrupt	1	One always
	4	Sensor zero failed	1	One always
	5	Undefined	0	Zero always
	6	Undefined	0	Zero always
	7	Undefined	0	Zero always
1	0	Flow sensor error	0/1*	
	1	Temp. sensor error	0/1*	
	2	Analogue output error	0/1*	
	3	Setpoint over range (undefined in case of meter model)	0/1*	
	4	Flow sensor out of range	0/1*	
	5	Analogue output out of range	0/1*	
	6	Valve out of range (undefined in case of meter model)	0/1*	
	7	Undefined	0	Zero always
2	0	Low flow alarm (DMFC Rev.E only)	0/1*	
	1	High flow alarm (DMFC Rev.E only)	0/1*	
	2	Totalizer overflow (DMFC Rev.E only)	0/1*	
	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
3	0	Ambient temp. too high	0/1*	
	1	Power too low	0/1*	
	2	No-flow indication	0/1*	
	3	Bad software performance	0/1*	
	4	Ambient temperature too low	0/1*	
	5	Undefined	0	Zero always
	6	Undefined	0	Zero always
	7	Undefined	0	Zero always

Table A.27.2 Additional Device Status and Masking for SLA58xxS and SLAMfxxS Models

Additional device status and masking				
Byte #	**Bit #**	**Status bit description 0=no error 1=specified error occurred**	**Device status masking**	
			Mask bit 0=disabled 1=enabled (* default)	**Remarks**
0	0	Flash Memory corrupt	1	One always
	1	RAM test failure	1	One always
	2	Undefined	0	Zero always
	3	EEPROM test failure	1	One always
	4	Undefined	0	Zero always
	5	Internal power supply failure Undefined	1	One always
	6	Undefined	0	Zero always
	7	Flash Memory corrupt	0	Zero always
1	0	Undefined	0	Zero always
	1	Temp. sensor error	1*	One always
	2	Flow Output Current Loop Open	0*/1	
	3	Setpoint out of range	0/1*	
	4	Flow sensor out of range	0/1*	
	5	Flow output out of range	0/1*	
	6	Setpoint Deviation (Controller Error)	0/1*	
	7	Undefined	0	Zero always
2	0	Low flow alarm (Flow Alarm 1)	0*/1	
	1	High flow alarm (Flow Alarm 2)	0*/1	
	2	Totalizer overflow	0*/1	
	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
3	0	Undefined	0	Zero always
	1	User Power Supply out of limits	0/1*	
	2	No-flow indication	0/1*	
	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

Table A.27.3 Additional Device Status and Masking for 48xxS Models

Additional device status and masking				
Byte #	**Bit #**	**Status bit description 0=no error 1=specified error occurred**	**Device status masking**	
			Mask bit 0=disabled 1=enabled (* default)	**Remarks**
0	0	Undefined	0	Zero always
	1	Undefined	0	Zero always
	2	MFC communication failure Undefined	1	One always
	3	Sensor zero failed	0	Zero always
	4	Internal power supply failure Undefined	1	One always
	5	Undefined	1	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	Undefined	0	Zero always
	7	Undefined	0	Zero always
2	0	Low flow alarm (Flow Alarm 1)	0*/1	
	1	High flow alarm (Flow Alarm 2)	0*/1	
	2	Undefined	0	Zero always
	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
3	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	Undefined	0	Zero always
	7	Undefined	0	Zero always

Table A.28 Orifice Size Codes

Orfice size codes (with related maximum pressure drop values)						
Code	5850S		5851S		5853S	
	Orifice size	Max.press. drop [bar]	Orifice size	Max.press. drop [bar]	Orifice size	Max.press drop [bar]
0	0.0013 inch	100	0.0040 inch	100	0.0200 inch	20
1	0.0020 inch	100	0.0067 inch	100	0.0280 inch	20
2	0.0030 inch	100	0.0091 inch	45	0.0320 inch	20
3	0.0040 inch	100	0.0120 inch	35	0.0480 inch	20
4	0.0050 inch	100	0.0160 inch	26		
5	0.0070 inch	100	0.0210 inch	22		
6	0.0100 inch	45	0.0260 inch	18		
7	0.0140 inch	38	0.0310 inch	13		
8	0.0200 inch	22	0.0360 inch	11		
9	0.0280 inch	16	0.0410 inch	10		
10	0.0320 inch	12	0.0465 inch	6		
11	0.0480 inch	6	0.0550 inch	5		
12	0.0520 inch	5	0.0635 inch	4		
13	0.0620 inch	4	0.0700 inch	4		
14	0.0670 inch	4	0.0760 inch	3		
15	0.0780 inch	3	0.0820 inch	3		
16	0.0930 inch	2	0.0935 inch	2		
17	0.1160 inch	1.5	0.1065 inch	1.5		
18	0.1200 inch	1.5	0.1200 inch	1.5		
19			0.1405 inch	1.5		

Table A.29 Supported DDE Items per Device Type

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
1	0	ITEMID_NONE	√	X	X	X	X
2	1	ITEMID_MFR_ID	√	√	√	√	√
3	2	ITEMID_MFR_DEVICE_TYPE	√	√	√	√	√
4	3	ITEMID_DEVICE_ID_NUM	√	X	√	√	√
5	4	ITEMID_UNIV_CMD_REV	√	X	√	√	√
6	5	ITEMID_TRANS_SPEC_REV	√	X	√	√	√
7	6	ITEMID_SOFT_REV	√	X	√	√	√
8	7	ITEMID_HARD_REV	√	X	√	√	√
9	8	ITEMID_BROOKS_ORDER_NUM	√	X	X	√	√
10	9	ITEMID_FINAL_ASSEMBLY	√	X	X	√	√
11	10	ITEMID_USER_PW	√	X	X	√	√
12	11	ITEMID_WRITE_PROTECT	√	X	X	√	√
13	12	ITEMID_TAG_NUM	√	√	√	√	√
14	13	ITEMID_DESCRIPTOR	√	X	√	√	√
15	14	ITEMID_DATE_Y	√	X	√	√	√
16	15	ITEMID_DATE_M	√	X	√	√	√
17	16	ITEMID_DATE_D	√	X	√	√	√
18	17	ITEMID_MESSAGE	√	X	X	√	√
19	18	ITEMID_MAX_TEMP_UNITS	√	X	X	X	X
20	19	ITEMID_MAX_TEMP_RANGE_MIN	√	X	X	X	X
21	20	ITEMID_MAX_TEMP_RANGE_MAX	√	X	X	X	X
22	21	ITEMID_MAX_PRESS_UNITS	√	X	X	X	X
23	22	ITEMID_MAX_PRESS	√	X	X	X	X
24	23	ITEMID_VALVE_TYPE	√	X	X	X	X
25	24	ITEMID_ORIFICE_SIZE	√	X	X	X	X
26	25	ITEMID_VALVE_SEAT_MAT	√	X	X	X	X
27	26	ITEMID_O_RING_MATERIAL	√	X	X	X	X
28	27	ITEMID_MAX_PRESS_DROP	√	X	X	X	X
29	28	ITEMID_FLOW_CONTROL	√	X	X	X	X
30	29	ITEMID_DATA_RATE	√	X	X	X	X
31	30	ITEMID_POLLING_ADDRESS	√	X	X	√	√
32	31	ITEMID_RESP_PREAMBLES	√	X	√	√	√
33	32	ITEMID_CALIBRATOR	√	X	X	X	X
34	33	ITEMID_CALIBRATION_DATE_Y	√	X	X	X	X
35	34	ITEMID_CALIBRATION_DATE_M	√	X	X	X	X
36	35	ITEMID_CALIBRATION_DATE_D	√	X	X	X	X
37	36	ITEMID_PROCESS_GAS_01	√	X	X	X	√
38	37	ITEMID_DENSITY_UNITS_01	√	X	X	X	√
39	38	ITEMID_DENSITY_01	√	X	X	X	√
40	39	ITEMID_FLOW_UNITS_01	√	X	X	X	√

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
41	40	ITEMID_REF_TEMP_UNITS_01	√	X	X	X	√
42	41	ITEMID_REF_TEMP_01	√	X	X	X	√
43	42	ITEMID_REF_PRES_UNITS_01	√	X	X	X	√
44	43	ITEMID_REF_PRESS_01	√	X	X	X	√
45	44	ITEMID_FLOW_RANGE_01	√	X	X	X	√
46	45	ITEMID_RANGE_FACTOR_01	√	X	X	X	X
47	46	ITEMID_LINEARIZATION_1_01	√	X	X	X	X
48	47	ITEMID_LINEARIZATION_2_01	√	X	X	X	X
49	48	ITEMID_LINEARIZATION_3_01	√	X	X	X	X
50	49	ITEMID_LINEARIZATION_4_01	√	X	X	X	X
51	50	ITEMID_TEMP_UNITS_01	√	X	X	X	X
52	51	ITEMID_PRES_UNITS_01	√	X	X	X	X
53	52	ITEMID_PRES_REF_01	√	X	X	X	X
54	53	ITEMID_PROCESS_TEMP_01	√	X	X	X	X
55	54	ITEMID_PROCESS_INLET_PRESS_01	√	X	X	X	X
56	55	ITEMID_PROCESS_OUTLET_PRESS_01	√	X	X	X	X
57	56	ITEMID_CAL_GAS_01	√	X	X	X	X
58	57	ITEMID_CAL_TOOL_01	√	X	X	X	X
59	58	ITEMID_CAL_TEMP_01	√	X	X	X	X
60	59	ITEMID_CAL_INLET_PRESS_01	√	X	X	X	X
61	60	ITEMID_CAL_OUTLET_PRESS_01	√	X	X	X	X
62	61	ITEMID_GAS_FACTOR_01	√	X	X	X	X
63	62	ITEMID_PROCESS_GAS_02	√	X	X	X	√
64	63	ITEMID_DENSITY_UNITS_02	√	X	X	X	√
65	64	ITEMID_DENSITY_02	√	X	X	X	√
66	65	ITEMID_FLOW_UNITS_02	√	X	X	X	√
67	66	ITEMID_REF_TEMP_UNITS_02	√	X	X	X	√
68	67	ITEMID_REF_TEMP_02	√	X	X	X	√
69	68	ITEMID_REF_PRES_UNITS_02	√	X	X	X	√
70	69	ITEMID_REF_PRESS_02	√	X	X	X	√
71	70	ITEMID_FLOW_RANGE_02	√	X	X	X	√
72	71	ITEMID_RANGE_FACTOR_02	√	X	X	X	X
73	72	ITEMID_LINEARIZATION_1_02	√	X	X	X	X
74	73	ITEMID_LINEARIZATION_2_02	√	X	X	X	X
75	74	ITEMID_LINEARIZATION_3_02	√	X	X	X	X
76	75	ITEMID_LINEARIZATION_4_02	√	X	X	X	X
77	76	ITEMID_TEMP_UNITS_02	√	X	X	X	X
78	77	ITEMID_PRES_UNITS_02	√	X	X	X	X
79	78	ITEMID_PRES_REF_02	√	X	X	X	X
80	79	ITEMID_PROCESS_TEMP_02	√	X	X	X	X
81	80	ITEMID_PROCESS_INLET_PRESS_02	√	X	X	X	X
82	81	ITEMID_PROCESS_OUTLET_PRESS_02	√	X	X	X	X
83	82	ITEMID_CAL_GAS_02	√	X	X	X	X
84	83	ITEMID_CAL_TOOL_02	√	X	X	X	X
85	84	ITEMID_CAL_TEMP_02	√	X	X	X	X
86	85	ITEMID_CAL_INLET_PRESS_02	√	X	X	X	X

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
87	86	ITEMID_CAL_OUTLET_PRESS_02	√	X	X	X	X
88	87	ITEMID_GAS_FACTOR_02	√	X	X	X	X
89	88	ITEMID_PROCESS_GAS_03	√	X	X	X	√
90	89	ITEMID_DENSITY_UNITS_03	√	X	X	X	√
91	90	ITEMID_DENSITY_03	√	X	X	X	√
92	91	ITEMID_FLOW_UNITS_03	√	X	X	X	√
93	92	ITEMID_REF_TEMP_UNITS_03	√	X	X	X	√
94	93	ITEMID_REF_TEMP_03	√	X	X	X	√
95	94	ITEMID_REF_PRES_UNITS_03	√	X	X	X	√
96	95	ITEMID_REF_PRESS_03	√	X	X	X	√
97	96	ITEMID_FLOW_RANGE_03	√	X	X	X	√
98	97	ITEMID_RANGE_FACTOR_03	√	X	X	X	X
99	98	ITEMID_LINEARIZATION_1_03	√	X	X	X	X
100	99	ITEMID_LINEARIZATION_2_03	√	X	X	X	X
101	100	ITEMID_LINEARIZATION_3_03	√	X	X	X	X
102	101	ITEMID_LINEARIZATION_4_03	√	X	X	X	X
103	102	ITEMID_TEMP_UNITS_03	√	X	X	X	X
104	103	ITEMID_PRES_UNITS_03	√	X	X	X	X
105	104	ITEMID_PRES_REF_03	√	X	X	X	X
106	105	ITEMID_PROCESS_TEMP_03	√	X	X	X	X
107	106	ITEMID_PROCESS_INLET_PRESS_03	√	X	X	X	X
108	107	ITEMID_PROCESS_OUTLET_PRESS_03	√	X	X	X	X
109	108	ITEMID_CAL_GAS_03	√	X	X	X	X
110	109	ITEMID_CAL_TOOL_03	√	X	X	X	X
111	110	ITEMID_CAL_TEMP_03	√	X	X	X	X
112	111	ITEMID_CAL_INLET_PRESS_03	√	X	X	X	X
113	112	ITEMID_CAL_OUTLET_PRESS_03	√	X	X	X	X
114	113	ITEMID_GAS_FACTOR_03	√	X	X	X	X
115	114	ITEMID_PROCESS_GAS_04	√	X	X	X	√
116	115	ITEMID_DENSITY_UNITS_04	√	X	X	X	√
117	116	ITEMID_DENSITY_04	√	X	X	X	√
118	117	ITEMID_FLOW_UNITS_04	√	X	X	X	√
119	118	ITEMID_REF_TEMP_UNITS_04	√	X	X	X	√
120	119	ITEMID_REF_TEMP_04	√	X	X	X	√
121	120	ITEMID_REF_PRES_UNITS_04	√	X	X	X	√
122	121	ITEMID_REF_PRESS_04	√	X	X	X	√
123	122	ITEMID_FLOW_RANGE_04	√	X	X	X	√
124	123	ITEMID_RANGE_FACTOR_04	√	X	X	X	X
125	124	ITEMID_LINEARIZATION_1_04	√	X	X	X	X
126	125	ITEMID_LINEARIZATION_2_04	√	X	X	X	X
127	126	ITEMID_LINEARIZATION_3_04	√	X	X	X	X
128	127	ITEMID_LINEARIZATION_4_04	√	X	X	X	X
129	128	ITEMID_TEMP_UNITS_04	√	X	X	X	X
130	129	ITEMID_PRES_UNITS_04	√	X	X	X	X
131	130	ITEMID_PRES_REF_04	√	X	X	X	X
132	131	ITEMID_PROCESS_TEMP_04	√	X	X	X	X

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
133	132	ITEMID_PROCESS_INLET_PRESS_04	√	X	X	X	X
134	133	ITEMID_PROCESS_OUTLET_PRESS_04	√	X	X	X	X
135	134	ITEMID_CAL_GAS_04	√	X	X	X	X
136	135	ITEMID_CAL_TOOL_04	√	X	X	X	X
137	136	ITEMID_CAL_TEMP_04	√	X	X	X	X
138	137	ITEMID_CAL_INLET_PRESS_04	√	X	X	X	X
139	138	ITEMID_CAL_OUTLET_PRESS_04	√	X	X	X	X
140	139	ITEMID_GAS_FACTOR_04	√	X	X	X	X
141	140	ITEMID_PROCESS_GAS_05	√	X	X	X	√
142	141	ITEMID_DENSITY_UNITS_05	√	X	X	X	√
143	142	ITEMID_DENSITY_05	√	X	X	X	√
144	143	ITEMID_FLOW_UNITS_05	√	X	X	X	√
145	144	ITEMID_REF_TEMP_UNITS_05	√	X	X	X	√
146	145	ITEMID_REF_TEMP_05	√	X	X	X	√
147	146	ITEMID_REF_PRES_UNITS_05	√	X	X	X	√
148	147	ITEMID_REF_PRESS_05	√	X	X	X	√
149	148	ITEMID_FLOW_RANGE_05	√	X	X	X	√
150	149	ITEMID_RANGE_FACTOR_05	√	X	X	X	X
151	150	ITEMID_LINEARIZATION_1_05	√	X	X	X	X
152	151	ITEMID_LINEARIZATION_2_05	√	X	X	X	X
153	152	ITEMID_LINEARIZATION_3_05	√	X	X	X	X
154	153	ITEMID_LINEARIZATION_4_05	√	X	X	X	X
155	154	TEMID_TEMP_UNITS_05	√	X	X	X	X
156	155	ITEMID_PRES_UNITS_05	√	X	X	X	X
157	156	TEMID_PRES_REF_05	√	X	X	X	X
158	157	ITEMID_PROCESS_TEMP_05	√	X	X	X	X
159	158	ITEMID_PROCESS_INLET_PRESS_05	√	X	X	X	X
160	159	ITEMID_PROCESS_OUTLET_PRESS_05	√	X	X	X	X
161	160	ITEMID_CAL_GAS_05	√	X	X	X	X
162	161	ITEMID_CAL_TOOL_05	√	X	X	X	X
163	162	ITEMID_CAL_TEMP_05	√	X	X	X	X
164	163	ITEMID_CAL_INLET_PRESS_05	√	X	X	X	X
165	164	ITEMID_CAL_OUTLET_PRESS_05	√	X	X	X	X
166	165	ITEMID_GAS_FACTOR_05	√	X	X	X	X
167	166	ITEMID_PROCESS_GAS_06	√	X	X	X	√
168	167	ITEMID_DENSITY_UNITS_06	√	X	X	X	√
169	168	ITEMID_DENSITY_06	√	X	X	X	√
170	169	ITEMID_FLOW_UNITS_06	√	X	X	X	√
171	170	ITEMID_REF_TEMP_UNITS_06	√	X	X	X	√
172	171	ITEMID_REF_TEMP_06	√	X	X	X	√
173	172	ITEMID_REF_PRES_UNITS_06	√	X	X	X	√
174	173	ITEMID_REF_PRESS_06	√	X	X	X	√
175	174	ITEMID_FLOW_RANGE_06	√	X	X	X	√
176	175	ITEMID_RANGE_FACTOR_06	√	X	X	X	X
177	176	ITEMID_LINEARIZATION_1_06	√	X	X	X	X
178	177	ITEMID_LINEARIZATION_2_06	√	X	X	X	X

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
179	178	ITEMID_LINEARIZATION_3_06	√	X	X	X	X
180	179	ITEMID_LINEARIZATION_4_06	√	X	X	X	X
181	180	ITEMID_TEMP_UNITS_06	√	X	X	X	X
182	181	ITEMID_PRES_UNITS_06	√	X	X	X	X
183	182	ITEMID_PRES_REF_06	√	X	X	X	X
184	183	ITEMID_PROCESS_TEMP_06	√	X	X	X	X
185	184	ITEMID_PROCESS_INLET_PRESS_06	√	X	X	X	X
186	185	ITEMID_PROCESS_OUTLET_PRESS_06	√	X	X	X	X
187	186	ITEMID_CAL_GAS_06	√	X	X	X	X
188	187	ITEMID_CAL_TOOL_06	√	X	X	X	X
189	188	ITEMID_CAL_TEMP_06	√	X	X	X	X
190	189	ITEMID_CAL_INLET_PRESS_06	√	X	X	X	X
191	190	ITEMID_CAL_OUTLET_PRESS_06	√	X	X	X	X
192	191	ITEMID_GAS_FACTOR_06	√	X	X	X	X
193	192	ITEMID_PROCESS_GAS_07	√	X	X	X	√
194	193	ITEMID_DENSITY_UNITS_07	√	X	X	X	√
195	194	ITEMID_DENSITY_07	√	X	X	X	√
196	195	ITEMID_FLOW_UNITS_07	√	X	X	X	√
197	196	ITEMID_REF_TEMP_UNITS_07	√	X	X	X	√
198	197	ITEMID_REF_TEMP_07	√	X	X	X	√
199	198	ITEMID_REF_PRES_UNITS_07	√	X	X	X	√
200	199	ITEMID_REF_PRESS_07	√	X	X	X	√
201	200	ITEMID_FLOW_RANGE_07	√	X	X	X	√
202	201	ITEMID_RANGE_FACTOR_07	√	X	X	X	X
203	202	ITEMID_LINEARIZATION_1_07	√	X	X	X	X
204	203	ITEMID_LINEARIZATION_2_07	√	X	X	X	X
205	204	ITEMID_LINEARIZATION_3_07	√	X	X	X	X
206	205	ITEMID_LINEARIZATION_4_07	√	X	X	X	X
207	206	ITEMID_TEMP_UNITS_07	√	X	X	X	X
208	207	ITEMID_PRES_UNITS_07	√	X	X	X	X
209	208	ITEMID_PRES_REF_07	√	X	X	X	X
210	209	ITEMID_PROCESS_TEMP_07	√	X	X	X	X
211	210	ITEMID_PROCESS_INLET_PRESS_07	√	X	X	X	X
212	211	ITEMID_PROCESS_OUTLET_PRESS_07	√	X	X	X	X
213	212	ITEMID_CAL_GAS_07	√	X	X	X	X
214	213	ITEMID_CAL_TOOL_07	√	X	X	X	X
215	214	ITEMID_CAL_TEMP_07	√	X	X	X	X
216	215	ITEMID_CAL_INLET_PRESS_07	√	X	X	X	X
217	216	ITEMID_CAL_OUTLET_PRESS_07	√	X	X	X	X
218	217	ITEMID_GAS_FACTOR_07	√	X	X	X	X
219	218	ITEMID_PROCESS_GAS_08	√	X	X	X	√
220	219	ITEMID_DENSITY_UNITS_08	√	X	X	X	√
221	220	ITEMID_DENSITY_08	√	X	X	X	√
222	221	ITEMID_FLOW_UNITS_08	√	X	X	X	√
223	222	ITEMID_REF_TEMP_UNITS_08	√	X	X	X	√
224	223	ITEMID_REF_TEMP_08	√	X	X	X	√

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
225	224	ITEMID_REF_PRES_UNITS_08	√	X	X	X	√
226	225	ITEMID_REF_PRESS_08	√	X	X	X	√
227	226	ITEMID_FLOW_RANGE_08	√	X	X	X	√
228	227	ITEMID_RANGE_FACTOR_08	√	X	X	X	X
229	228	ITEMID_LINEARIZATION_1_08	√	X	X	X	X
230	229	ITEMID_LINEARIZATION_2_08	√	X	X	X	X
231	230	ITEMID_LINEARIZATION_3_08	√	X	X	X	X
232	231	ITEMID_LINEARIZATION_4_08	√	X	X	X	X
233	232	ITEMID_TEMP_UNITS_08	√	X	X	X	X
234	233	ITEMID_PRES_UNITS_08	√	X	X	X	X
235	234	ITEMID_PRES_REF_08	√	X	X	X	X
236	235	ITEMID_PROCESS_TEMP_08	√	X	X	X	X
237	236	ITEMID_PROCESS_INLET_PRESS_08	√	X	X	X	X
238	237	ITEMID_PROCESS_OUTLET_PRESS_08	√	X	X	X	X
239	238	ITEMID_CAL_GAS_08	√	X	X	X	X
240	239	ITEMID_CAL_TOOL_08	√	X	X	X	X
241	240	ITEMID_CAL_TEMP_08	√	X	X	X	X
242	241	ITEMID_CAL_INLET_PRESS_08	√	X	X	X	X
243	242	ITEMID_CAL_OUTLET_PRESS_08	√	X	X	X	X
244	243	ITEMID_GAS_FACTOR_08	√	X	X	X	X
245	244	ITEMID_PROCESS_GAS_09	√	X	X	X	√
246	245	ITEMID_DENSITY_UNITS_09	√	X	X	X	√
247	246	ITEMID_DENSITY_09	√	X	X	X	√
248	247	ITEMID_FLOW_UNITS_09	√	X	X	X	√
249	248	ITEMID_REF_TEMP_UNITS_09	√	X	X	X	√
250	249	ITEMID_REF_TEMP_09	√	X	X	X	√
251	250	ITEMID_REF_PRES_UNITS_09	√	X	X	X	√
252	251	ITEMID_REF_PRESS_09	√	X	X	X	√
253	252	ITEMID_FLOW_RANGE_09	√	X	X	X	√
254	253	ITEMID_RANGE_FACTOR_09	√	X	X	X	X
255	254	ITEMID_LINEARIZATION_1_09	√	X	X	X	X
256	255	ITEMID_LINEARIZATION_2_09	√	X	X	X	X
257	256	ITEMID_LINEARIZATION_3_09	√	X	X	X	X
258	257	ITEMID_LINEARIZATION_4_09	√	X	X	X	X
259	258	ITEMID_TEMP_UNITS_09	√	X	X	X	X
260	259	ITEMID_PRES_UNITS_09	√	X	X	X	X
261	260	ITEMID_PRES_REF_09	√	X	X	X	X
262	261	ITEMID_PROCESS_TEMP_09	√	X	X	X	X
263	262	ITEMID_PROCESS_INLET_PRESS_09	√	X	X	X	X
264	263	ITEMID_PROCESS_OUTLET_PRESS_09	√	X	X	X	X
265	264	ITEMID_CAL_GAS_09	√	X	X	X	X
266	265	ITEMID_CAL_TOOL_09	√	X	X	X	X
267	266	ITEMID_CAL_TEMP_09	√	X	X	X	X
268	267	ITEMID_CAL_INLET_PRESS_09	√	X	X	X	X
269	268	ITEMID_CAL_OUTLET_PRESS_09	√	X	X	X	X
270	269	ITEMID_GAS_FACTOR_09	√	X	X	X	X

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
271	270	ITEMID_PROCESS_GAS_10	√	X	X	X	√
272	271	ITEMID_DENSITY_UNITS_10	√	X	X	X	√
273	272	ITEMID_DENSITY_10	√	X	X	X	√
274	273	ITEMID_FLOW_UNITS_10	√	X	X	X	√
275	274	ITEMID_REF_TEMP_UNITS_10	√	X	X	X	√
276	275	ITEMID_REF_TEMP_10	√	X	X	X	√
277	276	ITEMID_REF_PRES_UNITS_10	√	X	X	X	√
278	277	ITEMID_REF_PRESS_10	√	X	X	X	√
279	278	ITEMID_FLOW_RANGE_10	√	X	X	X	√
280	279	ITEMID_RANGE_FACTOR_10	√	X	X	X	X
281	280	ITEMID_LINEARIZATION_1_10	√	X	X	X	X
282	281	ITEMID_LINEARIZATION_2_10	√	X	X	X	X
283	282	ITEMID_LINEARIZATION_3_10	√	X	X	X	X
284	283	ITEMID_LINEARIZATION_4_10	√	X	X	X	X
285	284	ITEMID_TEMP_UNITS_10	√	X	X	X	X
286	285	ITEMID_PRES_UNITS_10	√	X	X	X	X
287	286	ITEMID_PRES_REF_10	√	X	X	X	X
288	287	ITEMID_PROCESS_TEMP_10	√	X	X	X	X
289	288	ITEMID_PROCESS_INLET_PRESS_10	√	X	X	X	X
290	289	ITEMID_PROCESS_OUTLET_PRESS_10	√	X	X	X	X
291	290	ITEMID_CAL_GAS_10	√	X	X	X	X
292	291	ITEMID_CAL_TOOL_10	√	X	X	X	X
293	292	ITEMID_CAL_TEMP_10	√	X	X	X	X
294	293	ITEMID_CAL_INLET_PRESS_10	√	X	X	X	X
295	294	ITEMID_CAL_OUTLET_PRESS_10	√	X	X	X	X
296	295	ITEMID_GAS_FACTOR_10	√	X	X	X	X
297	296	ITEMID_TEMP_SENSOR_CORR_1	√	X	X	X	X
298	297	ITEMID_TEMP_SENSOR_CORR_2	√	X	X	X	X
299	298	ITEMID_BRIDGE_ZERO	√	X	X	X	X
300	299	ITEMID_BRIDGE_CAL_TEMP	√	X	X	X	X
301	300	ITEMID_TEMP_ZERO_CORR	√	X	X	X	X
302	301	ITEMID_TEMP_SPAN_CORR	√	X	X	X	X
303	302	ITEMID_STD_TEMP_UNIT	√	X	X	X	√
304	303	ITEMID_STD_TEMP	√	X	X	X	√
305	304	ITEMID_STD_PRESS_UNIT	√	X	X	X	√
306	305	ITEMID_STD_PRESS	√	X	X	X	√
307	306	ITEMID_SELECTED_GAS	√	X	X	√	√
308	307	ITEMID_SELECTED_FLOW_UNIT	√	√	√	√	√
309	308	ITEMID_SELECTED_FLOW_REF	√	X	X	√	√
310	309	ITEMID_SELECTED_TEMP_UNIT	√	X	√	√	√
311	310	ITEMID_ADDITIONAL_DAMPING	√	X	X	√	X
312	311	ITEMID_ANALOG_ENABLE	√	X	X	X	X
313	312	ITEMID_ANALOG_SPAN	√	X	X	X	X
314	313	ITEMID_ANALOG_OFFSET	√	X	X	X	X
315	314	ITEMID_TEMP_ENABLE	√	X	X	X	X
316	315	ITEMID_TEMP_SPAN	√	X	X	X	X

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
317	316	ITEMID_TEMP_OFFSET	√	X	X	X	X
318	317	ITEMID_K_SENSOR	√	X	X	X	X
319	318	ITEMID_N_SENSOR	√	X	X	X	X
320	319	ITEMID_SETPOINT_SOURCE	√	X	X	√	√
321	320	ITEMID_SETPOINT_SPAN	√	X	X	√	√
322	321	ITEMID_SETPOINT_OFFSET	√	X	X	√	√
323	322	ITEMID_SOFTSTART	√	X	X	√	√
324	323	ITEMID_SOFTSTART_RAMP	√	X	X	√	√
325	324	ITEMID_KP	√	X	X	√	X
326	325	ITEMID_KI	√	X	X	√	X
327	326	ITEMID_KD	√	X	X	√	X
328	327	ITEMID_VALVE_RANGE	√	X	X	√	X
329	328	ITEMID_VALVE_OFFSET	√	X	X	√	X
330	329	ITEMID_FLAGS	√	X	√	√	√
331	330	ITEMID_ADD_STATUS_1	√	X	X	√	√
332	331	ITEMID_ADD_STATUS_2	√	X	X	√	√
333	332	ITEMID_ADD_STATUS_3	√	X	X	√	√
334	333	ITEMID_ADD_STATUS_4	√	X	X	√	√
335	334	ITEMID_DEVICE_STATUS	√	X	X	X	X
336	335	ITEMID_VOR	√	√	√	√	√
337	336	ITEMID_SETPOINT_UNITS	√	√	√	√	√
338	337	ITEMID_SETPOINT_PCNT	√	√	√	√	√
339	338	ITEMID_ACTUAL_FLOW_PCNT	√	√	√	√	√
340	339	ITEMID_ACTUAL_FLOW_UNITS	√	√	√	√	√
341	340	ITEMID_ACTUAL_TEMP	√	X	√	√	√
342	341	ITEMID_VALVE_CONTROL_VAL	√	X	X	√	√
343	342	ITEMID_ANALOG_OUT_PCNT	√	X	X	X	X
344	343	ITEMID_ANALOG_OUT_VOLT	√	X	X	√	X
345	344	ITEMID_ANALOG_OUT_CURR	√	X	√	√	√
346	345	ITEMID_TEMP_OUT_PCNT	√	X	X	X	X
347	346	ITEMID_TEMP_OUT_VOLT	√	X	X	X	X
348	347	ITEMID_TOTALIZER_MODE	√	X	X	√	X
349	348	ITEMID_FLOW_TOTALIZER	√	X	X	√	X
350	349	ITEMID_SELECTED_TOT_UNIT	√	X	X	√	X
351	350	ITEMID_ADAPTIVE_CONTROL	√	X	X	√	X
352	351	ITEMID_ADD_STATUS_ENABLE_1	√	X	X	√	√
353	352	ITEMID_ADD_STATUS_ENABLE_2	√	X	X	√	√
354	353	ITEMID_ADD_STATUS_ENABLE_3	√	X	X	√	√
355	354	ITEMID_ADD_STATUS_ENABLE_4	√	X	X	√	√
356	355	ITEMID_LOW_PV_ALARM_LIMIT	√	X	X	√	√
357	356	ITEMID_HIGH_PV_ALARM_LIMIT	√	X	X	√	√
358	357	ITEMID_AMBIENT_TEMP_UNIT	√	X	X	X	X
359	358	ITEMID_AMBIENT_TEMP	√	X	X	X	X
360	359	ITEMID_GAS_SELECTOR	√	X	X	X	√
361	360	ITEMID_SETPOINT_UNIT	√	X	√	√	√
362	361	ITEMID_OUTPUT_SELECTOR	√	X	X	√	X

Supported √
Not Supported X

Table A.29 Supported DDE Items per Device Type (continued)

S.No	HART Item No.	Item Description	Device type				
			58xxS MfxxS	254	154	SLA58xxS SLAMfxxS	48xxS GF40/80
363	362	ITEMID_OUTPUT_UNIT_SEL	√	X	X	X	X
364	363	ITEMID_NEW_USER_PW	√	X	X	√	X
365	364	ITEMID_MASTER_RESET	√	X	X	X	X
366	365	ITEMID_ZERO_SENSOR	√	X	X	X	X
367	366	ITEMID_EEPROM_CTL_CODE	√	X	X	X	X
368	367	ITEMID_CONFIG_PW	√	X	X	X	X
369	368	ITEMID_EXPANSION	√	X	√	√	√
370	369	ITEMID_ZERO	√	X	X	√	√
371	370	ITEMID_NOT_USED	√	X	X	√	√
372	371	ITEMID_NAN	√	X	X	√	√
		Total Items Supported	**372**	**9**	**25**	**65**	**144**

Supported √
Not Supported X

Table A.30 Execute Commands

S.No	Execute Command	Device type			
		58xxS MfxxS	0154	SLA58xxS SLAMfxxS	48xxS GF40/80
1	UNPROTECT	√	X	√	√
2	PROTECT	√	X	√	√
3	DOWNLOAD	√	√	√	√
4	BACKUP	√	X	X	X
5	RESTORE	√	X	X	X
6	CHANGEPASSWORD	√	X	√	X
7	RESET	√	X	X	√
8	ZERO	√	X	√	√
9	LOAD	√	√	√	√
10	SAVE	√	√	√	√
11	CALTEMPSENSOR	√	X	X	X
	Total Execute commands Supported	**11**	**3**	**7**	**7**

Note that the 0254 Read Out doesn't support the HART based protocol but a proprietary protocol, for this reason the 0254 device type is not listed in the 'Commands' and 'Execute Commands' tables.

Supported √
Not Supported X

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Table B.1 provides a list of all execute requests supported by Smart DDE. The table shows a description of the execute request function, it shows the corresponding Smart DDE User Interface (UI) function (when feasible) and the table provides the item number for status information (beware, status information is only applicable for execute command which are processed within the DMFC). The item number for status information can be used to request information, informing about the status of the last execution of the mentioned execute command.

Table B.1 Execute Requests

Execute requests			
Command	**Description**	**Corresponding User Interface option**	**Item no. for status info**
UNPROTECT(<password>)	Request Smart DDE to send the command to the DMFC to disable the write protection. The DMFC only performs this function if the correct password of the DMFC is sent in combination with the instruction (replace <*password*> by the DMFC-password; default: Brooks).	**DMFC|Write protection**	[11]
PROTECT(<password>)	Request Smart DDE to send the command to the DMFC to enable the write protection. The DMFC only performs this function if the correct password of the DMFC is sent in combination with the instruction (replace <*password*> by the DMFC-password; default: Brooks).	**DMFC|Write protection**	[11]
BACKUP	Request Smart DDE to send the command to the DMFC to make a backup of the internal database, stored in the volatile RAM memory, to the non-volatile EEPROM memory in the DMFC.	**DMFC|Backup to EEPROM**	[366]
RESTORE	Request Smart DDE to send the command to the DMFC to restore all the settings from the EEPROM database memory, into the working RAM memory.	**DMFC|Restore from EEPROM**	[366]
ZERO	Request Smart DDE to send the zero-command to the DMFC. This commands the DMFC micro-processor to balance the flow sensor bridge.	Not feasible from the UI	[365]
CHANGEPASSWORD (<old pw>,<new pw>)	Request Smart DDE to send the command to the DMFC to change the password from the <*old password*> into the <*new password*>.	**DMFC|Change password**	[10]
CALTEMPSENSOR (<ambient temperature>)	Request Smart DDE to send the command to the DMFC to perform a temperature sensor calibration action. Therefor, the DMFC needs to know the actual <*ambient temperature*>, which must be sent as a part of the execute request (in **Kelvin** only).	Not feasible from the UI	[358]
RESET	Request Smart DDE to send the command to the DMFC to perform a master reset. This command implies a reset of the on board micro-processor which results in an initialization of the DMFC. The settings of the DMFC database are restored from the backup database in the DMFC EEPROM memory.	Not feasible from the UI	[364]

Table B.1 Execute Requests (cont'd)

Execute requests			
Command	**Description**	**Corresponding User Interface option**	**Item no. for status info**
DOWNLOAD	Request Smart DDE to download all readable settings from the working database of the DMFC to the internal Smart DDE buffers.	**DMFC|Read from DMFC**	-
LOAD	Request Smart DDE to load all readable settings, according to the DMFC, from the ".DMF" file into the internal Smart DDE buffers.	**DMFC|Read from File**	-
SAVE	Request Smart DDE to store all readable settings, according to the DMFC, from the internal Smart DDE buffers to a ".DMF" file on disk.	**DMFC|Write to File**	-
REFRESH	Request Smart DDE to update all advise links immediately, i.e. the advise-link items are read from the DMFC(s) and send to the client through the DDE-conversation .	Not feasible from the UI	-
REFRESHRATE(<msec>)	Request Smart DDE to change the refresh rate used to update advise links.	**Preference|Refresh rate**	-

This section summarises the status messages generated by a device, shows the possible causes and the actions to be taken to remove the message.

The summarised information on troubleshooting fatal alarms is shown in Table 1C.1.

In order to speed up the repair of the device it is important that you take good notice of the situation in which the alarm occurred and of the actions you have taken attempting to remove the error.

Table C.1 Troubleshooting Fatal Alarms

Indication/Message	Possible cause	Action
LED flashing at 20 Hz/Alarm output activated. No communication.	Checksum mismatch detected in program memory at power up, caused by: 1. Possible faulty electronics.	Contact factory! Device needs servicing!
LED flashing at 10 Hz/Alarm output activated. No communication.	Write/Read error in SRAM location detected at power up, caused by: 1. Possible faulty electronics.	Contact factory! Device needs servicing!
LED flashing at 5 Hz/Alarm output activated. Status: "Database corrupt", indicated by additional status byte# 0, bit# 2 (refer to *Table A.27: Additional device status and masking).* No flow control.	Checksum mismatch at a parameter in the volatile database, caused by: 1. Possible irregular change of database parameter(s). 2. Possible faulty electronics.	1. Retry a power up (changes made to the data are lost). 2. If the error turns up again within approx. 5 min. after power up: Contact factory! Device needs servicing!
LED flashing at 5 Hz/Alarm output activated. Status: "EEPROM corrupt", indicated by additional status byte# 0, bit# 3 (refer to *Table A.27: Additional device status and masking).* No flow control.	Compare mismatch between volatile and non-volatile database, caused by: 1. Possible irregular change of database parameter(s). 2. Possible faulty electronics.	1. Retry a power up (changes made to the data are lost). 2. If the error turns up again within approx. 10 min. after power up: Contact factory! Device needs servicing!
LED flashing at 5 Hz/Alarm output activated. Status: "Sensor zero failed", indicated by additional status byte# 0, bit# 4 (refer to *Table A.27: Additional device status and masking).* No flow control.	A proper balancing (zeroing) of the flow sensor could not be established, caused by: 1. Possible faulty electronics. 2. Possible faulty sensor.	1. Remove the can. Make sure the flow sensor is connected to the printed circuit board (see note). 2. Re-apply power and retry a zero command. 3. If the alarm turns up again: Contact factory! Device needs servicing!

NOTE: When checking the sensor flow cable, please note that there are 7 pins on the cable, but 8 pins on the mating connector on the main board. The sensor cable should be connected to pin 1 to 7 (left to right) and leave exactly one pin open on the left of the cable connection.

NOTE: The LED is located under the electronics cover. Remove cover to make the LED visible.

Table C.2 Troubleshooting Non-Fatal Alarms

Indication/Message	Possible cause	Corrective action
"Flow sensor error", indicated by additional status byte# 1, bit# 0 (refer to *Table A.27: Additional device status and masking)* . (Flow sensor signal missing)	1. Possible disconnected or faulty sensor. 2. Possible faulty electronics.	1. Remove the can and make sure the flow sensor is connected to the printed circuit board. 2. If the alarm turns up again: Contact factory! Device needs servicing!
"Temperature sensor error", indicated by additional status byte# 1, bit# 1 (refer to *Table A.27: Additional device status and masking).* (Temperature sensor signal missing)	1. Possible disconnected or faulty sensor. 2. Possible faulty electronics.	1. Remove the can and make sure the flow sensor is connected to the printed circuit board. 2. If the alarm turns up again: Contact factory! Device needs servicing!
"Analogue output error", indicated by additional status byte# 1, bit# 2 (refer to *Table A.27: Additional device status and masking).* (True analogue output voltage deviates more then 10% from expected value)	1. Power too low ("Power too low" message also shown). 2. Incorrect output load (short circuit?) 3. Possible faulty electronics.	1. Make sure the applied power is at least 15 Volts. 2. Make sure the output is correctly connected. 3. If the error still remains: Contact factory! Device needs servicing!
"Setpoint overrange", indicated by additional status byte# 1, bit# 3 (refer to *Table A.27: Additional device status and masking).* (Analogue Setpoint > 100%)	1. Selected setpoint source is either 0-5 Volt or 1-5 Volt, but analogue signal is more then 5 Volt. 2. Selected setpoint source is either 0-20mA or 4-20mA, but current jumper J1 is disconnected or missing.	1. Make sure that the (voltage) signal stays below 5 Volt, or 2. If setpoint source is 0-20mA or 4-20mA, make sure the current jumper is present (J1 on the main board).
"Flow sensor out of range", indicated by additional status byte# 1, bit# 4 (refer to *Table A.27: Additional device status and masking).* (Flow sensor signal > 110%)	1. Flow is too high. 2. Possible clogging restrictor. 3. Possible wrongly connected sensor flat cable ("Ambient temperature too high" message also shown). 4. Possible faulty sensor or electronics.	1. Make sure the flow is within range. 2. Remove the can and check the sensor flat cable. 3. Remove the restrictor. Make sure it is not clogged. 4. If the error still remains: Contact factory! Device needs servicing!
"Analogue output out of range", indicated by additional status byte# 1, bit# 5 (refer to *Table A.27: Additional device status and masking)* . (Analogue output set value too high for D/A converter)	1. Flow is too high or flow sensor is too high (see "Flow sensor out of range"), the output can not follow.	1. Make sure the flow is within range.
"Valve out of range", indicated by additional status byte# 1, bit# 6 (refer to *Table A.27: Additional device status and masking)* . (Valve maximal opened, unable to create flow).	1. No gas is applied to the device ("No-flow indication" is also shown). 2. Not enough gas pressure on the inlet, or the pressure for which the valve was calibrated is not applied. 3. The valve has suffered from mechanical distress. 4. The power applied to the system (and the valve) is not sufficient to control the valve (applies to 5851S model). 5. The orifice may be clogged	1. Make sure gas is applied to the device with the correct pressure. 2. Make sure the power supplied is sufficient for the valve. Try a "valve override open" command to check if the valve is capable of achieving flow at all. 3. Re-adjust the valve offset and the valve span to enable correct control. 4. Clean the orifice if necessary. 5. If the error still remains: Contact factory! Device needs servicing!

Table C.2 Troubleshooting Non-Fatal Alarms (cont'd)

Indication/Message	Possible cause	Corrective action
"Ambient temperature too high" or "Ambient temperature too low", indicated by additional status byte# 3, bit# 0 or 4 (refer to *Table A.27: Additional device status and masking).* (Ambient temperature outside its operating limits).	1. Ambient temperature is too high or too low for the specified device. 2. Possible wrongly connected sensor flat cable ("Flow sensor error" or "Flow sensor out of range" message also shown). 3. Possible faulty sensor or electronics.	1. Make sure the operating temperature is within the operating limits. 2. Remove the can and check the sensor flat cable. 3. If the error still remains: Contact factory! Device needs servicing!
"Power too low", indicated by additional status byte# 3, bit# 1 (refer to *Table A.27: Additional device status and masking).* (Analogue power < 12 Volt)	1. The applied power is less then 15 Volt. 2. Possible short circuit on the printed circuit box.	1. Make sure the applied power is sufficient for the device. 2. If the error still remains: Contact factory! Device needs servicing!
"No-flow indication", indicated by additional status byte# 3, bit# 2 (refer to *Table A.27: Additional device status and masking).* (Flow sensor output less then 2%, with valve opened)	1. Occurs only together with "Valve out of range" message (see there). Possible absence of gas. 2. The gas sensor may be clogged. 3. No flow can be achieved, due to the valve not opening.	1. Make sure gas is applied to the system. 2. Make sure the applied gas pressure and the valve settings are correct. 3. Clean the sensor if necessary.

Table C.3 Troubleshooting Additional Non-Fatal Alarms

Indication/Message	Possible cause	Corrective action
"Low flow alarm" or "High flow alarm", indicated by additional status byte# 2, bit# 0 or 1 (refer to *Table 8.27: Additional device status and masking).* (Measured flow outside specified limits).	The DMFC is indicating that the measured flow exceeds the specified limits. These limits can be altered, using the *Low flow alarm limit* item ([355]) and the *High flow alarm limit* item ([356]).	In case high or low flow limit alarms are not desired, turn off these alarms using the *Additional status enable/disable* item ([353])
"Totalizer overflow", indicated by additional status byte# 2, bit# 2 (refer to *Table 8.27: Additional device status and masking).* (Totalizer counter exceed maximum value)	The flow totalizer counter exceeds the maximum value and starts again beginning from zero (0).	Use the *Flow totalizer mode* item ([347]) in order to stop the totalizer, reset the flow totalizer counter and start the totalizer at a particular time. In case the totalization function is not desired, turn off the totalizer function (item [347]) and disable the totalizer overflow alarm (item [353]).

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D.1 Calibrating the Analog Setpoint Input

In case a DMFC is configured for analog setpoint source, the user can calibrate the analog input if necessary to make it comply with his system (i.e. the system may be used with long interconnection lines between power supply/read out unit and the device, thus resulting in loss of signal due to cable resistance). The span and the offset of the analog input can be adjusted in order to achieve the correct setpoint signal at the Brooks Digital Mass Flow Meter of Controller. This means that if a 5 Volt setpoint is given in order to get a 100% flow, the adjustments can be made such that the signal received at the device is interpreted as a 100% setpoint.

In order to calibrate the analog setpoint input, perform the following actions:

1. Configure the desired analog setpoint source (item [319]) and initialize the span (item [320]) and offset (item [321]) to 1.000 and 0.000 respectively (i.e. uncalibrated analog input).

2. Apply either from your system or a separate accurate source a known low analog signal to the setpoint input, e.g. for a 0 to 5 Volt setpoint input (0% to 100%) apply 0.25 Volt (= 5%), for 4 to 20 mA range apply 4.8 mA (= 5%).

a. Recalculate the analog input to a percentage of full scale, e.g. for a 0 to 5 Volt range, recalculate the 0.25 Volt to 5%.

b. Request the measured setpoint from the device, using item [337] (Setpoint in percentage of full scale).

3. Apply a known high analog signal to the setpoint input, e.g. for a 0 to 5 Volt setpoint input (0% to 100%) apply 4.75 Volt (= 95%), for 4 to 20 mA range apply 19.2 mA (= 95%).

a. Recalculate the analog input to a percentage of full scale, e.g. for a 0 to 5 Volt range, recalculate 4.75 Volt to 95%.

b. Request the measured setpoint from the device, using item [337] (Setpoint in percentage of full scale).

4. Use the two setpoint readings to calculate the correction values for span and offset using:

$$\text{spancorrection} = \frac{(\text{Input}_{high} - \text{Input}_{low})}{(\text{Setpoint}_{high} - \text{Setpoint}_{low})}$$

$$\text{offsetcorrection} = - \frac{(\text{Setpoint}_{low} * \text{Input}_{high} - \text{Setpoint}_{high} * \text{Input}_{low})}{(\text{Input}_{high} - \text{Input}_{low})}$$

The spancorrection is a dimensionless factor (mostly around 1.0), whereas the offset correction is expressed in % of full scale.

5. Change the two correction values found with the above formulas in the DMFC using the poke request with item [320] and [321].

The offset correction value is in the Brooks Mass Flow Controller added to the measured setpoint value, after which the resulting value is multiplied with the span correction value. The values which can be entered are limited to a range of 0.8 to 1.2 for the span correction factor and -10% to 10% for the offset correction.

EXAMPLE: Suppose for a device with a 4 to 20 mA setpoint input selected, the lower analog value entered by the user is 5.6 mA, which equals 10% and the higher analog value entered by the user is 19.2 mA, which equals 95%. The measured values for the setpoint might be 10.25% and 97.5% respectively. Using the above formulas the span and offset correction values will be:

$$\text{spancorrection} = \frac{(95.0 - 10.0)}{(97.5 - 10.25)} = 0.97421$$

$$\text{offsetcorrection} = - \frac{(10.25 * 95.0 - 97.5 * 10.0)}{(95.0 - 10.0)} = 0.01471$$

For this specific example this means that the correction for the offset for the 10.25% value would result in 10.25 + 0.01471 = 10.26471, and after that the correction for the span would result in 10.26471*0.97421 = 9.999983, which rounds to 10.0%.

D.2 Calibrating the Analog Flow Outputs

In order to use the analog outputs correctly in the user system, they can be calibrated to provide the correct output signal at the point of detection. Again, as with the analog setpoint signal, this feature facilitates the use of e.g. long supply lines in the user system. The analog output uses the flow percentage value to set the physical output value through a D/A-converter. In most cases, e.g. with long lines present this conversion will seem to the user to be a non-one-to-one conversion, i.e. span and offset values in the conversion will not be equal to 1.000 and 0.000 respectively.

Calibration can be performed by changing the analog output span and offset parameters. The values for these parameters can be determined by measurement of the analog output signal at the spot where actual signal detection takes place (e.g. at the end of a long line at the terminals of a readout unit). Therefor, perform the following steps:

1. Configure the desired analog output (item [311]) and initialize the span (item [312]) and offset (item [313]) to 1.000 and 0.000 respectively (i.e. uncalibrated analog output).

2. Force the analog output into a low flow fixed mode, e.g.:
- 0 to 5 Volt flow output (0 to 100%): use the poke request to set item [343] to 0.25 Volt (= 5%)
- 4 to 20 mA flow output (0 to 100%): use the poke request to set item [344] to 4.8 mA (= 5%).

Recalculate, if necessary, the analog output value, measured at the detection point, to a percentage of full scale, e.g. for a 0 to 5 Volt range, recalculate 0.25 Volt to 5%. When using a Brooks model 0152/0154 readout unit the flow value in percentage of full scale can be read from the display.

3. Force the analog output into a high flow fixed mode, e.g.:
- 0 to 5 Volt flow output (0 to 100%): use the poke request to set item [343] to 4.75 Volt (= 95%)
- 4 to 20 mA flow output (0 to 100%): use the poke request to set item [344] to 19.2 mA (= 95%).

Recalculate, if necessary, the analog output value, measured at the detection point, to a percentage of full scale, e.g. for a 0 to 5 Volt range, recalculate 0.25 Volt to 5%.

4. Use the two flow readings to calculate the values for span and offset correction using:

$$\text{spancorrection} = \frac{(\text{flow}_{\text{high}} - \text{flow}_{\text{low}})}{(\text{output}_{\text{high}} - \text{output}_{\text{low}})}$$

$$\text{offsetcorrection} = -\frac{(\text{output}_{\text{low}} * \text{flow}_{\text{high}} - \text{output}_{\text{high}} * \text{flow}_{\text{low}})}{(\text{flow}_{\text{high}} - \text{flow}_{\text{low}})}$$

The spancorrection is a dimensionless factor (mostly around 1.0), whereas the offset correction is expressed in % of full scale.

5. Change the two correction values found with the above formulas in the DMFC using the poke request with item [312] (analog output span) and [313] (analog output offset).

The offset correction value is in the Brooks Mass Flow Controller added to the flow percentage value to be used in setting the output D/A-converter. The resulting value is multiplied with the span correction value. The values which can be entered are limited to a range of 0.8 to 1.2 for the span correction factor and -10% to 10% for the offset correction.

EXAMPLE: Suppose a device is configured with a 0 to 5 Volt output. In case the ouput is set to a fixed value of 0.5 Volt (i.e. 10%), the output value measured is 0.51 Volt, which equals 10.2%. For the high flow fixed mode, the ouput is set to a fixed value of 4.75 Volt (i.e. 95%), the output value measured is 4.77 Volt, which equals 95.4%. Using the above formulas the span and offset correction values for the analog output will be:

$$\text{spancorrection} = \frac{(95 - 10)}{(95.4 - 10.2)} = 0.99765$$

$$\text{offsetcorrection} = -\frac{(10.2 * 95 - 95.4 * 10)}{(95 - 10)} = -0.17647$$

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Installation and Operation Manual
X-SW-DDE-MFC-eng
Part Number 541C057AAG
January, 2013

Smart DDE Software

Smart DDE Software

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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.
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