DH Instruments
A Fluke Company

MFC-CB™

MFC Control Box

Operation and Maintenance Manual

Document No. 550123b-01
040330
Printed in the USA.

DH Instruments
A Fluke Company

TABLE OF CONTENTS

TABLES

FIGURES

ABOUT THIS MANUAL

This manual provides the user with the basic information necessary to set up and operate an MFC-CB MFC Control Box. It also includes a great deal of additional information provided to help you optimize MFC-CB use and take full advantage of its many features and functions.

Before using the manual, take a moment to familiarize yourself with the Table of Contents structure. All first time MFC-CB users should read Sections 1 and 2. Section 3 provides a comprehensive description of general MFC-CB operating principles. Section 4 is for remote operation from an external computer. Section 5 provides maintenance and calibration information. Section 6 is a quick troubleshooting guide. Use Section 6 to troubleshoot unexpected MFC-CB behavior based on the symptoms of that behavior.

Certain words and expressions have specific meaning as they pertain to MFC-CB. Section 7.4 is useful as a quick reference for the definition of specific words and expressions as they are used in this manual.

FOR THOSE OF YOU WHO "DON'T READ MANUALS", GO DIRECTLY TO SECTION 2.3, INITIAL SETUP, TO SET UP YOUR MFC-CB. THEN GO TO SECTION 2.4, POWER UP AND VERIFICATION. THIS WILL GET YOU RUNNING QUICKLY WITH MINIMAL RISK OF CAUSING DAMAGE TO YOURSELF OR YOUR MFC-CB. THEN… WHEN YOU HAVE QUESTIONS OR START TO WONDER ABOUT ALL THE GREAT FEATURES YOU MIGHT BE MISSING, GET INTO THE MANUAL!

Manual Conventions

(CAUTION) is used in throughout the manual to identify user warnings and cautions.

(NOTE) is used throughout the manual to identify operating and applications advice and additional explanations.

[ ] indicates direct function keys (e.g., **[UNIT]**).
< > indicates MFC-CB screen menus and displays (e.g., **<1yes>**).

NOTES

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

MFC-CB is a two channel analog input/output device designed to set and read voltage and current signals from analog Mass Flow Controllers (MFC) and Mass Flow Meters (MFM). A **DH Instruments** MFC Switchbox may be connected to either channel allowing switching of the channel's control between five permanently powered channels. As an option, (8) external 12 V drivers can also be included to excite peripheral equipment such as solenoid valves.

MFC-CB provides a local user interface via a front panel key pad and display and includes advanced on-board functions. Remote communication capability is supported by RS232 and IEEE-488 interfaces.

MFC-CB is intended for applications where convenient local and remote control of analog MFCs and/or MFMs is desired, for example in setting up an MFC calibration system using a **DH Instruments** molbox1 or molbox RFM flow standard.

1.2 SPECIFICATIONS

1.2.1 GENERAL SPECIFICATIONS

Power Requirements	100 to 240 VAC, 50 to 60 Hz, 38 VA max. consumption
Power Supply Output	± 15 VDC @ 1 Amp max, 0.5 Amp per channel
Operating Temperature Range	15 to 35 °C
Storage Temperature Range	-20 to 70 °C
Warm Up Time	1 hour for best electrical measurement specifications
Vibration	Meets MIL-T-28800D
Weight	2 kg (4.4 lb)
Dimensions	8 cm H x 22.5 cm W x 20 cm D (3.1 in. x 8.9 in. x 7.9 in.) approx.
Microprocessor	Motorola 68302, 16 MHz
Communication Ports	RS232 (COM1), RS232 (COM2), IEEE-488, **DHI** MFC Switchbox
Electrical Connections	DEV1 and DEV2: 25 pin female DSUB
CE Conformance	Available. Must be specified.

1.2.2 ANALOG OUTPUT SPECIFICATIONS

VOLTAGE OUTPUT

Range	0 to 6 VDC
Uncertainty	± 0.015 %FS
Resolution	0.1 mVDC
Output Impedance (max)	100 Ω per channel
Load Impedance (min)	10 kΩ per channel
Short Circuit Protection	Yes (indefinite)

CURRENT OUTPUT

Range	4 to 20 mA
Uncertainty	± 0.025 %FS
Resolution	0.4 µA
Maximum Load	500 Ω (compliance voltage: 10 VDC)
Short Circuit Protection	Yes (indefinite)

1.2.3 ANALOG INPUT SPECIFICATIONS

VOLTAGE INPUT (MEASURE AND SENSE)

Range	0 to 6 VDC
Min to Max Measurable	-0.25 to 6.00 VDC
Uncertainty	± 0.015 %FS
Resolution	0.1 mVDC
Input Impedance (min)	1 MΩ

CURRENT INPUT (MEASURE)

Range	4 to 20 mA
Min to Max Measurable	4 to 20 mA
Uncertainty	± 0.025 %FS
Resolution	0.4 µA
Input Impedance	250 Ω

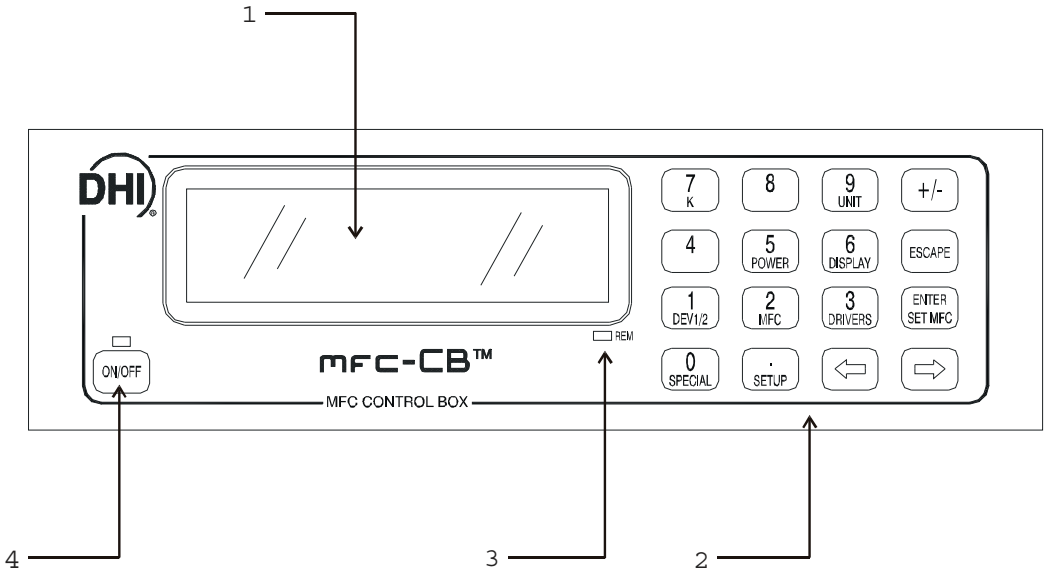
1.2.4 VALVE TEST POINT SPECIFICATIONS

Range	+2 to +15 VDC (in reference to -15 VDC)
Accuracy	± 0.1 %FS
Resolution	0.3 mVDC

1.2.5 FRONT AND REAR PANELS

1.2.5.1 FRONT PANEL

The front panel assembly provides a 2 x 20 vacuum fluorescent display, a membrane keypad for local user interface and a SOFT ON/OFF key.

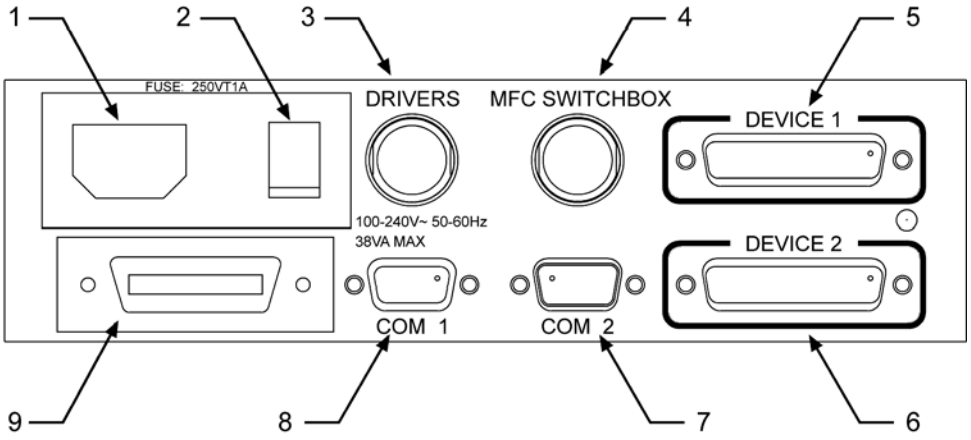


1. Display
2. Multi-Function Keypad
3. Remote Communication Indicator
4. SOFT ON/OFF Key and Indicator

Figure 1. MFC-CB Front Panel

1.2.5.2 REAR PANEL

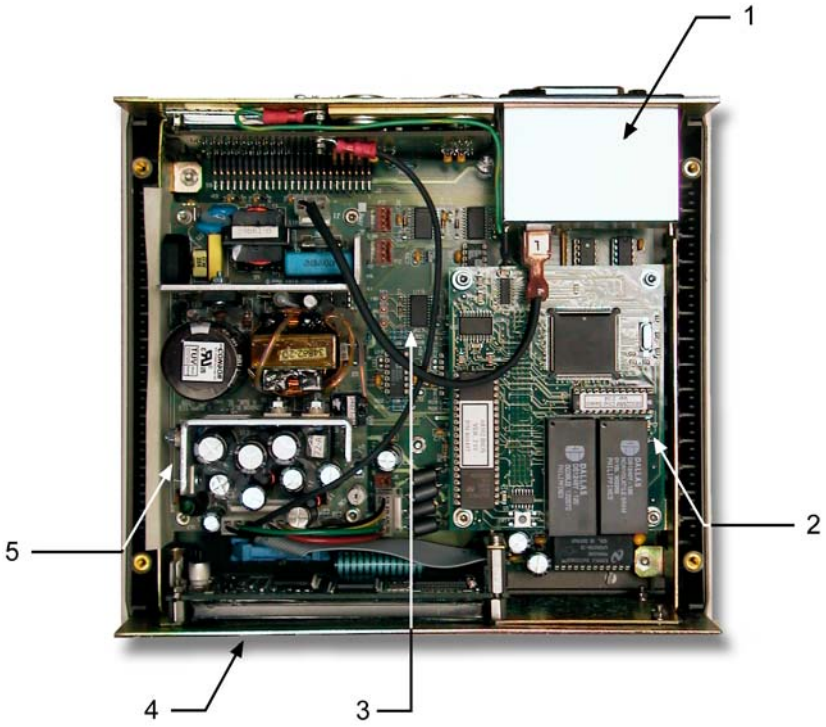
The rear panel assembly provides DEVICE1 and DEVICE2 analog input/output channels, a 12 V drivers connection, communications interfaces and the power connection module.



1. Electrical power connector (IEC60320)
2. Power ON/OFF switch
3. Connector for 12V DRIVERS
4. Connector for MFC Switchbox control
5. DEVICE1 electrical input/output connection
6. DEVICE2 electrical input/output connection
7. COM2 connection for pass through communication
8. COM1 connection for host computer
9. IEEE-488 connection for host computer

Figure 2. MFC-CB Rear Panel

1.2.6 INTERNAL VIEW



1. Power entry module
2. Micro board
3. Main board (under power supply and micro board)
4. Display
5. Power supply

Figure 3. MFC-CB Internal View

1.2.6.1 DISPLAY

2 x 20 vacuum fluorescent, alpha-numeric display mounted to front panel.

1.2.6.2 POWER SUPPLY

MFC-CB has one 65 W switching power supply with three DC voltage outputs:

- 5 VDC @ 7 Amp max.
- +15 VDC @ 2.5 Amp max.
- -15 VDC @ 2 Amp max.

1.2.6.3 POWER ENTRY MODULE

Includes ON/OFF switch, fuse (1 Amp @ 250 VAC) and AC filter.

1.2.6.4 MICRO BOARD

The micro board supports a Motorola 68302 micro-controller, EPROM, EEPROM, 128k x 16 bit NVRAM, 8 Mbit flash memory; RS232 and IEEE-488.2 communications; keypad and display control. An I/O port controls other ports and devices within MFC-CB.

1.2.6.5 MAIN BOARD

The main board is controlled by the micro board (see Section 1.2.6.4). The main board supports the drivers for the 12 V external drivers, MFC/MFM voltage supply, MFC/MFM control signal input and output.

2. INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 REMOVING FROM PACKAGING

MFC-CB is delivered, along with its standard accessories, in a corrugated container with polyurethane inserts to hold it in place.

Remove the MFC-CB and its accessories from the shipping container and remove each item from its protective plastic bag.

2.1.2 INSPECTING CONTENTS

Check that all items are present and have no visible damage.

An MFC-CB is delivered complete with:

Table 1. MFC-CB Delivery List

DESCRIPTION	PART #
MFC-CB Mass Flow Control Box	401710 or 401710-CE
Report of Calibration	550100
ACCESSORIES	
Operation and Maintenance Manual	550123
Power Cord (7.5 ft.)	100770 or 100770-CE
(2) MFC Cable and Connections Kit	401230 or 401230-CE
molbox1/MFC-CB Analog Calibration Cable	401256
Drivers Connector	401635 (optional)
General Accessories Disk (Important: Includes system support software and documentation)	102987

2.2 SITE REQUIREMENTS

Install MFC-CB on any stable surface at a convenient height. The front feet are extendible so that the unit can be inclined for easier viewing.

MFC-CB can also be mounted in a standard 19-in. rack using the optional rack mount kit (P/N 401465). For additional information, contact your **DHI** Sales Representative.

If the MFC-CB will be used with an optional **DHI** MFC Switchbox, consider placement of the Switchbox and the connection and disconnection of MFC cables (see Section 3.4.6, Figure 5).

2.3 INITIAL SETUP

2.3.1 PREPARING FOR OPERATION

No special preparation of MFC-CB is required prior to putting it into operation.

Connect the power cord supplied to the MFC-CB and to a power source.

2.3.2 MFC-CB TO MFC OR MFM CONNECTION

Prepare an MFC-CB to MFC or MFM cable using one of the kits provided with the MFC-CB (see Section 7.2 for information on cable pin out) or an optional preassembled cable if you have one.

Connect the MFC-CB to MFC/MFM cable to the DEV1 or DEV2 25 pin DSUB connection on the MFC-CB rear panel.

If you are using an optional MFC Switchbox, connect the Switchbox to the DEV1 or DEV2 MFC-CB rear panel connection and then connect the MFC or MFM to the MFC Switchbox (see the MFC Switchbox User's Manual and Section 3.4.6, Figure 5).

2.4 POWER UP AND VERIFICATION

2.4.1 POWER UP

Turn ON the MFC-CB rear panel main power switch. Observe the front panel display as MFC-CB initializes, error checks and goes to the MAIN run screen (see Section 3.1.1).

The front panel ON/OFF key controls a SOFT ON/OFF (see Section 3.1.2.3). This allows MFC-CB's front panel to be turned off while maintaining the power supply to devices that are connected to it.

If the MFC-CB fails to reach the MAIN run screen, service may be required. Record the sequence of operations and displays observed and contact a **DHI** Authorized Service Provider.

2.4.2 CHECK/SET SECURITY LEVEL

MFC-CB has a security system based on user levels. By default, the security system is set to "low", which includes certain access restrictions, and there is no password required to change the security level. See Section 3.4.2 and Table 4 for information on the security level system. As part of the MFC-CB startup, set your desired security level and a password.

MFC-CB is delivered with the security level set to low to avoid inadvertent altering of critical internal settings but with access to changing security levels unrestricted. It is recommended that the low security level be maintained at all times and password protection be implemented if control over setting of security levels is desired.

NOTES

3. OPERATION

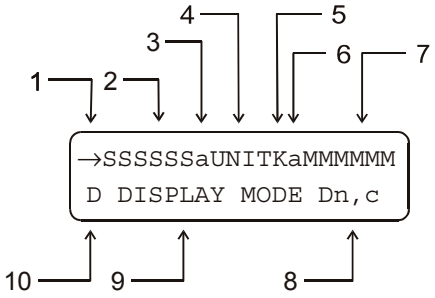
3.1 GENERAL MANUAL OPERATION

MFC-CB is designed to offer the optimum balance between simple, intuitive operation and the availability of a variety of functions with a high level of operator discretion. The local operator interface is through the front panel's 2 x 20 character alpha-numeric display and a 4 x 4 multi-function keypad.

3.1.1 MAIN RUN SCREEN

The MFC-CB MAIN run screen is its home display that is reached on power up and from which other functions and menus are accessed. It is the top level of all menu structures.

The MAIN run screen is where the MFC-CB is left in normal operation. It displays the set point output, if applicable, and the measurement from the MFC or MFM as well as a variety of additional information if desired.



1. **<→>** Active channel indication in DEV1&2 DISPLAY mode (see Section 3.2.4.1). Blank if not in DEV1&2 DISPLAY mode.
2. **<SSSSSS>**: Numerical value and sign of the set point (see Section 3.2.8).
3. **<a>**: Indicates whether a user adjustment is being applied to the set point (see Section 3.3.5). **<a>** if an adjustment is being applied, blank if no adjustment is being applied.
4. **<UNIT>**: Unit of measure of the set point and measurement numerical values (see Section 3.2.2).
5. **<K>**: Indicates whether a gas correction factor (*K factor*) is being applied (see Section 3.2.1). **<K>** if a factor is being applied, blank if no factor is being applied.
6. **<a>**: Indicates whether a user adjustment is being applied to the measurement value (see Section 3.3.5). **<a>** if an adjustment is being applied, blank if no adjustment is being applied.
7. **<MMMMMM>**: Numerical value of the measurement from the MFC or MFM.
8. **<Dn,c>**: Indicates which device channel is being displayed on the top line of the display. **<n>** is **<1>** for DEV1, **<2>** for DEV2. **<c>** indicates the current channel of the MFC Switchbox if a Switchbox is connected to DEVn, blank if no Switchbox is in use (see Section 3.4.6).
9. **<DISPLAY MODE DATA>**: Information displayed depends on current DISPLAY mode (see Section 3.2.4).

10. **<D>**: Indication of what is being displayed on the bottom line of the display as set by the DISPLAY function (see Section 3.2.4). Possible indications include:
    - **<→>**: Current DISPLAY mode is DEV1&DEV2 (see Section 3.2.4.1) and the active device channel is DEV2. The arrow is on the first line if the active device channel is DEV1.
    - **<Σ>** and far right of bottom line is Dn + Dn: Current DISPLAY mode is SUM (see Section 3.2.4.2).
    - **<Δ>** and far right of bottom line is Dn - Dn: Current DISPLAY mode is DIF (see Section 3.2.4.3).
    - **<blank>** and far right of bottom line is Dn/Dn: Current DISPLAY mode is RATIO (see Section 3.2.4.4).
    - **Blank, and no characters other than Dn on bottom line**: Current DISPLAY mode is CLEAN (see Section 3.2.4.5).

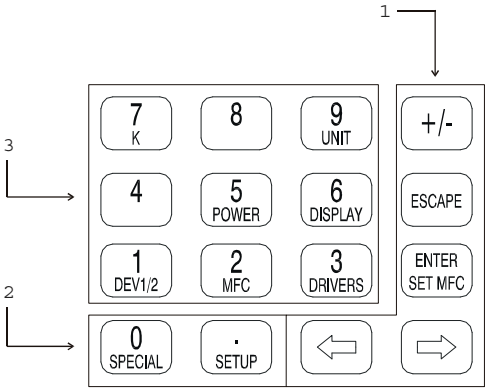
*When a number is too large to show in the allocated display space, MFC-CB displays <********>.*

MFC-CB has a SCREEN SAVER function that causes the display to dim if no key is pressed for 10 minutes. Pressing a key restores full power to the display. The screen saver activation time can be changed or screen saving can be completely suppressed (see Section 3.4.3.1).

3.1.2 GENERAL OPERATING PRINCIPLES

3.1.2.1 KEYPAD LAYOUT AND PROTOCOL

MFC-CB has a 4 x 4 keypad for local operator access to direct functions, function menus and for data entry.



1. The Editing and Execution keys are for execution, suspending execution, backing up in menus and editing entries.
2. The Menu/Data keys provide access to function menus from the MAIN run screen. The menu name is on the bottom half of the key. The SETUP menu is for more frequently used functions. The SPECIAL menu is for functions that are not generally used as a part of day to day operation. These keys enter numerical values when editing.
3. The Function/Data keys allow very commonly used functions to be accessed directly from the MAIN run screen by a single keystroke. The name of the function is on the bottom half of the key (see Section 3.1.2.5). These keys enter numerical values when editing.

Figure 4. MFC-CB Keypad Layout

Key press confirmation is provided by both tactile and audible feedback. A single beep confirms a valid entry. A descending two note tone signals an invalid entry. The audible entry feedback can be suppressed or modified (see Section 3.4.3.2).

Pressing the **[ENTER]** key generally causes execution or forward movement in the menu tree.

Pressing the **[ESCAPE]** key generally allows movement back in the menu tree and/or causes execution to cease or suspend without changes being implemented. Pressing **[ESCAPE]** repeatedly eventually returns to the MAIN run screen. From the MAIN run screen, pressing **[ESCAPE]** allows momentary viewing of the MFC-CB identification screen.

Pressing the **[+/-]** key changes a numerical sign when editing. From the MAIN run screen, it provides a momentary view of the active MFC profile (see Section 3.3.1).

Pressing the **[←]** and **[→]** keys allows reverse and forward cursor movement when editing data entry. These keys are also used to scroll through choices. When in the MAIN run screen, they are used by the JOG function to increment the MFC set point up and down (see Section 3.2.9).

Menu selections can be made by pressing the number of the selection directly or by pressing **[←]** or **[→]** to place the cursor on the number of the desired selection and pressing **[ENTER]**.

Some screens go beyond the two lines provided by the display. This is indicated by a flashing down arrow in the second line of the display. Press [←] and [→] to move the cursor to access the lines that are not visible or directly enter the number of the hidden menu choice if you know it.

3.1.2.2 SOUNDS

MFC-CB is equipped with a variable frequency tone device to provide audible feedback and alarms. Sounds are used for the following indications:

Valid key press: Brief beep. Choice between three frequencies or NO sound is available (see Section 3.4.5.2).

Invalid key press: Descending two tone “blurp”. Choice of NO sound is available (see Section 3.4.5.2).

3.1.2.3 SOFT [ON/OFF] KEY

MFC-CB is equipped with a SOFT **[ON/OFF]** key and indicator LED on the bottom left hand corner of the front panel. The purpose of the SOFT ON/OFF key is to put MFC-CB into a dormant mode in which the display is turned OFF.

When MFC-CB is SOFT OFF, power is still supplied to DEV1 and DEV2 and the MFC set points are maintained if the rear panel main power switch is on.

When MFC-CB is ON, the ON/OFF indicator is ON continuously. When MFC-CB is SOFT OFF and the main power switch is on, the ON/OFF indicator blinks every 5 seconds.

When MFC-CB is SOFT OFF, receiving a remote command turns it ON.

3.1.2.4 ACTIVE DEVICE CHANNEL INDICATION

The MFC-CB active device channel (DEV1 or DEV2) is the channel whose set point and measurement values are displayed on the top line of the MFC-CB display. The characters on the bottom right hand corner of the display (**<D1>** or **<D2>**) indicate which channel is currently active. The active channel is the channel that is affected by all channel specific settings and adjustments.

Channel specific MFC-CB settings include:

- **[K]** (see Section 3.2.1).
- **[UNIT]** (see Section 3.2.2).
- **[MFC]** (see Section 3.2.6).
- **[SETUP]**, **<2jog>** (see Section 3.3.2).
- **[SETUP]**, **<5adj>** (see Section 3.3.5).
- **[SET MFC]** (see Section 3.2.8).

Regardless of which channel is currently active from the display, both DEV1 and DEV2 are always active in the sense that their set point is maintained.

3.1.2.5 DIRECT FUNCTION KEYS SUMMARY

Local operation of MFC-CB is through the front panel, 4 x 4, pressure sensitive keypad. To minimize the use of multi-layered menu structures, the keypad numerical keys also provide direct access to commonly used functions. The function accessed is labeled on the bottom half of the each key. Direct function keys are active whenever MFC-CB is in its MAIN run screen. Table 2 summarizes the operation of the direct function keys. See the corresponding manual sections for full detail on each direct function.

It may be useful to keep a copy of Table 2 near the MFC-CB, especially when first becoming acquainted with its operation.

Table 2. Summary of MFC-CB Direct Function Key Operation

Direct Function Keys are active from the MAIN run screen See corresponding manual sections for full detail	
. SETUP	Menu of commonly used setup features including creating and editing MFC profiles, adjusting set point jog value and display resolution.
0 SPECIAL	Menu of less frequently used internal functions and settings including resets, user preferences, internal calibration, remote interface setup and Switchbox setup.
1 DEV1/2	Toggle active device channel between DEV1 and DEV2.
2 MFC	Select MFC profile which sets V or mA operation and the electrical signal to flow unit relationship.
3 DRIVERS	Turn ON and OFF MFC-CB's optional 12 V drivers.
5 POWER	Display the set point unaltered by K and/or adjustment values and the valve test point.
6 DISPLAY	Define the DISPLAY function for the second line of the MFC-CB display. Choices include DEV1&2, sum, difference, ratio, 2nd unit, clean.
7 K	Set/change an MFC gas correction factor (*K factor*).
9 UNIT	Set point and measure unit (electrical, %FS, flow).
+/-	View a summary of the active MFC profile for the active channel (DEV1 or DEV2).
ENTER SET MFC	Enter a set point to output on the active device channel.
← **→**	Jog the set point up or down.

3.2 DIRECT FUNCTION KEYS

3.2.1 [K]

PURPOSE

To specify a gas measurement conversion factor, *K*, to be applied to the active device channel when using and MFC or MFM calibrated with one gas to set and/or measure the flow of another gas.

PRINCIPLE

MFCs and MFMs respond differently to different gas species due the different specific heats of the gases and different behavior in the device. Therefore, the calibration of an MFC or MFM with one gas may not be valid with another gas. MFC manufacturers often provide gas conversion factors, known as K factors, to convert an MFC from the gas it was calibrated with to another gas.

The MFC-CB's K function allows the device manufacturer's K factor to be entered and applied to the active channel so that set points and measurement values are automatically adjusted by the K factor. This feature can be useful when using an MFC calibrated with one gas to control or measure a different gas.

MFC-CB applies the K factor only when the unit of measure is a flow unit. When the unit of measure is an electrical unit (V or mA) or %FS, the K factor has no effect.

See Section 7.1.1 for details on the calculations used to apply the K factor.

When using MFC-CB in conjunction with a molbox/molbloc mass flow standard to calibrate or verify an MFC, the K factor function of the MFC-CB is NOT normally used. K factors are applied to the molbox measured flow to simulate a process gas with a surrogate gas (see the molbox Operation and Maintenance manual Section concerning K factors).

OPERATION

To enable a *gas conversion factor* press **[K]** from the MAIN run screen. The display is:

```
K factor: (1.0000)
1off 2on          D1
```

If **<2off>** is selected, no conversion factor will be applied. If **<1on>** is selected, the next screen is:

```
K factor:
1.00000           D1
```

The value of the *gas conversion factor* can be edited as desired. Press **[ENTER]** to return to the MAIN run screen with the entered *K factor* active. **The K factor is only used if the current unit of measure is a flow unit (see Section 3.2.2). The letter <K> is always appended to the flow unit indication in the run screens when the K function is ON (e.g., sccmK).**

Turning K ON or OFF or making a change to the K factor value resets the active device channel output to zero.

K factor ON/OFF and the K factor value are device channel specific (DEV1, DEV2). Settings made for one device channel do not affect the other channel.

3.2.2 [UNIT]

PURPOSE

To specify the unit of measure in which MFC-CB displays set points and measured values on the active device channel.

PRINCIPLE

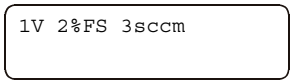
MFC-CB operates in either volts (V) or milliamps (mA). It also converts V or mA to flow values using a simple linear relationship between the voltage or current range and the flow range in a flow unit (see Section 7.1.2).

The electrical mode and range in which to operate as well as the flow unit and the flow unit range are specified by the active MFC profile for each device channel (see Section 3.3.1).

The units of measure available to display MFC-CB set points and measurements are V or mA, %FS and a flow unit if the MFC profile specifies a flow unit. MFC profiles #1 and #2 are factory default profiles that do not specify a specific flow range. MFC profile #1 specifies operation from 0 to 5 V and MFC profile #2 specifies operation from 4 to 20 mA. When using profile #1 or #2, no flow unit is available.

OPERATION

To change the unit of measure press **[UNIT]**.
The display is:



Select the desired unit of measure. Operation returns to the MAIN run screen with the display unit changed to the selected unit.

The flow unit available under [UNIT] is determined by the MFC profile active for the device channel. When using MFC profile #1 or #2, no flow unit is available as none is specified by the profile. To work in a flow unit, set up and use a custom MFC profile (see Section 3.3.1). MFC profile #1 is 0 to 5 V. MFC profile #2 is 4 to 20 mA.

The UNIT function is device channel specific. The unit setting for one device channel does not affect the other device channel.

3.2.3 [POWER]

PURPOSE

To display of the set value unaltered by K or adjustment values and to display the valve test point.

PRINCIPLE

The electrical value actually output by MFC-CB in response to a set point entry may be different from the set point value due to the application of a K factor (see Section 3.2.1) and/or an adjustment factor (see Section 3.3.5). See Section 7.1.1 for details on the calculation of the actual set point. The **[POWER]** screen displays the actual electrical value output by MFC-CB in response to a set point input.

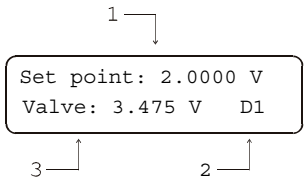
Some mass flow controllers allow access to a valve test point voltage measurement to assist in troubleshooting the MFC's operation. MFC-CB can measure and display the valve test point voltage. A display of this value is available by pressing the **[POWER]** function key.

The valve test point is always in Volts (V), even for an MFC whose set point and flow measurement are in current (mA.).

For MFC-CB to display the valve test point, the MFC being used must support valve test point measurement and be properly connected to the MFC-CB. Refer to the MFC manufacturer's documentation for information on the valve test point and to Section 7.2 for information on MFC-CB DEV1 and DEV2 connections and pin outs.

OPERATION

To display the set point and MFC valve test point press **[POWER]** from the run screen. The display is:



1. Actual set point for active device channel.
2. Active device channel indicator.
3. Current valve test point reading.

Press **[ESCAPE]** or **[ENTER]** to return to the MAIN run screen.

The POWER run screen displays the actual MFC set point which may be different from the entered set point due to the application of a K factor and/or adjustment factors (see Section 7.2).

The POWER screen is a run screen from which other functions can be accessed. For example, while in the POWER screen, press [SET MFC] to change the MFC set point, [DEV1/2] to change device channels or [MFC] to select a new MFC profile.

3.2.4 [DISPLAY]

PURPOSE

To select, from a variety of choices, the information that is displayed on the second line of the MFC-CB display.

PRINCIPLE

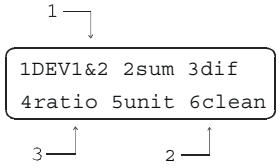
MFC-CB supports a variety of advanced DISPLAY functions that are displayed on the bottom line of the MFC-CB display. The available DISPLAY functions are:

- **DEV1&2** (see Section 3.2.4.1): Displays both device channels simultaneously with DEV1 always on the top line and DEV2 always on the bottom line. This function can be useful when working with two MFCs simultaneously.
- **SUM** (see Section 3.2.4.2): Displays the sum of the two device channel measurements. Requires that DEV1 and DEV2 be set to the same unit of measure. This function can be useful to view the combined flow of two MFCs.
- **DIF** (see Section 3.2.4.3): Displays the difference between the inactive device channel and the active device channel measurements (inactive channel-active channel). Requires that DEV1 and DEV2 be set to the same unit of measure. This function can be useful to view the difference between two flow rates.
- **RATIO** (see Section 3.2.4.4): Displays the ratio of the inactive device channel measurement and the active device channel measurement (inactive channel/active channel). Requires that DEV1 and DEV2 be set to the same unit of measure. This function can be useful to view the ratio of two flow rates.
- **UNIT** (see Section 3.2.4.5): Allows the current device channel measurement to be viewed in two of its available units of measure simultaneously. This function can be used to display the MFC sensor's electrical output and corresponding flow rate simultaneously.
- **CLEAN** (see Section 3.2.4.6): Blanks out the second line of the display except for the active device channel indicator. This function is used when only a simple display of set point and measurement for the active device channel with no other information is wanted. The CLEAN DISPLAY is MFC-CB's default display.

OPERATION

To select a DISPLAY function, press **[DISPLAY]** from the MAIN run screen.

The display is:



The cursor is on the active DISPLAY function. Selecting a DISPLAY function returns to the run screen with the selected DISPLAY function active.

See PRINCIPLE above and Sections 3.2.4.1 through 3.2.4.6 for details on each DISPLAY function.

The default DISPLAY function is CLEAN which causes the second line of the display to be empty except for the active device channel indicator at the far right (see Section 3.1.1).

3.2.4.1 <1DEV1&2>

- **PURPOSE**

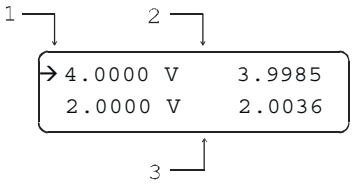
  To view both MFC-CB device channels simultaneously.

  See Section 3.2.4, PRINCIPLE.

- **OPERATION**

  To activate the DEV1&2 DISPLAY, press **[DISPLAY]** and select **<1DEV1&2>.** Selecting **<1DEV1&2>** returns to the MAIN run screen with the DEV1&2 DISPLAY active.

  With the DEV1&2 DISPLAY active, the MAIN run screen is:



1. Active device channel indicator.
2. Standard set point and measurement line for DEV1.
3. Standard set point and measurement line for DEV2.

DEV1 is always on the top line and DEV2 is always on the bottom line, regardless of which device channel was active when the DEV1&2 DISPLAY was selected. The device channel indicator **<→>** indicates which device channel is active for set point changes and other functions. Press **[DEV1/2]** to toggle the active device channel indicator between DEV1 and DEV2.

To go to a DISPLAY other than DEV1&2, press [DISPLAY] and make a new DISPLAY choice.

3.2.4.2 <2SUM>

- **PURPOSE**

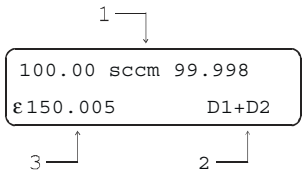
To display the sum of DEV1 and DEV2 measurement values.

See Section 3.2.4, PRINCIPLE.

- **OPERATION**

To activate the SUM DISPLAY, press **[DISPLAY]** and select **<2sum>**. To reach the SUM DISPLAY, it is required that DEV1 and DEV2 be set in the same unit of measure. If the SUM DISPLAY is attempted while the unit of measure on the two device channels is not the same, an error message displays. In this case, set both channels to the same unit of measure and retry.

With the SUM DISPLAY active the MAIN run screen is:



1. Standard MAIN run screen top line for the active device channel.
2. Indication of sum calculation, the active device channel is to the right.
3. Sum of DEV1 and DEV2 measurements.

While in the SUM DISPLAY, changing the unit of measure causes the display to revert back to the CLEAN DISPLAY. This can happen by making a unit change using **[UNIT]** or by selecting a new MFC profile using **[MFC]**.

To switch the SUM DISPLAY from D2 + D1 to D1 + D2 and vice versa, change the active channel by pressing [DEV1/2].

To go to a DISPLAY other than SUM, press [DISPLAY] and make a new DISPLAY choice.

3.2.4.3 <3DIF>(DIFFERENCE)

- **PURPOSE**

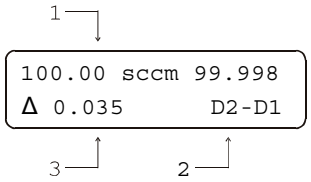
To display the difference between the measurement of the inactive device channel and of the active device channel.

See Section 3.2.4, PRINCIPLE.

❍ **OPERATION**

To activate the DIF DISPLAY, press **[DISPLAY]** and select **<3dif>**. To reach the DIF DISPLAY, it is required that DEV1 and DEV2 be set in the same unit of measure. If the DIF DISPLAY is attempted while the unit of measure on the two device channels is not the same, an error message appears. In this case, set both channels to the same unit of measure and retry.

With the DIF DISPLAY active, the MAIN run screen is:



1. Standard MAIN screen top line for the active device channel.
2. Indication of difference calculation formula, the active device channel is to the right.
3. Difference of the inactive and active device channel measurements.

While in the DIF DISPLAY, changing the unit of measure causes the display to revert back to the CLEAN DISPLAY. This can happen by making a unit change using **[UNIT]** or by selecting a new MFC profile using **[MFC]**.

To switch the DIF DISPLAY from D2 – D1 to D1 – D2 and vice versa, change the active channel by pressing [DEV1/2].

To go to a DISPLAY other than DIF, press [DISPLAY] and make a new DISPLAY choice.

3.2.4.4 <4RATIO>

❍ **PURPOSE**

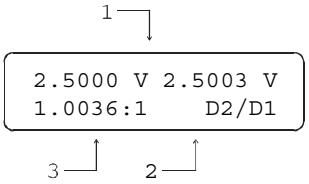
To display the ratio of the measurements of the inactive device channel and the active device channel.

See Section 3.2.4, PRINCIPLE.

❍ **OPERATION**

To activate the RATIO DISPLAY, press **[DISPLAY]** and select **<4ratio>**. To reach the RATIO DISPLAY, it is required that DEV1 and DEV2 be set in the same unit of measure. If the RATIO DISPLAY is attempted while the unit of measure on the two device channels is not the same, an error message appears. In this case, set both channels to the same unit of measure and retry.

With the RATIO DISPLAY active, the MAIN run screen is:



1. Standard MAIN screen top line for the active device channel.
2. Indication of ratio calculation formula, the active device channel is to the right.
3. Ratio of the inactive and active device channel measurements.

While in the RATIO DISPLAY, changing the unit of measure causes the display to revert back to the CLEAN DISPLAY. This can happen by making a unit change using **[UNIT]** or by selecting a new MFC profile using **[MFC]**.

To switch the RATIO DISPLAY from D2/D1 to D1/D2 and vice versa, change the active channel by pressing [DEV1/2].

To go to a DISPLAY other than RATIO, press [DISPLAY] and make a new DISPLAY choice.

3.2.4.5 <5UNIT>

- **PURPOSE**

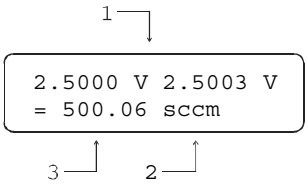
To display the measurement of the active device channel in two different units of measure.

See Section 3.2.4, PRINCIPLE.

- **OPERATION**

To activate the UNIT DISPLAY, press **[DISPLAY]** and select **<5unit>**. The unit of measure to use for the second line of the MAIN run screen display is then selected. The unit selection process is identical to that of the **[UNIT]** function key (see Section 3.2.2). Once the unit has been selected, operation returns to the MAIN run screen with the UNIT DISPLAY active.

With the UNIT DISPLAY active the MAIN run screen is:



1. Standard MAIN run screen top line.
2. Alternate unit of measure selected for UNIT DISPLAY.
3. Equivalent of the measurement in the alternate unit of measure.

When the UNIT DISPLAY is selected on the active device channel, the UNIT DISPLAY is also used for the other device channel if possible. When changing device channels, the same unit types are used. If the UNIT DISPLAY setting on the active device channel was for "electrical unit = flow unit", the display of the new channel will be "electrical unit = flow unit". If a required unit type is not available (for example there is no flow unit because the current MFC profile is a factory default profile) the display defaults to the CLEAN DISPLAY.

To go to a DISPLAY other than UNIT, press [DISPLAY] and make a new DISPLAY choice.

3.2.4.6 <6CLEAN>

- **PURPOSE**

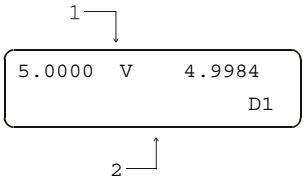
To activate the CLEAN DISPLAY.

See Section 3.2.4, PRINCIPLE.

- **OPERATION**

To activate the CLEAN DISPLAY press **[DISPLAY]** and select **<6clean>**. Selecting **<6clean>** returns to the MAIN run screen with the CLEAN DISPLAY active.

With the CLEAN DISPLAY active, the MAIN run screen is:



1. Standard MAIN run screen top line.
2. "Clean" second line.

To go to a DISPLAY other than CLEAN, press [DISPLAY] and make a new DISPLAY choice.

3.2.5 [DEV1/2]

- **PURPOSE**

To toggle the active device channel between DEV1 and DEV2.

- **PRINCIPLE**

MFC-CB has two analog device channels designated DEVICE 1 and DEVICE 2 (DEV1 and DEV2) (see Section 3.1.2.4). Both channels are always active in the sense that their set points are maintained and they continuously measure.

However, one device channel is considered active from the standpoint of various displays and as the device channel to which a variety of channel specific settings, adjustments and functions apply. The active device channel is always indicated by the active device channel indicator at the bottom right hand corner of the display (D1 or D2). An exception is the DEV1&2 DISPLAY (see Section 3.2.4.1) in which the two channels are displayed simultaneously, one on each display line, and the active channel is indicated by an arrow in the far left character of the line.

[DEV1/2] is used to switch active device channels.

Do not confuse the MFC-CB DEVICE 1 and DEVICE 2 channels with the five (5) channels available on the optional MFC Switchbox. The MFC Switchbox allows MFC-CB DEVICE 1 or DEVICE 2 to be directed to one of five continuously powered Switchbox channels (see Section 3.4.6).

- **OPERATION**

To switch the MFC-CB active channel press **[DEV1/2]** from any run screen.

If an MFC Switchbox is connected and active on MFC-CB DEV1 or DEV2, use [MFC] to switch channels on the Switchbox (see Sections 3.2.6 and 3.4.6).

3.2.6 [MFC]

- **PURPOSE**

To select the MFC profile for the active MFC-CB device channel. Also specifies the MFC Switchbox channel to use if an optional MFC Switchbox is connected to the active MFC-CB device channel (see Section 3.4.6).

- **PRINCIPLE**

MFC-CB is a two channel analog input/output device designed to apply electrical set points and read back sensor output from mass flow controllers (MFC) and mass flow meters (MFM). MFC-CB can set and read voltage or current. When it has the necessary information, it can also convert voltage or current linearly to a flow unit.

Whether MFC-CB operates in voltage or current and how electrical values are converted to flow values is determined by information contained in an **MFC Profile**. There are two default MFC profiles, one for voltage (#1) and one for current (#2) that do not specify a unit of flow. Customized MFC profiles (up to 97 additional) may be created by the user that specify electrical signal, electrical range, flow unit and flow range (see Section 3.3.1).

[MFC] is used to select the **MFC Profile** for the active MFC-CB device channel. When an optional MFC Switchbox is connected and activated on the current device channel, **[MFC]** also specifies which Switchbox channel to use (see Section 3.4.6).

❍ **OPERATION**

To select the MFC profile for the active MFC-CB device channel, press **[MFC]** from the run screen.

If an optional MFC Switchbox is connected and active on the active MFC-CB device channel (see Section 3.4.6), when **[MFC]** is first pressed the screen prompts the operator:

```
Select MFC Switchbox
channel: 1          D1
```

Enter Switchbox channel **<1>**, **<2>**, **<3>**, **<4>** or **<5>** as desired.

If an MFC Switchbox is NOT being used, the first display is:

```
Select MFC profile:
        # 3
```

The number refers to the MFC profile number (see Section 3.3.1, PRINCIPLE). The profile number shown is the last profile number used. Edit the profile number to the desired profile and press **[ENTER]**. When the profile number is entered, a summary of the profile is displayed. Press **[ESCAPE]** to back up and select a different profile. Press **[ENTER]** to return to the run screen with the selected MFC profile active.

MFC-CB cannot operate with a different type of electrical signal on its two device channels. Selecting an MFC profile whose electrical signal is different for the electrical signal active on the other channel prompts a warning that confirming the profile will cause the other channel to switch to the default factory profile that specifies the same electrical signal as the profile being selected (#1 for voltage, #2 for current).

MFC profiles #1 and #2 are factory default profiles. #1 is for 0 to 5 V operation and #2 is for 4 to 20 mA operation. These do not support operation in a flow unit. If you have not yet set up any custom profiles, use profile #1 or #2 to operate. To set up custom MFC profiles that include flow units, see Section 3.3.1.

Pressing [+/-] from a run screen causes an instant display of a summary of the MFC profile that is active on the active device channel. This can be used for a quick check of the characteristics of the currently active MFC profile.

MFC profile selections made using [MFC] are device channel specific. The set point entered on one device channel does not affect the other channel.

3.2.7 [DRIVERS] (OPTIONAL)

- **PURPOSE**

To control the output signals of MFC-CB's eight (8), 12 V external drivers.

- **PRINCIPLE**

MFC-CB external drivers are available to drive peripheral equipment, for example solenoid valves, in a system that includes MFC-CB. The driver electrical connections are available from a rear panel connector.

See Section 7.3 for driver specifications and pin outs.

- **OPERATION**

To access the driver control function press **[SETUP]** and select **<4drivers>**.

The display is:

```
External drivers:  1
2  3  4  5  6  7  8
```

Pressing the keypad numerical key driver number turns that driver ON and OFF with either a momentary or a toggled response (see next paragraph). An active driver is indicated by **<*>** immediately following the driver number.

Pressing **[ENTER]** while in the **<External drivers>** menu causes a menu to appear that allows selection of whether the driver actuation will be **<1momentary>** or **<2toggle>**.

3.2.8 [SET MFC]

- **PURPOSE**

To enter a set point value for MFC-CB to output on the active device channel (DEV1 or DEV2).

- **PRINCIPLE**

MFC-CB outputs and reads electrical signals on its two device channels, DEV1 and DEV2. The value to output (the MFC set point) can be specified remotely or by front panel entry using **[SET MFC]**.

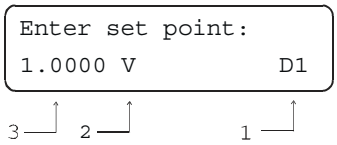
The set points unit of measure is determined by the unit selected using **[UNIT]** (see Section 3.2.2). When set point entry is in a flow unit, the flow unit is converted to an electrical value using the electrical and flow range information in the active MFC profile. The conversion of a flow value to an electrical value is by a simple linear relationship between the flow range and the electrical range (see Section 7.1.2).

Set point and measured values can be affected by the K factor setting (see Section 3.2.1) and/or the use of the adjustment function (see Section 3.3.5).

In addition to using **[SET MFC]**, the set point value can also be adjusted incrementally from the run screen using the jog function (see Section 3.2.9).

OPERATION

To enter a set point for the active device channel, press **[SET MFC]** from the run screen. The display is:



1. Active device channel indicator.
2. Unit of measure.
3. Entry field for set point value. Defaults to last entry or zero.

Use the numerical and editing keys to enter the set point value desired. Press **[ENTER]** when the desired set point is displayed to return to the run screen with the new set point active.

If the set point value entered results in an out of range electrical output value, MFC-CB displays an error message. Press [ESCAPE] or [ENTER] to return to the <Enter set point:> screen and enter a valid set point value. Consider that a set point that appears valid may cause an out of range condition due to the application of a K factor or adjustment value (see Sections 3.2.1, 3.3.5 and 7.1.1).

If the active MFC profile is not a controller, an error message appears when a set point value is entered. To enter set point values, use MFC profile #1 (for V) or #2 (for mA) or set up and select an MFC profile for a controller (see Section 3.3.1).

The set point value may be adjusted incrementally directly from the run screen using the [←] or [→] keys to "jog" the set point (see Section 3.2.9).

To view a summary of the active MFC profile, press [+/-] from the run screen.

Set point entries are device channel specific. The set point entered on one device channel does not affect the other device channel.

3.2.9 [←] AND [→] (JOG MFC SET POINT)

PURPOSE

To adjust (jog) the MFC set point by a small value directly from the run screen, rather than by entering a new set point using **[SET MFC]**.

See Section 3.3.2 for information on setting the jog increment values.

PRINCIPLE

MFC-CB set points are entered using **[MFC]**. In some cases, it can be useful to adjust or trim the set point slightly, directly from the run screen without going through set point entry.

The MFC-CB jog function makes it easy to adjust the set point slightly. Pressing the **[←]** or **[→]** key when in the MAIN run screen causes the set point value to increase or decrease by the amount specified in **[SETUP]**, **<2jog>** (see Section 3.3.2).

Use [SET MFC] to enter a new set point (see Section 3.2.8).

OPERATION

The MFC set point value can be jogged from the MAIN run screen or from the POWER screen.

To jog the set point, press **[←]** to decrease the value or **[→]** to increase the value.

Each time **[←]** or **[→]** is pressed, the set point value is adjusted up or down by the value specified in **[SETUP]**, **<2jog>** (see Section 3.3.2).

Use **[SET MFC]** to enter a completely new set point (see Section 3.2.8).

See Section 3.3.2 for information on setting the jog increment values.

3.3 [SETUP]

PURPOSE

To access a menu of commonly used MFC-CB functions and features that DO NOT have direct function keys.

PRINCIPLE

The **[SETUP]** key accesses a menu of commonly used MFC-CB functions and features that do NOT have direct function keys. These functions include:

- **MFC** (see Section 3.3.1): To create, store and edit the MFC profiles available for selection from **[MFC]**.
- **jog** (see Section 3.3.2): To adjust the set point jog increment value.
- **res** (see Section 3.3.3): To adjust the resolution of MFC-CB set point and measurement displays.
- **flowU** (see Section 3.3.4): To customize the flow unit choices available when setting up MFC profiles.
- **adj** (see Section 3.3.5): To adjust the MFC set points and/or measurements by an *adder* and/or a *multiplier*.

OPERATION

To access the SETUP menu, press **[SETUP]** from the run screen. The display is:

```
1MFC 2jog 3res
4flowU 5adj
```

Select the desired SETUP function.

See PRINCIPLE above and Sections 3.3.1 to 3.3.5 for details on each SETUP function.

3.3.1 <1MFC> (EDIT MFC PROFILES)

PURPOSE

To create, store and edit the MFC profiles available for selection from **[MFC]** (see Section 3.2.8).

PRINCIPLE

MFC profiles specify the electrical signal type and range and flow unit type and range in which MFC-CB operates. MFC profiles are set up using **[SETUP]**, **<1MFC>**. The MFC profile to use is selected using **[MFC]** (see Section 3.2.6).

MFC profiles are stored under profile numbers. The profile numbers available are 1 to 99.

MFC profiles #1 and #2 are factory default profiles that cannot be edited. #1 is 0 to 5 V, #2 is 4 to 20 mA. These profiles do not specify a flow unit or range and therefore do not allow operation in a unit of flow.

MFC profiles number 3 to 99 are available for user set up using **[SETUP]**, **<1MFC>**. In custom profiles, a flow unit and range are specified so that MFC-CB can convert between electrical values and flow values and support set point entry and measurement display in a flow unit.

OPERATION

To create or edit an MFC profile, press **[SETUP]**, **<1MFC>**.

The display is:

```
Edit MFC profile:
        # 3
```

Select the profile number to edit and press **[ENTER]**.

MFC profiles #1 and #2 are factory default profiles for working in electrical or %FS units only. They cannot be edited. Profile #1 is 0 to 5 V, profile #2 is 4 to 20 mA.

The next display is:

```
Signal type:
1voltage   2current
```

Select the analog signal type of the MFC or MFM.

The next display is used to enter the full scale voltage or current. Enter the full scale voltage or current of the device and press **[ENTER]**. If configuring a current (mA) electrical type MFC, you will also be prompted to enter the 0 flow current output value which must be 4 mA or greater. MFC-CB does not support mixed current/voltage MFCs.

The next selection specifies the flow unit of measure for this MFC profile. The choice of units available in this screen can be customized using **[SETUP]**, **<4flowU>** (see Section 3.3.4).

```
1sccm 2slm 3mg/s
4mol/s 5sm3h 6scfh
```

After the flow unit of measure has been selected the display prompts for the flow range. Enter the numerical value of full scale of the MFC or MFM in the flow unit.

```
Enter range:
100.00 sccm
```

The next selection specifies whether the device is a mass flow meter only (MFM) or a mass flow controller (MFC). Choose **<1measure>** if the device for this profile measures only, choose **<2control>** if the device measures and controls flow.

```
Device type
1measure 2control
```

Once the device type has been selected, editing is complete and a prompt to edit the next profile number is presented. Enter another profile number to edit if desired. Pressing **[ESCAPE]** goes to **<Select MFC profile:>**. Pressing **[ESCAPE]** again returns to the run screen.

To clear/reset all MFC profiles, except the #1 and #2 factory default profiles, use [SPECIAL], <1reset>, <3MFC> (see Section 3.4.1.3).

3.3.2 <2JOG>

PURPOSE

To adjust the increment by which one key press adjusts the set point when the set point jog function is used (see Section 3.2.9).

OPERATION

To adjust the set point jog function increment, press **[SETUP]**, **<2jog>**. The display is:

```
Set jog step:
0.10 %FS < and > D1
```

Use the **[←]** and **[→]** keys to adjust the value. Maximum is 1.00 %FS. Minimum is 0.01 %FS. The FS value is the full scale specified in the active MFC profile (see Section 3.3.1). Press **[ENTER]** to return to the run screen with the jog value active.

The jog increment setting is device channel specific (DEV1, DEV2). Changing the jog increment value set for one device channel does not affect the other device channel.

3.3.3 <3RES> (RESOLUTION)

- **PURPOSE**

To set the display resolution of MFC-CB set point and measurement displays.

- **PRINCIPLE**

The resolution with which the MFC-CB displays set points and measurements can be adjusted. This feature can be used to reduce the display resolution when lower precision measurements are being made and additional digits might confuse or distract the operator.

The desired resolution is calculated based on full scale of the active MFC profile (see Section 3.3.1), then rounded to the furthest digit to the right (e.g., resolution of 0.1 %FS on a 5 V MFC is 0.001 V).

The default resolution setting is 0.01 %FS. The resolution setting does not affect the resolution of information transmitted remotely. Remote information always has maximum resolution.

- **OPERATION**

To access the RESOLUTION function, press **[SETUP]**, **<3res>**. The display is:

```
Display resolution:
 0.01% FS < and > D1
```

Press the **[←]** or **[→]** key to set the desired level of resolution. Maximum is 1.00 %FS. Minimum is 0.01 %FS. The FS value is the full scale specified by the active MFC profile (see Section 3.3.1). Press **[ENTER]** to return to the MAIN run screen with the selected display resolution.

The resolution setting is device channel specific (DEV1, DEV2). The resolution set for one device channel does not affect the other device channel.

3.3.4 <4FLOWU> (FLOW UNITS)

- **PURPOSE**

To customize the selection of flow units that are available when editing MFC profiles (see Section 3.3.4).

- **PRINCIPLE/OPERATION**

The unit selection screen presented when editing MFC profiles provides a choice of six different flow units of measure. The units that are available by default are the six indicated in Section 3.2.2. MFC-CB supports many other units. These other units can be made available by customizing the MFC profile unit selection screen.

To customize the MFC profile unit selection screen, press **[SETUP]**, **<4flowU>**. The display is:

```
Set up user unit #6
```

<#6> corresponds to the sixth of the six available selections in the MFC profile unit screen. Enter the number of the selection that you would like to change. The display becomes:

```
Flow unit type: 1std
3vlm 4none
```

Select the type of flow unit desired (see Table 3). Then select the desired unit.

Table 3. Available Flow Units

<1std>	<2vlm>	<3none>
<1mol/s> <2kg/s> <3mg/s> <4slm> <5sccm> <6scfm> <7scfh> <8slh> <9sm3h>	<1ccm> <2lm> <3lh> <4m3h> <6cfm> <7cfh>	This selection causes the position for this unit to be blank.

<1std> units are units of mass flow. <2vlm> units are units of volume flow.

3.3.5 <5ADJ> (ADJUSTMENT)

- **PURPOSE**

To apply an *adder* and/or *multiplier* to the MFC-CB set point and/or measurement.

- **PRINCIPLE**

The adjustment function gives the user the capability to mathematically adjust the set point output and the value measured back by MFC-CB. This is accomplished by setting an *adder* and/or a *multiplier*.

There are separate *adders* and *multipliers* for the set point and for the measurement.

The **set point** *adder* and *multiplier* alter the set point actually output by MFC-CB following:

actual set point = (requested and displayed set point * *multiplier*) + *adder*

The **measurement** *adder* and *multiplier* alter the value measured by MFC-CB as follows:

displayed measurement = (actual measurement **multiplier*) + *adder*

The *adder* is a constant that is always expressed in terms of %FS. The full scale value is determined by the active MFC profile (see Section 3.3.1). The *multiplier* is dimensionless.

If a K factor is active (see Section 3.2.1), the *adder* and *multiplier* are applied **after** the K factor is applied. However, if the unit of measure is electrical or %FS, the K factor is not used.

The adjustment function is intended to allow MFC-CB to correct an MFC or MFM that is connected to it by making an offset and/or slope adjustment automatically.

For additional information on the calculations used by the adjustment function and how they interact with other MFC-CB calculations, see Section 7.1.1.

Do NOT use the adjustment function to calibrate MFC-CB set point and measurement signals. The internal calibration function should be used for this purpose (see Section 5.2).

OPERATION

To access the adjustment function press **[SETUP]**, **<5adj>**. The display is:

```
Signal to adjust:
1set 2measure     D1
```

Select **<1set>** to adjust the set point *adder* and/or *multiplier* or **<2measure>** to adjust the measurement *adder* and/or *multiplier*.

The next display is (an **<s>** or **<m>** precedes the active device channel indicator to indicate *set* or *measure*):

```
Adder: 0.000 %FS
Multiplier:1.0000
```

Edit the values as desired. Press **[ENTER]** to return to the run screen with the edited *adder* and *multiplier* values applied.

An indicator appears on the MAIN run screen whenever an *adder* and/or *multiplier* is active. The indication is by an **<a>** just to the right of the set point value for set point adjustments and an **<a>** just to the left of the measured value for measurement adjustments (see Section 3.1.1 for detailed run screen information).

The adjustment function flow *adder* and *multiplier*, if different from 0 and 1, alter the set points output and readings made by the MFC-CB. The adjustment function is always "ON", even if MFC profiles are changed. Take care not use *adders* and/or *multipliers* unintentionally.

Making a change to an adjustment function value sets the affected device channel output to zero.

The adjustment function is device channel specific (DEV1, DEV2). *Adders* and *multipliers* are set independently for the two device channels and the *adders* or *multipliers* on one channel have no effect on the other channel.

3.4 [SPECIAL]

PURPOSE

To access menu of MFC-CB functions and settings that are less commonly or not normally used in regular operation.

PRINCIPLE

The **[SPECIAL]** key accesses a menu of MFC-CB functions and settings that are less commonly or not normally used in regular operation. These functions include:

- **reset** (see Section 3.4.1): Access and execute various reset options.
- **level** (see Section 3.4.2): View and change security protection of MFC-CB functions.
- **prefs** (see Section 3.4.3): View and set user operational preferences including screen saver, keypad sounds, time and ID features.
- **cal** (see Section 3.4.4): View and edit MFC-CB electrical signal calibration coefficients and calibration date.
- **remote** (see Section 3.4.5): Set up/modify MFC-CB RS232 (COM1, COM2) and IEEE-488 interfaces. Test RS232 ports.
- **xbox** (see Section 3.4.6): Activate an optional MFC Switchbox on a device channel (DEV1, DEV2).
- **log** (see Section 3.4.7): View and reset the MFC-CB incident log.

OPERATION

To access the SPECIAL menu, press **[SPECIAL]** from the MAIN run screen.

The display is:

```
1reset 2level 3prefs
4cal 5remote 6xbox  ↓
7log
```

Select the desired function.

See PRINCIPLE above and Sections 3.4.1 to 3.4.7 for details on each SPECIAL function.

Some screens (i.e., the SPECIAL menu) go beyond the two lines provided by the display. This is indicated by a flashing down arrow in the second line of the display. Press the [←] and [→] keys to move the cursor to access the lines that are NOT visible or directly enter the number of the hidden menu choice if you know it.

3.4.1 <1RESET>

PURPOSE

To reset various MFC-CB settings to default or factory values.

PRINCIPLE

MFC-CB stores user definable settings in non-volatile memory. The reset menu allows the user to selectively or completely reset these values to factory defaults. Resets clear settings that the user may have made, and should be used only to restore the MFC-CB to a known state. MFC-CB will go through its reboot routine after any type of reset is executed.

OPERATION

To access the reset choices press **[SPECIAL]** and select **<1reset>**. The display is:

```
1sets 2units 3MFC
4cal 5all
```

Select the desired reset. After confirmation, the reset occurs. A reset always puts the MFC-CB through its power up routine as if power had been turned OFF and back ON.

See Sections 3.4.1 through 3.4.5 for detailed information on the specific reset choices.

⚠ RESET functions change user settings that affect set point and read signals. If not used properly, resetting can cause out of tolerance measurements. RESET functions should only be used by qualified personnel with reference to this manual.

3.4.1.1 <1SETS>

PURPOSE/OPERATION

To access Reset - Sets, press **[SPECIAL]**, **<1reset>**, **<1sets>**.

Reset - Sets clears and sets to default the following user settings:

- DISPLAY mode to CLEAN (see Section 3.2.4.6).
- Device channel selection to DEV1 (see Section 3.1.2.4).
- K factor OFF and value to 1.0000 (see Section 3.2.1).
- Unit to Volts (V) (see Section 3.2.2).
- DEV1 and DEV2 MFC profile selection to #1 (see Section 3.2.6).
- All drivers (optional) OFF and drive operation to toggle (see Section 3.2.7).
- Jog value to 0.1 %FS (see Section 3.3.2).
- Resolution to 0.01 %FS (see Section 3.3.3).

- Adjustment *adder* to 0 and *multiplier* to 1 (see Section 3.3.5).
- MFC Switchbox to none (see Section 3.4.6).
- Screen saver activation to 10 minutes (see Section 3.4.3.1).
- Keypad sounds to medium (see Section 3.4.3.2).

3.4.1.2 <2UNITS>

PURPOSE/OPERATION

To access Reset - Units, press **[SPECIAL]**, **<1reset>**, **<2units>**.

Reset - Units clears and sets to default all UNIT OF MEASURE functions. These include:

- Six flow units of measure selectable in MFC profile editing to defaults (see Section 3.3.4).
- DEV1 and DEV2 display unit to electrical signal (see Section 3.2.2).

3.4.1.3 <3MFC>

PURPOSE/OPERATION


Use special caution with this reset as it will delete up to 97 custom MFC profile entries which will have to be reentered if deleted inadvertently.

To access Reset - MFC, press **[SPECIAL]**, **<1reset>**, **<3MFC>**.

Reset - MFC clears and sets to default all MFC profile functions. These include:

- DEV1 and DEV2 to MFC profile #1 (see Section 3.2.6).
- Clear all custom MFC profiles (see Section 3.3.1).

3.4.1.4 <4CAL>

PURPOSE/OPERATION


Use special caution with this reset as critical calibration data may be altered.

To access Reset - Cal, press **[SPECIAL]**, **<1reset>**, **<4cal>**.

Reset - Cal clears and sets to default the user calibration values (see Section 5) including:

- DEV1 and DEV2 sense, measure, set and valve:

  Adder: 0
  Multiplier: 1
- DEV1 and DEV2 calibration date to 19980101.

3.4.1.5 <5ALL>

- **PURPOSE/OPERATION**

Use special caution with this reset as critical calibration data may be altered.

To access Reset - All, press **[SPECIAL]** and select **<1reset>**, **<5all>**.

Reset - All returns MFC-CB to the original, as delivered factory condition (except the user security level which is not affected by resets). Performs the SETS, UNITS, MFC and CAL RESET functions. Also resets:

- COM1 and COM2

Baud rate:	2 400
Parity:	Even
Data bits:	7
Stop bits:	1
Terminating characters:	**<CR>**, **<LF>**

- IEEE-488 (GPIB)

Address:	10
Terminating characters:	**<CR>**, **<LF>**

3.4.2 <2LEVEL>

- **PURPOSE**

To set user protection levels that restrict access to certain functions and to edit the password required for changing user levels.

- **PRINCIPLE**

MFC-CB's front panel user interface provides the means to access all MFC-CB user defined data, settings and functions including calibration data. Inadvertent, uninformed or unauthorized altering or deleting of data, settings and functions could require extensive reconfiguration by the user and might cause invalid readings. For these reasons, depending upon the application in which MFC-CB is being used, it may be desirable to restrict access to certain functions. The USER LEVEL function makes this possible. Four different levels of security are available: **none**, **low**, **medium** and **high**.

Access to changing security levels can be left open, or be protected by a password so that security levels can be used as a convenient way to avoid accidental changing of data or as a secured means of preventing tampering with MFC-CB settings.

3.4.2.1 SECURITY LEVELS

The security levels are structured to support typical operating environments as follows:

None This level is intended for use only by the system manager and/or calibration facility. It allows access and editing in all areas including calibration information and other settings that affect measurement integrity.

Low Low security is designed to protect system calibration information and system diagnostic and maintenance functions against accidental alteration. It is intended for an advanced operator performing many different tasks. Low security is the default user level setting.

Medium Medium security is designed to protect system calibration information and to assure that the MFC-CB is operated with consistent operational parameters.

High High security protects all operating parameters. It is intended to minimize operator choices (e.g., to operate in a single, inalterable configuration).

MFC-CB is delivered with the security level set to low to avoid inadvertent altering of critical internal settings but with unrestricted access to changing security level setting. It is recommended that the low security level be maintained at all times and password protection be implemented if control over setting of security levels is desired.

If there is a risk of unauthorized changing of the security level, changing authority should be password protected (see OPERATION of this section).

The High security level disables remote communications and returns an error message ("ERROR") to all remote commands. All other security levels have NO effect on remote communications.

The security levels are structured to support typical levels of operation. Specifically, the security levels **prevent** execution of the functions accessed by the keystrokes marked by "•" in Table 4.

Table 4. Security Levels - Functions NOT Executed Per Function/Level

KEYS	LOW	MEDIUM	HIGH
[K]		•	•
[UNIT]		•	•
[POWER]			•
[DISPLAY]			•
[DEV1/DEV2]			•
[MFC]		•	•
[DRIVERS]		•	•
[SETUP], <1MFC>		•	•
[SETUP], <2jog>			•
[SETUP], <3res>		•	•
[SETUP], <4flowU>		•	•
[SETUP], <5adj>		•	•
[SPECIAL], <1reset>		•	•
[SPECIAL], <1reset>, <1sets>		•	•
[SPECIAL], <1reset>, <2units>		•	•
[SPECIAL], <1reset>, <3MFC>		•	•
[SPECIAL], <1reset>, <4cal>	•	•	•
[SPECIAL], <1reset>, <5all>	•	•	•
[SPECIAL], <1reset>, <5cal>, <view>	•	•	•
[SPECIAL], <3prefs>			•
[SPECIAL], <3prefs>, <1ScrSvr>		•	•
[SPECIAL], <3prefs>, <2sound>		•	•
[SPECIAL], <3prefs>, <3time>, <view>		•	•
[SPECIAL], <3prefs>, <3time>, <edit>	•	•	•
[SPECIAL], <3prefs>, <4ID>, <view>		•	•
[SPECIAL], <3prefs>, <4ID>, <edit>	•	•	•
[SPECIAL], <4cal>, <view>		•	•
[SPECIAL], <4cal>, <edit>	•	•	•
[SPECIAL], <5remote>		•	•
[SPECIAL], <6xbox>		•	•
[SPECIAL], <9Log>, <view>			•
[SPECIAL], <9Log>, <clear>	•	•	•
Remote communications disabled			•

OPERATION

MFC-CB is delivered with NO active password so access to the User Level menu is open. The user level is set to <1Low>. User levels can be changed freely until a password has been created. RESET functions (see Section 3.4.1) do not affect the password setting.

To access the USER LEVEL function, press **[SPECIAL]** and select **<2level>**.

If **NO password yet exists or if the correct password has been entered**, the display is:

```
1change user level
2edit password
```

Selecting **<1change user level>** brings up the restriction menu:

```
Restriction: 1none
2low 3medium 4high
```

You can then select the current restriction level, or press **[ESCAPE]** to return to the MAIN run screen.

Selecting **<2edit password>** displays the user password and allows it to be edited. Passwords can be up to six numbers in length and cannot start with a zero.

```
Password: pppppp
0 disables password
```

If **0** is entered as the password value, then the password is made inactive and a password will NOT be required to access the user level menu. This is the factory default with a security level of **<2low>**.

Once a password has been entered, the user level cannot be changed without reentering the password.

If there is an active password, the password entry screen appears.

```
RFM SN nnn-xx
Password: pppppp
```

The user must enter the user defined password or the factory **secondary** password to proceed. When a password is entered correctly, operation proceeds to the **<1change user level 2edit password>** screen.

The first field, ***<nnnn>***, is the serial number of the MFC-CB, followed by a second field, ***<xx>***, that counts the number of times that a **secondary** password has been used. This second field increments each time a **secondary** password is used. The third field, ***<pppppp>***, is for normal password entry.

The factory ***secondary*** password is available in case the user's password has been misplaced or forgotten. It can be obtained by contacting a **DHI** Authorized Service Provider. The factory ***secondary*** password is different for all MFC-CB's and changes each time it is used.

3.4.3 <3PREFS>

PURPOSE

To access a menu of MFC-CB internal operational preferences and functions. These include:

- **ScrSvr** (see Section 3.4.3.1): View and change the SCREEN SAVER function.
- **sounds** (see Section 3.4.3.2): View and change valid and invalid keypad entry sound settings.
- **time** (see Section 3.4.3.3): View and edit the internal time and date settings.
- **ID** (see Section 3.4.3.4): View and edit the MFC-CB user ID.

OPERATION

To access the PREFS menu press **[SPECIAL]**, **<5prefs>**.

The display is:

```
1ScrSvr 2sound 3time
4ID
```

See PRINCIPLE above and Sections 3.4.3.1 to 3.4.3.4 for additional information on each PREFS function.

3.4.3.1 <1SCRSVR>

PURPOSE

To adjust the activation time of MFC-CB's SCREEN SAVER function.

PRINCIPLE

MFC-CB has a SCREEN SAVER function which causes the display to dim after a front panel key is not pressed for a certain amount of time. The default screen saver activation time is 10 minutes. The time can be adjusted by the user or screen saving can be completely eliminated.

OPERATION

To access the SCREEN SAVER function, press **[SPECIAL]**, **<5prefs>**, **<1ScrSav>**. Edit the time, in minutes, after which the screen saver will activate to dim the screen. Set zero to eliminate the SCREEN SAVER function.

Setting screen saver time to zero eliminates the SCREEN SAVER function so that the display is permanently at full brightness. The display may also be completely suppressed using the SOFT [ON/OFF] key (see Section 3.1.2.3).

3.4.3.2 <2SOUND>

- **PURPOSE**

  To adjust or suppress the MFC-CB keypad key press sounds.

- **PRINCIPLE**

  MFC-CB provides audible feedback by a brief “beep” when a valid key press is made. Invalid key presses are indicated by a descending two tone “blurp”. The audio frequency of the valid key press beep may be selected from three choices or all keypress sounds may be suppressed.

- **OPERATION**

  To access the key press SOUND function, press **[SPECIAL]**, **<5prefs>**, **<2sound>**.

  Select **<1none>** to suppress the valid and invalid key press sounds completely.

  Select between **<2lo>**, **<3mid>** or **<4hi>** to adjust the valid key press tone frequency.

  The SOUND tone frequency function affects only the valid key press tone.

3.4.3.3 <3TIME>

- **PURPOSE**

  To view and edit the MFC-CB internal time and date settings.

- **OPERATION**

  To access the TIME function press **[SPECIAL]**, **<5prefs>**, **<3time>**.

  The display is:

  ```
  Edit: 1time 2date
  08:32:11 am 19980101
  ```

  Select **<1time>** to edit the time. Edit hours, then minutes pressing **[ENTER]** for each one. Then use the **[←]** and **[→]** keys to select **<AM>** or **<PM>** and **[ENTER]** the selection. Seconds go to zero when minutes are entered.

  Select **<2date>** to edit the date. The date must be specified in YYYYMMDD format.

  The MFC-CB date and time are set to United States Mountain Standard Time in the final test and inspection process at the factory. If desired, use the TIME function to set your local time and date.

3.4.3.4 <4ID>

- **PURPOSE**

  To view or edit the MFC-CB user ID and to view the MFC-CB serial number.

- **PRINCIPLE**

  MFC-CB has a factory programmed serial number that is included on the product label on the bottom of the case and can be viewed in the introductory screen.

  MFC-CB also allows the user to store a unique, twelve character, alpha numeric ID number. This feature is frequently used to assign an organizational control ID (e.g., an asset number, tool number, etc.). The ID function allows the ID number to be viewed and edited. It also displays the MFC-CB factory serial number.

- **OPERATION**

  To access the ID function press **[SPECIAL]**, **<5prefs>**, **<4ID>**. Select **<1view>,** to view the current ID.

  Select **<2edit>**, to edit the ID.

  The ID has twelve characters. When the edit screen is opened, the cursor is on the first character. Numerical values can be entered directly from the keypad. In addition, the **[←]** and **[→]** keys can be used to toggle through a list of available alpha numeric characters. Holding the key slews through the characters. Character order going up (**[→]**) is: blank space, symbols, lower case letters, upper case letters, numbers. Press **[ENTER]** to select a character and move to the next character.

  When a character is selected the cursor moves to the next character. To leave a blank character, press **[ENTER]** with the field for that character blank. Use this for the trailing characters if the ID being entered is less than twelve characters.

  After the last of the twelve characters has been entered, the **<Save ID?>** option is offered. Select **<1no>** to return to the ID edit screen. Select **<2yes>** to save the edited ID.

The ID can also be set remotely from a computer which is more convenient than entering characters one at a time from the keypad (see Section 4.3.5.2, "ID(=)" command).

The ID cannot be cleared or reset by any RESET function (see Section 3.4.1).

3.4.4 <4CAL>

- **PURPOSE**

To view and edit MFC-CB electrical signal calibration coefficients and calibration date.

The MFC-CB CALIBRATION function is considered part of MFC-CB maintenance and is therefore covered in the Maintenance, Adjustments and Calibration Section of this manual (see Section 5).

3.4.5 <5REMOTE>

- **PURPOSE**

To configure the MFC-CB COM1, COM2 and IEEE-488 communication ports. To test COM1 and COM2 communications.

- **PRINCIPLE**

The MFC-CB has two RS232 communications ports referred to as COM1 and COM2 and a single IEEE-488 port. COM1 and the IEEE-488 port are for communicating with a host computer (see Section 3.4.5). COM2 is reserved for communicating with an external device (e.g., a multimeter, molbox, second MFC-CB, etc.). All the communication ports can be set up from the MFC-CB front panel.

MFC-CB provides a self-test for its RS232 communication ports. The self-test allows verification that the MFC-CB RS232 ports (COM1 and COM2) are operating properly and that a valid interface cable is being used.

The RS232 test has two steps:

❶ COM1 sends a message to COM2.

❷ COM2 sends a message to COM1.

In each step, MFC-CB checks the message received at the receiving COM port. If the receiving COM port times out or receives an incorrect message, that step of the test fails.

- **OPERATION**

To access the port configurations, press **[SPECIAL]**, **<5remote>**.

Select **<1COM1>**, **<2COM2>**, or **<3IEEE-488>** to view and/or edit that port's settings.

Press **[SPECIAL]**, **<5remote>**, **<4RS232test>** to access the RS232 self-test.

3.4.5.1 <1COM1> AND <2COM2>

The COMx ports can be set for the specific settings required by the user. The settings are baud rate, parity, data bits and stop bits. The available options are found in Table 5.

Table 5. COM1 and COM2 Available Settings

BAUD RATE	300, 600, 1 200, 2 400, 4 800, 9 600, 19 200
PARITY	NONE, ODD or EVEN
DATA BITS	7 or 8
STOP BITS	1 or 2

The default COMx settings are **2400, E, 7,1** for both COM ports.

The MFC-CB appends a carriage return (**<CR>**) and a line feed (**<LF>**) to all messages that are sent out of the COM1 port to the host. It looks for a carriage return to terminate incoming messages and ignores line feeds. The user MUST wait for a reply to each message sent to the MFC-CB before sending another message to it (see Section 4).

3.4.5.2 <3IEEE-488>

The IEEE-488 port address can be defined from 1 to 31. The default address is 10.

The MFC-CB sends a line feed (**<LF>**) and asserts the EOI line at the end of all transmitted messages. It looks for a line feed and/or assertion of the EOI line to terminate incoming messages (see Section 4).

3.4.5.3 <4RS232 SELF-TEST>

The RS232 self-test is provided to check the MFC-CB COM ports and the interface cable independently of an external device or computer.

If you are having difficulty communicating with MFC-CB from a host computer using RS232, the RS232 self test can help establish that the MFC-CB COM1 port you are trying to communicate with and the interface cable you are using are good.

To run a self test of the RS232 ports (COM1 and COM2), press **[SPECIAL]**, **<5remote>**, **<4RS232test>**.

The display prompts you to connect COM1 to COM2 using a standard pin to pin DB-9 female to DB-9 male RS232 cable (see Section 4).

Once the cable has been installed, press **[ENTER]** to run the self-test. The test is first executed in the COM1→COM2 direction and then in the COM2→COM1 direction.

If the COM1→COM2 test passes: <PASSED> displays briefly and the test proceeds to COM2→COM1.

If COM2→COM1 passes: **<PASSED>** is displayed briefly followed by the conclusion, **<The RS232 test has PASSED>**.

If a test fails: Execution is suspended until **[ENTER]** is pressed.

The MFC-CB RS232 test can fail for three reasons:

1. The RS232 cable being used is incorrect (see Section 4.2.1 for information on the correct cable).
2. COM1 and COM2 do NOT have the same serial communications settings and therefore cannot communicate together (see Section 3.4.5.1 to set the COM ports).
3. COM1 or COM2 is defective.

The reason for failed communications is almost always a cable or incorrect RS232 interface settings. Be sure that these are correct before concluding that a COM port or MFC-CB communications are defective.

3.4.6 <6XBOX>

- **PURPOSE**

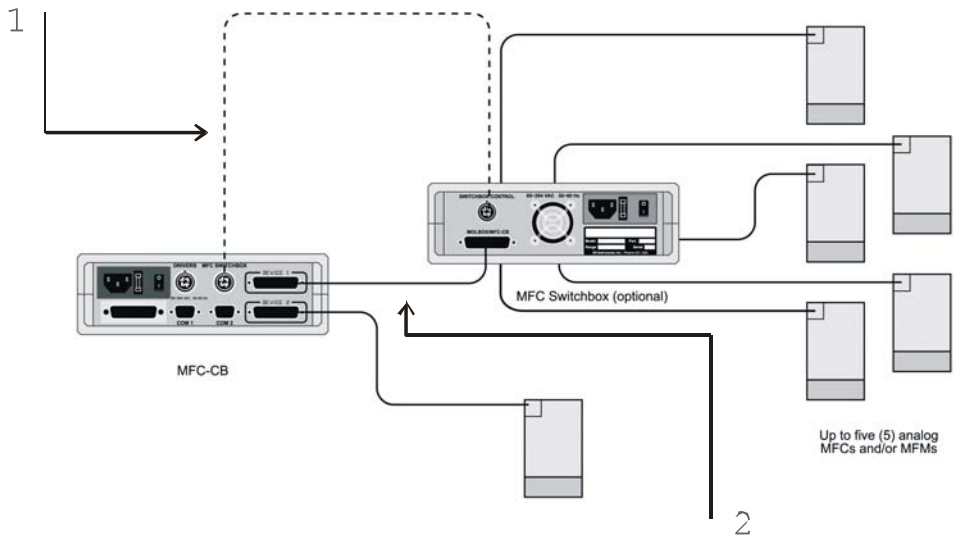
To set up an optional MFC Switchbox for operation on one of the MFC-CB device channels.

- **PRINCIPLE**

An optional MFC Switchbox is available. The MFC Switchbox is connected to one of the MFC-CB device channels (DEV1, DEV2) and allows that channel's set point and measurement to be switched between five channels on the Switchbox. This allows multiple MFCs or MFMs to be connected to one of the MFC-CB device channels and the MFC-CB device channel signal to be switched between them. As the MFC Switchbox permanently powers all five channels, this feature is frequently used to keep multiple MFCs connected and warmed up for immediate use.

MFC-CB only supports one MFC Switchbox at a time so the Switchbox must be connected either to DEV1 or DEV2. Figure 5 illustrates the setup of MFC-CB with an MFC Switchbox. See the MFC Switchbox User's Manual for additional information on setting up and using an MFC Switchbox.

When an MFC Switchbox is active on an MFC-CB device channel, the MFC Switchbox channel selection is specified when an MFC profile is selected using **[MFC]** (see Section 3.2.6).



1. MFC Switchbox control cable (provided with MFC Switchbox)
2. molbox1/MFC-CB to MFC Switchbox cable (provided with MFC-CB)

Figure 5. MFC-CB with MFC Switchbox Schematic

❍ OPERATION

To access the XBOX function press **[SPECIAL]**, **<5prefs>**.

The display is:

```
MFC Switchbox on:
1DEV1 2DEV2 3none
```

Select **<1DEV1>** or **<2DEV2>** to activate an MFC Switchbox on the desired MFC-CB device channel. Select **<3none>** to disable MFC Switchbox usage.

MFC-CB supports only one MFC Switchbox at a time.

When an MFC Switchbox is active, Switchbox channel selection occurs using [MFC] from the run screen (see Section 3.2.6).

An indicator appears on the normal MFC-CB device channel indicator whenever the MFC Switchbox is active. The current Switchbox channel number is appended to the MFC-CB device channel. For example, <D1>, is <D1,5> if an MFC Switchbox set for channel 5 is active on MFC-CB DEV1 (see Section 3.1.2.4).

3.4.7 <7LOG>

- **PURPOSE**

  To view and/or clear the MFC-CB event log.

- **PRINCIPLE**

  MFC-CB records to a log each time a memory or identifiable hardware fault occurs.

- **OPERATION**

  To view the event log press **[SPECIAL]** and select **<7log>**. The oldest logged event appears. Pressing **[ENTER]** steps through the logged events from the oldest to the most recent, ending with the option to clear the log **<Yes>** or **<No>.**

  If NO events have been logged, <End of log> displays.

NOTES

4. REMOTE OPERATION

4.1 OVERVIEW

Most of the MFC-CB's front panel functions can also be executed by commands from a remote computer. The host computer communicates with the MFC-CB using the MFC-CB COM1 RS232 port or the IEEE-488 port. The command syntax is the same for either port except when using the IEEE STD. 488.2 Common Commands.

4.2 INTERFACING

Sending a command to the MFC-CB places it into remote mode. The remote indicator at the lower right hand corner of the MFC-CB display lights when the MFC-CB is in remote mode. It also flickers when data transfers are occurring. The menus usually accessed from the front panel are locked-out while in remote, with the exception of the **[POWER]** key. This function will still respond and allow the user to display the set value unaltered by K or adjustment values and the valve test point while the MFC-CB is in remote mode. Pressing the **[ESCAPE]** key returns the MFC-CB to local operation unless the "REMOTE" command was sent to the unit. The "REMOTE" command locks out keypad operation until the "LOCAL" command is sent or power is cycled.

Most remote commands return a reply within 500 ms. You **must** wait for this reply before issuing another command to the MFC-CB. This ensures that the MFC-CB has completed the command. IEEE STD. 488.2 Common Commands (commands starting with an asterisk, see Section 4.3.5.1) are an exception. IEEE-488.2 Common Commands only generate a reply if using the COM1 port or if the query form of the common command is used (command followed by a "?"). The following commands take more than 500 ms to reply:

CIN, VIN, VSENSE, VVALTEST Up to 1 second to allow a new measurement.

4.2.1 RS232 INTERFACE

To establish RS232 communications, a standard pin to pin DB-9F to DB-9M RS232 cable must be used to connect the host COM port to MFC-CB COM1. The interface settings of both ports must be the same.

MFC-CB supports an independent RS232 self-test to verify that the MFC-CB RS232 ports are operating correctly and the interface cable being used is valid. Use this self-test to troubleshoot if you are having difficulty establishing communications with MFC-CB COM1 (see Section 3.4.5.3).

4.2.1.1 COM1

The MFC-CB COM1 RS232 interface is located on the rear panel. It is a 9-pin female DB connector configured as a DCE device. Data is transmitted out of MFC-CB using pin 2, and is received on pin 3. This allows a standard pin to pin DB-9M to DB-9F RS232 cable to be used to connect to a DTE host. Handshaking is NOT required or supported.

COM1 RS232 commands must be terminated with at least a single carriage return character, while line feed characters are ignored. All RS232 responses from the MFC-CB are terminated with a carriage return character and a line feed character.

Table 6. COM1 DB-9F Pin Designation

PIN #	FUNCTION	DESCRIPTION
2	TxD	This pin transmits serial data from the MFC-CB to the host.
3	RxD	This pin accepts serial data from the host computer.
5	Grn	This pin is the common return for the TxD and RxD signals.

IBM PC/XT DB-9F CONNECTIONS		IBM PC/XT DB-9M TO MFC-CB DB9F CONNECTION	
DB-25M	DB-9F	DB-9M	DB-9F
2	3	3	3
3	2	2	2
7	5	5	5

4.2.1.2 COM2

The MFC-CB COM2 RS232 interface is located on the rear panel. It is a 9-pin male DB connector configured as a DTE device. Data is transmitted out of the MFC-CB using pin 3 and is received on pin 2. This allows a standard pin to pin DB-9F to DB-9M RS232 cable to be used to connect to a DCE slave. Handshaking is NOT required or supported.

COM2 can be used to allow the host computer to communicate with another device (e.g., a molbox or another MFC-CB) through the MFC-CB. This allows one host COM port or IEEE-488 port to communicate with the MFC-CB and an additional RS232 device. This configuration is frequently used to communicate with a molbox and MFC-CB using only one computer COM port. Refer to the "PASSTHRU" "#" remote command for details (see Section 4.3.5.2).

Table 7. COM2 DB-9M Pin Designation

PIN #	FUNCTION	DESCRIPTION
2	RxD	This pin accepts serial data from another MFC-CB or another device.
3	TxD	This pin transmits serial data from the MFC-CB to another MFC-CB or another device.
4	DTR	Data Terminal Ready. Held at +5 Volts.
5	Grn	This pin is the common return for the TxD and RxD signals.

IBM PC/XT DB-25F TO DB-9M CONNECTIONS		IBM PC/XT DB-9F TO MFC-CB DB9M CONNECTION	
DB-25F	DB-9M	DB-9F	DB-9M
2	3	3	3
3	2	2	2
7	5	5	5

4.2.2 IEEE-488 (GPIB)

The MFC-CB IEEE-488 interface is located on the rear panel. The physical and electrical interface conforms to IEEE STD. 488.1-1987 Subset E2 and IEEE STD. 488.2-1992. You should NOT attempt to communicate with the IEEE-488 interface while using the COM1 interface. The IEEE-488 receive buffer is 250 bytes deep. The MFC-CB will hold OFF release of the NRFD handshake line until it can service and empty the receive buffer. This keeps the buffer from overflowing.

IEEE-488 commands must be terminated with a single line feed character along with the assertion of the EOI line. All IEEE-488 responses from the MFC-CB are terminated with a line feed character along with the assertion of the EOI line. Replies are held in a buffer until the host computer retrieves them, so it is possible to have old replies in this buffer, while you are expecting new replies from a just issued command. This is a very common problem when you send a query form command and do not receive the reply, and then unexpectedly receive this old reply instead of a new reply during the next query.

4.3 COMMANDS

4.3.1 COMMAND SYNTAX

All MFC-CB commands are ASCII strings. The user **must** wait for the MFC-CB to reply before sending another command. An exception to this is the use of any of the IEEE STD. 488.2 Common Commands via the IEEE-488 interface (these common commands are shown first, and always start with an asterisk, "*"). The common commands only generate a reply if using the COM1 port or the query form of the common command is used (command followed by a "?").

4.3.2 COMMAND SUMMARY

Table 8. Command Summary

SYNTAX	PURPOSE
*CLS	Clears the status registers and all queues.
*ESE(?)	Read or set the Event Status Enable register.
*ESR?	Read the Event Status Register.
*IDN?	Identify the product and embedded software version.
*OPC(?)	Read or set the Operation Complete register (not applicable).
*OPT?	Read the MFC-CB options installed.
*RST	Reset user settings to factory defaults.
*SRE(?)	Read or set the Service Request Register.
*STB?	Read the Status Byte.
*TST?	Read the system self-test results.
#	Send a command string out of the MFC-CB COM2 port.
ABORT	Stop set point from being set.
ACAL:DATE(=)	Read or set the MFC-CB calibration date.
ACAL:MEAS(*n*)(=)	Read or set the measurement calibration coefficients.
ACAL:SENSE(*n*)(=)	Read or set the sense calibration coefficients.
ACAL:SET(*n*)(=)	Read or set the set calibration coefficients.
ACAL:VALVE(*n*)(=)	Read or set the valve test calibration coefficients.
ADJ:MEAS(*n*)(=)	Read or set the user measurement adjustment setting.
ADJ:SET(*n*)(=)	Read or set the user set adjustment setting.
CIN(*n*)	Read the measurement current if in current mode.
COM*n*(=)	Read or set the configuration of the COM1 or COM2 port.
COUT(*n*)(=)	Read or set the set point current if in current mode.
DATE(=)	Read or set the internal date.
DEV(=)	Read or set the active device channel.
DISP(=)	Read or set the MFC-CB display mode.
DRV*n*(=)	Read or set the status of one of the optional external 12 V drivers.
DRV(=)	Read or set the status of all of the optional external 12 V drivers.
ERR	Read the last remote command error message.
GPIB(=)	Read or set the GPIB-488 address.
ID(=)	Read or set the MFC-CB's identification label.
KEY=	Simulate the press of a key on the front panel.
KFACT(*n*)(=)	Read or set the "K" factor.
LOCAL	Enable the front panel controls if in remote and go to local mode.
MEM	Read the power on memory test status.
MFCCH(*n*)(=)	Read or set the MFC device channel and output mode (voltage or current).
POWER=	Turns the MFC-CB's soft power ON/OFF.

Table 8. Command Summary (Continued)

SYNTAX	PURPOSE
REMOTE	**Enable remote local lockout operation.**
RESET	**Reset the MFC-CB settings to the default operating parameters.**
RES(*n*)(=)	**Read or set the display resolution.**
SCRSAV(=)	**Read or set the front panel screen saver period.**
SN	**Read the serial number of the MFC-CB.**
TEXT:CLR*n*=	**Clear a portion of the MFC-CB's front panel display.**
TEXT*n*=	**Specify text to be written to the MFC-CB's front panel display.**
TIME(=)	**Read or set the internal clock time.**
VER	**Read the MFC-CB embedded software version.**
VIN(*n*)	**Read the measurement voltage if in voltage mode.**
VOUT(*n*))(=)	**Read or set the set point voltage if in voltage mode.**
VSENSE(*n*)	**Read the sense voltage.**
VVALTEST(*n*)	**Read the valve voltage.**

4.3.3 ERROR MESSAGES

The MFC-CB always replies to a command except for the use of any of the IEEE STD. 488.2 Common Commands (non query form) via the IEEE-488 interface. If the command is incorrect or contains invalid data, an error number will be returned in the form "ERR# *n*" where *n* is an integer number that represents a specific error. This allows for easy error trapping by the host computer. Table 9 is a list of the possible error numbers and the error description for each.

Table 9. Error Messages

REPLY	DESCRIPTION
ERROR	"The MFC-CB is in high security level and cannot accept remote commands"
ERR# 0	"OK"
ERR# 2	"Text argument is too long"
ERR# 3	"User defined coefficient cannot be 0"
ERR# 4	"External device not detected"
ERR# 5	"External device improperly configured"
ERR# 6	"Numeric argument missing or out of range"
ERR# 7	"Missing or improper command argument(s)"
ERR# 8	"External device timeout error"
ERR# 9	"Unknown command"
ERR# 10	"Missing or invalid command suffix"
ERR# 11	"Command missing argument"
ERR# 13	"Text queue overflow"
ERR# 18	"Command not yet available"
ERR# 21	"User device not defined"
ERR# 23	"Option not available or installed"
ERR# 26	"COM port failed to initialize"
ERR# 27	"Internal device timeout error'
ERR# 28	"Device failure"
ERR# 35	"Memory write error"
ERR# 39	"Memory verify error"
ERR# 40	"Memory read error"
ERR# 41	"Memory invalid"
ERR# 43	"Incorrect mode"
ERR# 44	"Entry already exists"
ERR# 45	"Argument not allowed"
ERR# 52	"Command obsolete"

4.3.4

4.3.5 COMMAND DESCRIPTIONS

Each command description gives the full syntax showing usage. Ranges of parameters or parameter types are indicated. There are two types of commands. The Common and Status Commands support IEEE STD. 488.2, while the MFC-CB commands access all other functions.

4.3.5.1 IEEE STD. 488.2 COMMON AND STATUS COMMANDS

The MFC-CB supports a set of commands that are common to all instruments conforming to IEEE STD. 488.2 protocol. Though defined by the IEEE-488.2 standard, they also apply to MFC-CB RS232 (COM1) communications. These commands make it easy to perform basic functions for any device that supports them. These commands also cover the status reporting commands. Refer to Section 4.4 for details on the status registers mentioned in these commands. Query forms of these commands must be followed by a question mark and IEEE-488.2 Common Commands always start with an asterisk ("*"). Unlike the other MFC-CB commands, they must have a space instead of an equals sign ("=") between the command and any arguments. Also unlike the other MFC-CB commands, if you are using the IEEE-488 port, the query form (command is immediately followed by a "?") must be used to get a reply. If using the COM1 port and the command is not a query, "OK" is replied.

∗CLS	
Purpose	Clear all of the status and event structures.
Syntax	"∗CLS"
Remarks	This program message clears the following events and status registers: Standard Byte Register (STB) Standard Event Status Register (ESR) Error Queue Pending OPC operations
Example	Command: "*CLS" Reply: "OK" (using COM1, no reply if IEEE-488 port)

∗ESE(?)	
Purpose	Read or set the standard event status enable register.
Syntax	"∗ESE *n*" "∗ESE?"
Parameters	*n:* '0 to 255'. This is the decimal representation of the bit(s) to enable. To enable the PON and QYE bits, the argument would be 128 + 4 = 132.
Query Reply	*n* (0 to 255)
Remarks	The standard event status enable register determines which bits in the standard event status register are enabled and included in the status byte register (ESB bit), and can assert the SRQ line. The reply is in decimal numeric form.
Example	Command: "*ESE 132" Reply: "OK" (using COM1, no reply if IEEE-488 port) Command: "*ESE?" Reply: "132"

∗ESR?	
Purpose	Read the standard event register.
Syntax	"∗ESR?"
Query Reply	*n* (0 to 255)
Remark	The standard event register contents are cleared after reading. The reply is in decimal numeric form.
Example	Command: "*ESR?" Reply: 4"

∗IDN?	
Purpose	Identify the MFC-CB embedded software version, and serial number.
Syntax	"∗IDN?"
Remarks	The identification reply is made up of the manufacturer, the model, the serial number and the software version. Each is separated by a comma.
Query Reply	The version string
Example	Command: "*IDN?" Reply: "DH INSTRUMENTS INC, MFC-CB, 1001, Ver1.01 -dhf"

∗OPC(?)	
Purpose	Sets the operation complete bit when all operations have completed.
Syntax	"∗OPC" "∗OPC?"
Remarks	This command enables the MFC-CB to set the OPC bit in the standard event status register when it has completed all pending functions. The query replies with a "1" when all functions are complete. Since the MFC-CB does not support overlapping commands, this command has no practical use.
Query Reply	"0" or "1"
Example	Command: "*OPC" Reply: "OK" (using COM1, no reply if IEEE-488 port) Command: "*OPC?" Reply: "1"

∗OPT?	
Purpose	Reads the list of installed MFC-CB options. Since there are no extra options available, the reply will always be the same.
Syntax	"∗OPT?"
Remarks	This query returns any registered option(s) installed in the MFC-CB. Each option is separated by a comma.
Query Reply	A comma delimited text field of the installed options.
Example	Command: "*OPT?" Reply: "IEEE-488:0" (standard IEEE interface)

∗RST	
Purpose	Resets the MFC-CB settings to factory settings.
Syntax	"∗RST"
Remarks	This command sets the MFC-CB settings to factory settings which is equivalent to pressing **[SPECIAL]** on the front panel and selecting **<5Reset>, 1sets**. This does not affect the communications or calibration settings.
Example	Command: "*RST" Reply: "OK" (using COM1, no reply if IEEE-488 port)

∗SRE(?)	
Purpose	Read or set the service request enable register.
Syntax	"∗SRE *n*"
	"∗SRE?"
Parameters	*n:* '0 to 255'. This is the decimal representation of the bit(s) to enable. To allow the MAV and ESB bits to assert the SRQ line, the argument would be 32 + 16 = 48. Bit 6 (64) is reserved and cannot be set.
Remarks	The service request enable register determines which bits of the status byte can set the MSS bit of the status byte and request service by asserting the SRQ line of the IEEE-488 interface.
Query Reply	*n* (0 to 255)
Example	Command: "*SRE 48" Reply: "OK" using COM1, no reply if IEEE-488 port) Command: "*SRE?" Reply: "48"

∗STB?	
Purpose	Read the status byte register.
Syntax	"∗STB?"
Remarks	The status byte register reflects the general status of the MFC-CB. The 'MSS' bit state is represented by bit 6.
Query Reply	*n* (0 to 255)
Example	Command: "*STB?" Reply: "4"

∗TST?	
Purpose	Read the power on self test status.
Syntax	"∗TST?""
Remarks	The MFC-CB system memory stores the user settings (units, mode, resolution) and retains them when the unit is shutoff. On power up, this memory is checked. If this memory is corrupted, all user settings are reset to default (as if the "∗RST" program message was executed), and the ∗TST query returns a '1'. If the MFC-CB passed the test on power up OR if the ∗TST query was used at least once since the unit was powered up, the reply is '0'.
Query Reply	"0" or "1"
Example	Command: "*TST?" Reply: "1"

4.3.5.2 MFC-CB COMMANDS

#	
Purpose	To allow the host computer to communicate with a device connected to the MFC-CB COM2 port.
Syntax	"#XX"
Arguments	Xx: The string to send out of the COM2 port. It must be less than 40 characters long.
Remarks	The MFC-CB COM2 port can be used to communicate to another RS232 device (e.g., another MFC-CB or a multimeter). This allows the user to use one COM port or IEEE-488 port on the host computer to communicate with the MFC-CB and another device. A carriage return and a line feed (**<CR><LF>**) are added to the string. After this command is issued, the MFC-CB will reply back with the first string received by the MFC-CB COM2 port that is terminated with a carriage return. Line feeds are discarded. This will discontinue when any command is sent to the MFC-CB. There is no other reply from this command. Prior to using this command, you must ensure that the MFC-CB COM2 port is correctly set up to communicate with the device. Refer to the "COM2=" command.
Example	Command: "#VER" Reply: "DH INSTRUMENTS, INC MFC-CB Ver1.01"

ABORT	
Purpose	To halt a new target from being set.
Syntax	"ABORT"
Remarks	A new target voltage can take up to 1.5 seconds to complete. The "ABORT" command can be used to halt this operation.
Example	Command: "ABORT" Reply: "ABORT"
See Also	"VOUT", "COUT"

ACAL:DATE(=)	
Purpose	Read or set calibration date.
Syntax	"ACAL:DATE" "ACAL:DATE=date"
Arguments	date: The user calibration date from 19800101 to 20791231
Defaults	"ACAL:DATE=19800101"
Remarks	The user analog calibration date must be in the format "YYYMMDD".
Example	Command: "ACAL:DATE=20000101" Reply: "20000101"
Errors	ERR# 2: The date is greater than 8 characters ERR# 7: The date is invalid
See Also	5.2.2.6, "DEV"

ACAL:MEAS(*n*)(=)	
Purpose	Read or set the measurement calibration coefficients.
Syntax	"ACAL:MEAS*n*" "ACAL:MEAS*n*=Vadder, Vmult, Cadder, Cmult"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings '2' to address DEV2 settings Vadder: The voltage measurement *adder* in Volts Vmult: The voltage measurement *multiplier* Cadder: The current measurement *adder* in mA Cmult: The current measurement *multiplier*
Defaults	"ADJ:MEAS*n*=0.0000 V,1.00000, 0.0000 mA,1.00000"
Remarks	The measurement calibration coefficients affect the measurement signal. There are separate calibrations for voltage and current and for active device channel 1 and 2.
Example	Command: "ACAL:MEAS2=0.01, 1, 0.05, 1" Reply: "0.0100 V,1.00000, 0.0500 mA,1.00000"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid
See Also	5.2.2.1, 5.2.2.3, "DEV", "ACAL:SET", "ACAL:DATE"

ACAL:SENSE(*n*)(=)	
Purpose	Read or set the sense calibration coefficients.
Syntax	"ACAL:SENSE*n*" "ACAL:SENSE*n*=adder, mult"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings '2' to address DEV2 settings adder: The sense voltage *adder* in Volts mult: The sense voltage *multiplier*
Defaults	"ADJ:SENSE*n*=0.0000 V,1.00000"
Remarks	The sense calibration coefficients affect the voltage sense measurement. This in turn affects the voltage set operation as the sense measurement is used to set the voltage output as close as possible to the set point value, compensating for line loss.
Example	Command: "ACAL:SENSE2=0.01, 1" Reply: "0.0100 V,1.00000"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid
See Also	5.2.2.1, 5.2.2.2, 7.1.1, "DEV", "ACAL:SET", "ACAL:DATE"

ACAL:SET(*n*)(=)	
Purpose	Read or set the set point calibration coefficients.
Syntax	"ACAL:SET*n*" "ACAL:SET*n*=Vadder, Vmult, Cadder, Cmult"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings '2' to address DEV2 settings Vadder: The voltage set *adder* in Volts Vmult: The voltage set *multiplier* Cadder: The current set *adder* in mA Cmult: The current set *multiplier*
Defaults	"ADJ:SET*n*=0.0000 V,1.00000, 0.0000 mA,1.00000"
Remarks	The set calibration coefficients affect the set point signal output. There are separate coefficients for the voltage and current outputs and for each device channel. For the Voltage calibration, note that the sense calibration ("ACAL:SENSE" command) better determines the voltage actually set.
Example	Command: "ACAL:SET2=0.01, 1, 0.05, 1" Reply: "0.0100 V,1.00000, 0.0500 mA,1.00000"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid
See Also	5.2.2.1, 5.2.2.4, "DEV", "ACAL:SENSE", "ACAL:MEAS", "ACAL:DATE"

ACAL:VALVE(*n*)(=)	
Purpose	Read or set the valve calibration coefficients.
Syntax	"ACAL:VALVE*n*" "ACAL:VALVE*n*=adder, mult"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings '2' to address DEV2 settings adder: The valve voltage *adder* in Volts mult: The valve voltage *multiplier*
Defaults	"ADJ:VALVE*n*=0.0000 V,1.00000"
Remarks	The valve calibration coefficients affect the valve voltage measurement.
Example	Command: "ACAL:VALVE2=0.01, 1" Reply: "0.0100 V,1.00000"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid
See Also	5.2.2.1, 5.2.2.5, "DEV", "ACAL:SET", "ACAL:DATE"

ADJ:MEAS(*n*)(=)	
Purpose	Read or set the user measurement adjustment setting.
Syntax	"ADJ:MEAS*n*" "ADJ:MEAS*n*=adder, mult"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings '2' to address DEV2 settings adder: The measurement adjustment *adder* in %FS (0 to 100 %) mult: The adjustment *multiplier*
Defaults	"ADJ:MEASn=0.0000%, 1.0000"
Remarks	The user measurement adjustment affects the measurement signal and is used to compensate for line loss or other imperfections in the MFC/MFM or MFC/MFM interface when measuring MFC/MFC voltage or current. The measurement adjustment is device channel specific. Do not confuse this adjustment with the MFC-CB calibration coefficients.
Example	Command: "ADJ:MEAS2=3, 1.003" Reply: "0.0003%, 1.0030"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n"* is invalid
See Also	3.3.5, "ADJ:SET", "DEV"

ADJ:SET(*n*)(=)	
Purpose	Read or set the user set adjustment setting.
Syntax	"ADJ:SET*n*" "ADJ:SET*n*=adder, mult"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings '2' to address DEV2 settings adder: The set adjustment *adder* in %FS (0 to 100 %) mult: The set adjustment *multiplier*
Defaults	"ADJ:SETn=0.0000%, 1.0000"
Remarks	The user set adjustment affects the set point signal and is used to compensate for line loss or other imperfections in the MFC interface when setting the MFC voltage or current. The measurement adjustment is device channel specific. Do not confuse this adjustment with the MFC-CB calibration coefficients.
Example	Command: "ADJ:SET2=3, 1.003" Reply: "0.0003%, 1.0030"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n"* is invalid
See Also	3.3.5, "DEV", "ADJ:MEAS"

CIN(*n*)	
Purpose	Read the measurement current if in 'mA' mode.
Syntax	"CIN*n*"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 '2' to address DEV2
Remarks	The MFC-CB interface can measure current output of an MFC/MFM. The MFC-CB must be in 'mA' mode before this can be done (see the "MFCCH" command). The returned data is always in "mA".
Example	Command: "CIN" Reply: "5.342 mA"
Errors	ERR# 10: The prefix "*n*" is invalid ERR# 43: Not in the mA mode
See Also	3.1.2.4, "MFCCH"

COM*n*(=)	
Purpose	Set or read the configuration of the COM1 or COM2 ports.
Syntax	"COM*n*=*baud,parity,data,stop*" "COM*n*"
Arguments	*N*: The COM port: '1' or '2'. Baud: The baud rate. This may be '300', '600', '1200', '2400', '4800', '9600', '19200', '28800' or '38400'. Parity: The data parity. This may be 'O' for odd, 'E' for even or 'N' for none. Data: The data word length. This may be '7' or '8'. Stop: The number of stop bits. This may be '1' or '2'.
Defaults	"COM1=2400,E,7,1" "COM2=2400,E,7,1"
Remarks	The COM1 port is used to communicate with the MFC-CB. When the COM1 port configuration of the MFC-CB is changed, the command reply will be sent at the old COM1 settings, but all subsequent communications will be accomplished at the new COM1 settings. The COM2 port is used to allow commands to be passed through the MFC-CB to a device connected to the COM2 port (refer to the "#" command).
Example	Command: "COM1=9600,N,8,1" Reply: "9600,N,8,1"
Error	ERR# 7: Missing or improper command argument(s) ERR# 10: The prefix "*n*" is invalid
See Also	3.4.5, 4.2.1, "#"

COUT(*n*)(=)	
Purpose	Read or set the current output setpoint.
Syntax	"COUT*n*" "COUT*n*=current"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 '2' to address DEV2 Current: The current to be sent to the MFC (4 to 20 mA).
Defaults	"COUT*n*=4"
Remarks	The MFC-CB can set a current setpoint for an MFC. The MFC-CB must be in current mode before this can be done (see the "MFCCH" command). The data is always in "mA".
Example	Command: "COUT1=12" Reply: "12.00 mA"
Errors	ERR# 7: The current is invalid ERR# 10: The prefix "*n*" is invalid ERR# 43: Not in the current mode
See Also	3.2.8, "MFCCH"

DATE(=)	
Purpose	Read or set the internal clock date.
Syntax	"DATE" "DATE=YYYYMMDD
Arguments	yyyy: The year from 1980 to 2079. mm: The month from 1 to 12. dd: The day from 1 to the last valid day of the given month.
Example	Command: "DATE=19981005" Reply: "19981005"
Errors	ERR# 7: The date is invalid.
See Also	3.4.3.3, "TIME"

DEV(=)	
Purpose	Read or set the active device channel.
Syntax	"DEV" "DEV=device
Arguments	Device: '1' for DEV1. '2' for DEV2
Remarks	The active device channel determines which device channel's settings are accessible via the front panel. For remote operation, when the user does not specify the channel, the active device channel is the channel addressed.
Example	Command: "DEV=2" Reply: "2"
Errors	ERR# 7: The device specified is not '1' or '2' ERR# 10: The prefix "*n*" is invalid
See Also	3.1.2.4, 3.2.5, "MFCCH"

DISP(=)	
Purpose	Read or set the display mode for the MFC-CB front panel.
Syntax	"DISP" “DISP=mode
Arguments	Mode: '1' for DEV1&2 '2' for SUM '3' for DIF '4' for RATIO '5' for UNIT '6' for CLEAN
Defaults	“DISP=6” ("clean")
Remarks	There are six different display modes available in the MFC-CB. These can be selected locally using the **[DISPLAY]** key or by the "DISP=" command. For display modes 2, 3 and 4 to be selected the unit of measure displayed on the front panel for DEV1 and DEV2 must be identical.
Example	Command: “DEV=2” Reply: “2”
Errors	ERR# 7: "screen" is invalid ERR# 36: Units for DEV1 and DEV2 not the same
See Also	3.2.4

DRV*n*(=)	
Purpose	Read or set the status of one of the external 12V drivers.
Syntax	“DRVn=state” “DRVn”
Arguments	*n*: The driver channel to operate. This can be from 1 to 8. state: ‘0’ to de-energize the driver ‘1’ to energize the driver
Defaults	“DRVn=0”
Remarks	The MFC-CB has the option of controlling up to eight external 12V drivers. This command allows control of one driver without affected the other seven drivers. See “DRV” to control all of the drivers simultaneously.
Example	Command: “DRV3” Reply: “DRV3=1”
Errors	ERR# 7: The state specified is not '0' or '1' ERR# 10: The prefix "*n*" is invalid
See Also	3.2.7, "DRV"

DRV(=)	
Purpose	Read or set the status of all of the external 12V drivers.
Syntax	"DRV=bitfield "DRV"
Arguments	Bitfield: The Bitfield (0 to 255) defining which valves are energized, and which are de-energized. The following values represent the eight drivers: '1' Driver #1 '2' Driver #2 '4' Driver #3 '8' Driver #4 '16 Driver #5 '32' Driver #6 '64' Driver #7 '128' Driver #8
Defaults	"DRV=0"
Remarks	The "DRV" command controls all eight drivers at once. Sum the drivers that will be energized together. To energize Driver 2, 3 and 7 (leaving 1, 4, 5 and 6 off) you would set Bitfield to '70' (2 + 4 + 64 = 70). See "DRVn" to control individual drivers separately.
Example	Command: "DRV=70" Reply: "70"
Errors	ERR# 7: The Bitfield specified is invalid
See Also	3.2.7, "DRV*n*"

ERR	
Purpose	Read the last error message.
Syntax	"ERR"
Remarks	The "ERR" command provides more details about an error that has occurred. If the user receives an "ERR# nn" reply, the "ERR" command returns a brief description about the last error number that was replied.
Example	Command: "ERR" Reply: "Missing or improper command argument(s)"
See Also	4.3.3, Table 9

GPIB(=) cl	
Purpose	Read or set the GPIB-488 address.
Syntax	"GPIB" "GPIB=addr"
Arguments	addr: The primary GPIB address 1 to 31.
Defaults	"GPIB=10"
Remarks	The reply will be sent AFTER the address is changed.
Example	Command: "GPIB=20" Reply: "20"
Errors	ERR# 6: The addr is invalid.
See Also	3.4.5.2, 4.2.2

ID(=)	
Purpose	Read or set the user defined identification label.
Syntax	"ID=string" "ID"
Default	"ID=NONE"
Arguments	string: An alphanumeric string up to 12 characters wide.
Remarks	The user defined ID label can be used to allow the user to "tag" the MFC-CB with a unique identifier. The reply will be padded if needed to ensure it is 12 characters wide. This ID is stored in non-volatile memory and cannot be erased by a power failure, system fault or reset.
Example	Command: "ID=MFC-CB 001" Reply: "MFC-CB 001 "
Errors	ERR# 2: The label is too large.
See Also	3.4.3.4

KEY=	
Purpose	Simulate the press of a key on the front panel
Syntax	"KEY=keycode"
Arguments	Keycode: '0' to '9' to simulate keys '0' through '9' being pressed '10' for the decimal point key '11' for the **[⇐]** key '12' for the **[⇒]** key '13' for the **[ESCAPE]** key '14' for the **[ENTER]** key '15' for the **[±]** key '16' for the **[ON/OFF]** key
Remarks	The keypad queue can hold up to 20 entries before additional entries are ignored.
Example	Command: "KEY=5" Reply: "5"

KFACT(*n*)(=)	
Purpose	Read or set the "K" factor.
Syntax	"KFACT=*kfactor*" "KFACT"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 '2' to address DEV2 kfactor: The 'K" factor.
Defaults	"KFACT*n*=1.0" (Disabled)
Remarks	The "K" factor is set to 1.0 for normal operation. "K" factor setting is device channel specific.
Example	Command: "KFACT" Reply: "1.000000"
See Also	3.2.1

LOCAL	
Purpose	Enable the front panel controls if in remote and go to local mode.
Syntax	"LOCAL"
Remarks	In LOCAL mode, all front panel operations are available. The LOCAL command deactivates REMOTE mode.
Example	Command: "LOCAL" Reply: "LOCAL"
See Also	"REMOTE"

MEM	
Purpose	Read the memory test status.
Syntax	"MEM"
Remarks	On power up, a memory test is run to check the integrity of the MFC-CB internal data NVRAM. If the memory has been corrupted, "FATAL MEMORY FAULT" is displayed on power up to alert the user, and the memory test status command returns a '0'. The command returns a '1' if the memory is OK.
Example	Command: "MEM" Reply: "0"
See Also	"*TST"

MFCCH(*n*)(=)	
Purpose	Read or set the active device channel and mode (voltage or current).
Syntax	"MFCCH*n*" "MFCCH*n*=channel, mode"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 settings. '2' to address DEV2 settings. channel: The optional MFC Switchbox channel. 0 Disables the MFC Switchbox. 1 to 5 Enables the MFC Switchbox selects the MFC channel to use for optional MFC Switchbox. mode: The electrical mode. 'v' Voltage control and measure mode. The selected channel will be used for voltage setting and measuring 'mA' Current loop control and measure mode. The selected channel will be used for current loop setting and measuring. ' ' If this argument is not given, the MFC-CB will use the selected channel to measure the voltage, and will always use channel 1 to set the voltage. This is used to measure voltage MFM's that are connected to channels 2 through 5 with an MFC controlling on channel 1.
Defaults	"MFCCH*n*=1,V"
Remarks	The MFC-CB supports voltage or current controlled MFC's. There is also an available MFC Switchbox, which is assigned to either "DEV1" or "DEV2", depending on the last MFCCH*n* sent.
Example	Command: "MFCCH1=2,V" Reply: "2, V"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid ERR# 43: mA only available with Switchbox channel set to '1'
See Also	3.1.2.4, 3.4.6

POWER=	
Purpose	Turns the MFC-CB's soft power ON/OFF.
Syntax	"POWER=state"
Arguments	state: '0' to power the MFC-CB OFF '1' to power the MFC-CB ON
Remarks	The MFC-CB will automatically power up when it receives a remote command while in soft power OFF.
Example	Command: "POWER=1" Reply: "POWER=1"
Errors	ERR# 7: The state argument is not a '0' or a '1'
See Also	3.1.2.3

REMOTE	
Purpose	Enable remote local lockout operation.
Syntax	"REMOTE"
Remarks	A "REMOTE" command deactivates the front panel. All front panel controls are disabled. The "REMOTE" command can only be canceled by a "LOCAL" command or by turning the MFC-CB power OFF and then ON.
Example	Command: "REMOTE" Reply: "REMOTE"
See Also	"LOCAL"

RESET	
Purpose	Reset the MFC-CB to the default operating parameters.
Syntax	"RESET"
Remarks	The "RESET" command can be given to return certain MFC-CB settings to a default state. This reset corresponds to the RESET - SETS function from the front panel.
Example	Command: "RESET" Reply: "RESET"
See Also	3.4.1.1, "*RST"

RES(*n*)(=)	
Purpose	Read or set the front panel display resolution.
Syntax	"RES*n*=%FS" "RES*n*"
Arguments	*n*: Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 '2' to address DEV2 %FS: The %FS resolution (1 to 0.01 %).
Defaults	"RES*n*=0.010%"
Remarks	The display resolution affects only the front panel display resolution. Remote responses always have full resolution.
Example	Command: "RES1=0.1" Reply: "0.100"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid
See Also	3.3.3

SCRSAV(=)	
Purpose	Read or set the front panel screen saver period.
Syntax	"SCRSAV=period" "SCRSAV"
Default	"SCRSAV=10"
Arguments	Period: The period of inactivity before the display dims.
Remarks	The MFC-CB display will dim after a period of inactivity.
Example	Command: "SCRSAV=60" Reply: "60 "
Errors	ERR# 6: The data given is invalid
See Also	3.4.3.1

SN	
Purpose	Read the serial number of the MFC-CB.
Syntax	"SN"
Remarks	Each MFC-CB is serialized. This serial number is also imprinted on the product label on the bottom of the MFC-CB and is displayed in the power up introductory screen.
Example	Command: "SN" Reply: "SN"

TEXT:CLR*n*=	
Purpose	Clear text from the front panel.
Syntax	"TEXT:CLR*n*=size"
Arguments	*n*: The position on the front display to start clearing (1 to 40) size: The number of positions to clear (41 - *n*)
Remarks	The MFC-CB normally displays the measurement data while in remote, but can also be used to indicate user text. The "TEXT:CLRn=" command is used to clear sections of user text from the screen. Reverting to local operation or selecting a display type ("DISP=" command) will return the display to normal operation.
Example	Command: "TEXT:CLR1=20 Reply: "20"
Errors	ERR# 6: The data given is invalid ERR# 10: The prefix "*n*" is invalid
See Also	"TEXT*n*=", "DISP"

TEXT*n*=	
Purpose	Specify text to be written to the MFC-CB's front panel display.
Syntax	"TEXT*n*=text"
Arguments	*n*: The position on the front display to display the text (1 to 40) text: The text to display
Remarks	The MFC-CB normally uses the same displays in remote mode as in local operation, but the display can also be used to indicate user text. The "TEXTn=" command clears the display if the normal measurement data is still being displayed before displaying the text. Subsequent use of this command simply overwrites the current user text. Reverting to local operation or selecting a display type ("DISP=" command) will return the display to normal operation.
Example	Command: "TEXT21=The bottom line" (displays on the bottom line) Reply: "The bottom line""
Errors	ERR# 2: The data given is too large ERR# 10: The prefix "*n*" is invalid
See Also	"TEXT:CLR*n*=", "DISP="

TIME(=)	
Purpose	Read or set the internal clock time.
Syntax	"TIME" "TIME=hh:mmxx
Arguments	hh:mmxx: The time to set in the format where hh is the hours from 1 to 12, mm is the minutes from 1 to 59 followed by "am" or "pm".
Example	Comman "TIME=1:22am" "01:22am" Reply:
Errors	ERR# 7: The time given is invalid
See Also	3.4.3.3

VER	
Purpose	Read the MFC-CB embedded software version.
Syntax	"VER"
Remarks	The embedded software version of the MFC-CB can be read. This is useful for checking for the presence of the MFC-CB and for reference purposes.
Example	Command: "VER" Reply: "DH INSTRUMENTS, INC MFC-CB Ver1.00"

VIN(*n*)		
Purpose	Read the MFC measurement voltage if in voltage mode.	
Syntax	"VIN*n*"	
Arguments	*n*:	Device channel number (optional). Uses the active device channel if not given. '1' to address DEV1 '2' to address DEV2
Remarks	The MFC-CB can measure the voltage signal from an MFC/MFM. The MFC-CB must be in voltage mode before this can be done (see the "MFCCH" command). The returned data is always in volts.	
Example	Command: Reply:	"VIN2 "1.0137 V"
Errors	ERR# 10: ERR# 43:	The prefix "*n*" is invalid Not in volts mode
See Also	3.2.2, "DEV"	

VOUT(*n*)(=)		
Purpose	Read or set the voltage set point if in voltage mode.	
Syntax	"VOUT*n*" "VOUT*n*=volts"	
Arguments	*n*: volts:	Device number (optional). Uses the active device if not given. '1' to address DEV1 '2' to address DEV2 The voltage to be output (0 to 6 volts).
Defaults	"VOUT*n*=0"	
Remarks	The MFC-CB can output a voltage setpoint. The initial voltage is set, and then corrected if needed according to the measurement of the "sense" input. The MFC-CB must be in voltage mode before this can be done (see the "MFCCH" command). The data is always in volts.	
Example	Command: Reply:	"VOUT1=2" "2.0000 V"
Errors	ERR# 7: ERR# 10: ERR# 43:	The voltage is invalid The prefix "*n*" is invalid Not in volts mode
See Also	3.2.8, 7.1.1, "MFCCH", "VSENSE"	

VSENSE(*n*)	
Purpose	Read the voltage sensed at the MFC/MFM terminal.
Syntax	"VSENSE*n*"
Arguments	*n*: Device number (optional). Uses the active device if not given. '1' to address DEV1 '2' to address DEV2
Remarks	The MFC-CB uses a voltage sense line to measure the voltage present at an external MFC. This sense voltage is used to re-adjust the voltage sent to the MFC to compensate for line losses.
Example	Command: "VSENSE1 Reply: "2.00037 V"
Errors	ERR# 10: The prefix "*n*" is invalid ERR# 43: Not in volts mode
See Also	3.2.8, 7.1.1, "MFCCH", "VOUT"

VVALTEST(*n*)	
Purpose	Read voltage at MFC valve test terminal.
Syntax	"VVALTEST*n*"
Arguments	*n*: Device number (optional). Uses the active device if not given. '1' to address DEV1 '2' to address DEV2
Remarks	The MFC-CB provides an input to measure the MFC valve test voltage. This measurement is referenced to the MFC –15 Volt supply.
Example	Command: "VVALTEST1 Reply: "6.2371 V"
Errors	ERR# 10: The prefix "*n*" is invalid
See Also	"MFCCH"

4.4 STATUS SYSTEM

The status system includes the status reporting system which reports general MFC-CB events. The user can select which MFC-CB events will cause a status change event. These events are then reported to the status system (bit7 and bit3 of the status byte register), which also must be configured for the STATus subsystem to generate the service requests described in Section 4.4.1.

There are two 16 bit event registers that make up the top layer of the status subsystem. The OPERation status register handles conditions that are normal for the MFC-CB. The QUEStionable status register handles events that could cause measurements to be made under questionable conditions.

4.4.1 STATUS REPORTING SYSTEM

The MFC-CB status reporting system is used to track and report system status and errors. The status subsystem is layered under and reports to the status reporting system. It follows the model of the IEEE STD. 488.2 and works for the COM1 and the IEEE-488 port with slight differences. The MFC-CB can be programmed to respond to various status conditions by asserting the SRQ of the IEEE-488 interface. The COM1 port cannot be supported in this manner, so polling must be used.

4.4.1.1 STATUS BYTE REGISTER

The MFC-CB contains an 8 bit status byte register that reflects the general status of the MFC-CB.

Table 10. Status Byte Register

OPER (128)	RQS/MSS (64)	ESB (32)	MAV (16)	N/A (8)	ERROR (4)	N/A (2)	RSR (1)

This register is affected by the MFC-CB reply output queue, the error queue, the Standard Event Status register the Ready Event Status register, and the STATus subsystem.

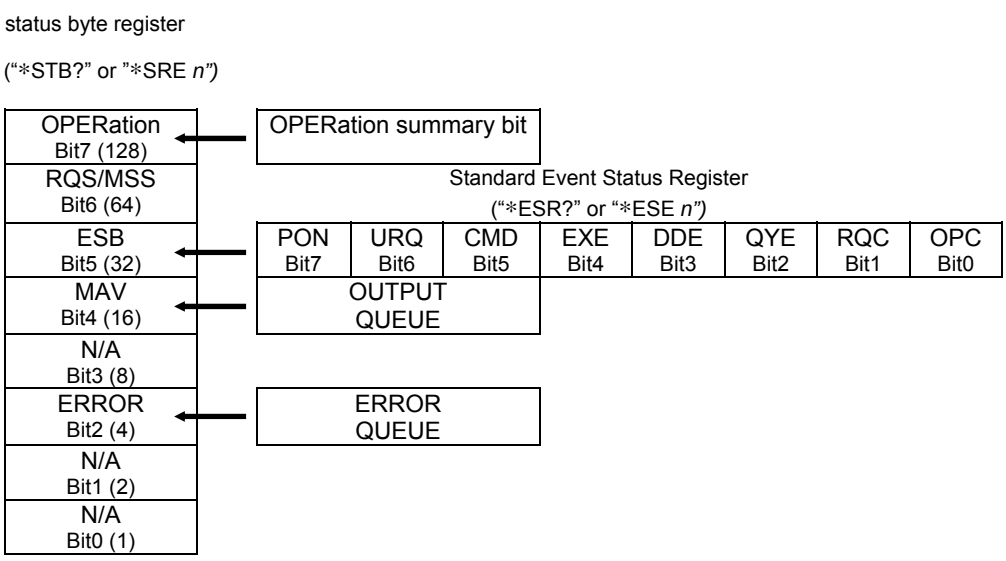


Figure 6. Status Byte Register

The status byte register can be read using the "*STB?" query, or by performing a serial poll on the IEEE-488 bus. If you read this using a serial poll then Bit 6 is the RQS. If the "∗STB?" query is used, then Bit 6 is the MSS bit. All of the other bits are common to both types of query.

Each of these status bits can cause an SRQ to occur. The Service Request Enable Register ("∗SRE" program message) determines which of these flags are able to assert the SRQ line. This enable register has a matching set of bits that each will enable the designated bit to cause an SRQ, except for the RQS/MSS bit(s) which cannot cause an SRQ. If you set this register to 20 ($14 hex), an SRQ will occur if the MAV or the ERROR bit are set. The description of these bits are given as:

- OPER: OPERational event register summary bit (Bit 7)

  This bit is not supported by the MFC-CB.

- RQS: Requested Service (Bit 6)

  Indicates that the SRQ line of the IEEE-488 interface has been asserted by the MFC-CB. This bit is cleared when a serial poll is performed on the MFC-CB, and is a part of the status byte register when read using a serial poll. This bit does not apply if the COM1 port is being used.

- MSS: Master Summary Status (Bit 6)

  Indicates that an event or events occurred that caused the MFC-CB to request service from the Host, much like the RQS bit. Unlike the RQS bit, it is READ ONLY and can be only cleared when the event(s) that caused the service request are cleared.

- ESB: Event Summary Bit (Bit 5)

  Indicates if an enabled bit in the Standard Event Status Register became set. (See Section 4.4.1.2.)

- MAV: Message Available Bit (Bit 4)

  Indicates that at least one reply message is waiting in the MFC-CB IEEE-488 output queue.

- ERR: Error Queue not empty (Bit 2)

  Indicates that at least one command error message is waiting in the MFC-CB IEEE-488 error message queue. Use the "ERR" command to get this message.

4.4.1.2 STANDARD EVENT REGISTER

The MFC-CB contains an 8 bit Standard event register that reflects specific MFC-CB events. Enabled events in this register will set or clear the ESB bit of the status byte register.

Table 11. Standard Event Register

PON (128)	URQ (64)	CMD (32)	EXE (16)	DDE (8)	QYE (4)	RQC (2)	OPC (1)

This register can be read using the "*ESR?" query. Each of these status bits can set the ESB bit of the status byte register, causing an SRQ to occur IF the ESB bit is enabled to do so. The Standard Event Status Enable Register ("*ESE" program message) determines which of these flags are able to assert the ESB bit. The description of these bits are given as:

- PON: Power On (Bit 7)

  Indicates that the MFC-CB power has been cycled since the last time this bit was read or cleared.

- URQ: User Request (Bit 6)

  Indicates that the MFC-CB was set to local operation manually from the front panel by the user (pressing the ESC key).

- Command Error (Bit 5)

  Indicates that a remote command error has occurred. A command error is typically a syntax error in the use of a correct program message.

- EXE: Execution Error (Bit 4)

  Indicates if a remote program message cannot be processed due to device related condition.

- DDE: Device Dependent Error (Bit 3)

  Indicates that an internal error has occurred in the MFC-CB (e.g., a transducer time-out).

- QYE: Query Error (Bit 2)

  Indicates that an error has occurred in the protocol for program message communications. This is typically caused by a program message being sent to the MFC-CB without reading a waiting reply.

- RQC: Request Control (Bit 1)

  This bit is not supported as the MFC-CB cannot become the active controller in charge.

- OPC: Operation Complete (Bit 0)

  Indicates that the MFC-CB has completed all requested functions.

5. MAINTENANCE, ADJUSTMENTS AND CALIBRATION

5.1 OVERVIEW

MFC-CB was designed for maintenance free operation. No maintenance is required other than:

- **Electrical Output and Measurement Calibration:** The stability of the analog voltage and current measurements over time is dependent upon the conditions of use. The MFC-CB voltage and current functions should be verified regularly. See Section 5.2 for instructions.

Calibration, maintenance and repair services for MFC-CB are offered by DHI Authorized Service Providers (see Table 18).

MFC-CB is a sophisticated measurement and control instrument with advanced on-board features and functions. Before assuming that unexpected behavior is caused by a system defect or breakdown, use this manual to become thoroughly familiar with MFC-CB operation. For rapid assistance in specific situations and other troubleshooting information, see Section 6.

MFC-CB is covered by a limited one year warranty (see Section 7.5). Unauthorized service or repair during the warranty period is undertaken at the owner's risk and may cause damage that is NOT covered under product warranty and/or may void the product warranty.

5.2 VERIFICATION AND CALIBRATION OF ELECTRICAL SIGNALS

5.2.1 PRINCIPLE

MFC-CB set and reads voltage and current values on two device channels (DEV1, DEV2).

The MFC-CB signals (each on 2 channels, DEVICE 1 and DEVICE 2) are:

- Set (V and mA): The electrical output. The "entered", "displayed" or "nominal" set value is the value input by the user and displayed on the MFC-CB front panel. The "actual" set value is the value actually output by MFC-CB.

  The "entered" and "actual" set values may differ due to the Sense adjustment. The Sense line (see immediately below) measures the actual set output. MFC-CB automatically adjusts the "actual" set value to make the Sense value agree with the "entered" set value compensated by the K factor and adjustment factors when applicable (see Section 7.1).

- Sense (V): Measurement of the set output. The set output is adjusted automatically by MFC-CB to cause the Sense to agree with the "entered" set.

- Measure (V and mA): Return from the MFC or MFM flow sensor.

- Valve (V): Direct measurement of the MFC internal valve voltage.

The MFC-CB measures voltage and uses on-board 5 and 10 V references to improve stability over time. Voltage is converted to current using a precision 250 Ω resistor. The values of the voltage references and resistor are determined and entered as part of the original factory adjustment procedure and are accessible to **DHI** Authorized Service Providers only.

For calibration after the original factory calibration, each MFC-CB signal can be adjusted mathematically using an *adder* and a *multiplier*. The normal procedure is to execute the process automatically using **CalTool for Analog** software provided on the General Accessories CD delivered with the MFC-CB and the special calibration cable included in the accessories. See the **CalTool for Analog** User's Manual on the General Accessories CD for complete instructions. MFC-CB *adders* and *multipliers* can also be edited locally from the front panel (see Section 5.2.2) or remotely (see Section 4.3).

See Section 7.2 for MFC-CB device channel connector pin outs.

CalTool for Analog and its User's Manual are available for free download at www.dhinstrument.com.

5.2.2 FRONT PANEL ADJUSTMENT OF ELECTRICAL SIGNALS

5.2.2.1 PRINCIPLES

See Section 5.2.1 for general information on the principles of MFC-CB electrical signal adjustment.

MFC-CB provides front panel capability to mathematically adjust each of the MFC-CB electrical output and input signals. The adjustments are accomplished by an *adder* and *multiplier* that is used to offset and adjust the slope of each signal's response.

The *adder* (A) and *multiplier* (M) affect the signal as follows:

Corrected Value = (Uncorrected Value X Multiplier) + Adder

Where:

- Corrected value, uncorrected value and *adder* are in the current unit of measure.
- *Multiplier* is dimensionless.

[SPECIAL], **<4cal>** provides capabilities to view each electrical signal value real time and edit its *adder* and *multiplier*. To calibrate or adjust the electrical signals, compare their values to a reference and adjust the corresponding *adder* and/or *multiplier* as needed to arrive at acceptable agreement.

As editing *adder* and *multiplier* values alters MFC-CB's calibration, they should only be edited by qualified personnel as part of the calibration process. Caution should be taken to avoid accidental editing. For information on preventing access to calibration information, see Section 3.4.2.

A new MFC-CB is delivered with all calibration *adder* and *multiplier* values set to zero (0) and one (1) respectively. This does NOT mean that the MFC-CB has NOT been calibrated. For the original factory calibration, privileged factory coefficients are used for calibration adjustment. This allows a new MFC-CB to be delivered with "virgin" calibration coefficients of A = 0 and M = 1 for all signals.

To facilitate signal verification and calibration, the view screens of the MFC-CB local calibration function ([SPECIAL], <4cal>) display the device channel electrical signals affected only by their calibration *adder* and *multiplier*. K factor and adjustment factors are NOT applied (see Section 7.1).

See Section 7.2 for MFC-CB device channel connector pin outs.

5.2.2.2 <1SENSE>

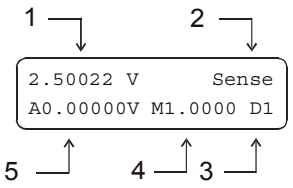
- **PURPOSE**

To view and adjust the readings of the device channel sense line.

See Sections 5.2.2.1 and 5.2.1 for information on MFC-CB device channel signal calibration.

- **OPERATION**

To **view** the reading of the sense line and the *adder*(A) and *multiplier*(M), press **[SPECIAL]**, **<4cal>**, select the desired device channel, and press **<1sense>**, **<1view>**. The display is:



1. Reading of the device channel Sense with the Sense cal *adder* and *multiplier* applied.
2. Indication that this is a display of the Sense signal.
3. Device channel indicator.
4. Current value of the *multiplier* applied to the Sense reading.
5. Current value of the *adder* (always in V) applied to the Sense reading.

While in the view screen, the **[SET MFC]** key is active so that set point values can be changed (see Section 3.2.8).

To **adjust** the value of the *adder* (A) and/or *multiplier* (M) press **[SPECIAL]**, select the desired device channel, and press **<1sense>**, **<2cal>** to access a screen in which the values of A and M can be edited. After entering the edited values, press **[ESCAPE]** and return to **<1sense>**, **<1view>** to view the sense line reading with the edited calibration coefficients applied.

See Section 5.2.1 for an explanation of adders and multipliers and their use in adjusting electrical settings and readings.

5.2.2.3 <2MEAS> (MEASURE)

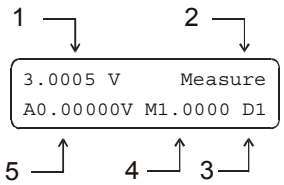
- **PURPOSE**

To view and adjust the device channel measure signal.

See Sections 5.2.2.1 and 5.2.1 for information on MFC-CB device channel signal calibration.

OPERATION

To **view** the device channel measure signal and the current measure *adder* (A) and *multiplier* (M), press **[SPECIAL]**, **<4cal>**, select the desired device channel, press **<2meas>**, select voltage or current, and press **<1view>**. The display is:



1. Measure value with the Measure cal *adder* and *multiplier* applied (V or mA).
2. Indication that this is a display of the Measure signal.
3. Device channel indicator.
4. Current value of the *multiplier* applied to the Measure reading.
5. Current value of the *adder* (V or mA) applied to the Measure reading.

While in the view screen, the **[SET MFC]** key is active so that set point values can be changed.

To **adjust** the value of the measure *adder* (A) and/or *multiplier* (M), press **[ESCAPE]** to return to the view/cal screen, and then press **<2cal>** to access a screen in which the values of A and M can be edited. After entering the edited values, press **[ESCAPE]** and return to **<1view>** to view the measure values with the edited calibration coefficients applied.

See Section 5.2.1 for an explanation of adders and multipliers and their use in adjusting electrical settings and readings.

5.2.2.4 <3SET>

PURPOSE

To view and adjust the device channel set command signal.

See Sections 5.2.2.1 and 5.2.1 for information on MFC-CB device channel signal calibration.

PRINCIPLE

The device channel set value is entered by the operator locally using **[SET MFC]** (see Section 3.2.8) or by remote command. Following execution of a set command, the actual set point value at the MFC is measured by the device channel sense line. The set point value is then automatically adjusted as needed (three iterations) to cause the value at the MFC to agree with the set command. This process compensates for the various electrical influences that can cause the electrical set value at the MFC to be different from the value output by the MFC-CB.

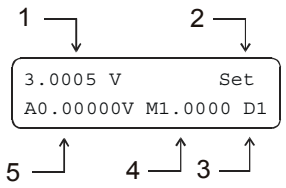
The calibration of the set value is used to minimize the amount of correction to the set point based on sense measurement that is necessary to achieve the desired set point at the MFC. This is accomplished by adjusting the set point value using an *adder* and a *multiplier* (see Section 5.2.1). When in the set view screen in the MFC calibration function, the set value displayed is the value actually output by MFC-CB after correction iterations based on the sense line readings. Thus, the difference between the set displayed and the set entered is the magnitude of the correction. Use the set *adder* and *multiplier* to minimize this value.

In normal MFC-CB operation, the actual set value may be modified by a K factor and/or adjustment factors in addition to the calibration coefficients (see Section 7.1). When in the set view screen of the MFC calibration function, K factors and adjustment factors are deactivated.

OPERATION

To **view** the device channel set value after sense line based corrections and the current set *adder* (A) and *multiplier* (M), press **[SPECIAL]**, **<4cal>**, select the desired device channel, press **<3set>**, select voltage or current, press **<1view>**.

The display is:



1. Set value after sense line based corrections with the Set *adder* and *multiplier* applied (V or mA).
2. Indication that this is a Set display.
3. Device channel indicator.
4. Current value of the *multiplier* applied to the Set value.
5. Current value of the *adder* (V or mA) applied to the Set value.

While in the view screen, the **[SET MFC]** key is active so that set point values can be changed. The set value displayed is the actual set value after sense line based corrections (see PRINCIPLE directly above).

To **adjust** the value of the *adder* (A) and/or *multiplier* (M), press **[ESCAPE]** to return to the view/cal screen, and then press **<2cal>** to access a screen in which the values of A and M can be edited. After entering the edited values, press **[ESCAPE]** and return to **<1view>** to view the set values with the edited calibration coefficients applied.

See Section 5.2.1 for an explanation of adders and multipliers and their use in adjusting electrical settings and readings.

5.2.2.5 <4VALVE>

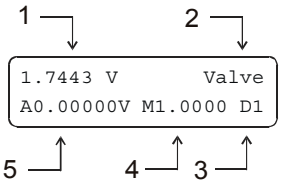
- **PURPOSE**

To view and adjust the device channel valve voltage signal.

See Sections 5.2.2.1 and 5.2.1 for information on MFC-CB device channel signal calibration.

- **OPERATION**

To **view** the device channel valve voltage signal and the current valve voltage *adder* (A) and *multiplier* (M), press **[SPECIAL]**, **<4cal>**, select the desired device channel, press **<4valve>**, **<1view>**. The display is:



1. Valve voltage value with the Valve *adder* and *multiplier* applied (V).
2. Indication that this is a display of the Valve signal.
3. Device channel indicator.
4. Current value of the *multiplier* applied to the Valve reading.
5. Current value of the *adder* (V or mA) applied to the Valve reading.

While in the view screen, the **[SET MFC]** key is active so that set point values can be changed.

To **adjust** the value of the valve voltage *adder* (A) and/or *multiplier* (M), press **[ESCAPE]** to return to the view/cal screen, and then press **<2cal>** to access a screen in which the values of A and M can be edited. After entering the edited values, press **[ESCAPE]** and return to **<1view>** to view the valve voltage values with the edited calibration coefficients applied.

See Section 5.2.1 for an explanation of adders and multipliers and their use in adjusting electrical settings and readings.

5.2.2.6 <5CAL DATE>

- **PURPOSE**

To view and edit the calibration date for the MFC-CB device channel.

- **OPERATION**

Press **[SPECIAL]** and select **<4cal>**. After selecting the device channel, select **<5date>**. The date format is YYYYMMDD.

There is only one calibration date for both device channels (DEV1 and DEV2).

5.3 RELOADING EMBEDDED SOFTWARE INTO FLASH MEMORY

MFC-CB uses FLASH memory. This allows the embedded software that controls MFC-CB operations and functions to be loaded into MFC-CB over its COM1 port from a computer with a simple FLASH loading utility.

To replace corrupted software or upgrade your software, access the **DHI** worldwide web site at www.dhinstruments.com and go to "SOFTWARE" located under "SUPPORT". A FLASH loading utility and the latest MFC-CB software are available for download at no charge. If you do not have access to the web or have difficulty downloading or loading software, contact your **DHI** representative or a **DHI** Authorized Service Provider for assistance.

If you believe you have discovered an error or "bug" in MFC-CB software, please report it with complete details by email to dhi@dhinstruments.com or submit an on-line "Quality Feedback" report at www.dhinstruments.com.

The DHI flash software loading utility and MFC-CB embedded software are available for download from the "SOFTWARE" section located under "SUPPORT" at DHI's world wide web site, www.dhinstruments.com.

6. TROUBLESHOOTING

6.1 OVERVIEW

MFC-CB is a sophisticated measuring instrument with advanced on-board features and functions. Before assuming that unexpected behavior is caused by a system defect or breakdown, the operator should use this manual and other training facilities to become thoroughly familiar with MFC-CB operation. This troubleshooting guide is intended as an aid in identifying the cause of unexpected MFC-CB behavior and determining whether the behavior is due to normal operation or an internal or external problem.

Identify the symptom or unexpected behavior you are observing from the **SYMPTOM** list below. A **PROBABLE CAUSE** is provided and a **SOLUTION** is proposed including references to manual sections that provide information that may be of assistance.

Table 12. Troubleshooting Checklist

SYMPTOM	PROBABLE CAUSE	SOLUTION
Will NOT power up.	Blown fuse.	Replace fuse.
Front panel keys seem to be disabled.	"REMOTE" command has been sent from a host computer.	Send "LOCAL" command from host computer or cycle MFC-CB power. (4.3)
Front panel display is dim.	Screen saver option has activated.	Press any key to resume full screen power, adjust screen saver activation time if desired. (3.4.3.1)
Keypad presses make undesired sounds or no sounds.	Keypad sound settings are incorrect.	Use SOUND function to set keypad sounds as desired. (3.4.3.2)
Cannot access certain functions. Display shows: **<ACCESS RESTRICTED>.**	Current user level setting restricts access to that function.	Change user level or consult system manager. (3.4.2)
Cannot establish communication over remote interface.	Computer and/or MFC-CB interface not correctly configured; incorrect or bad interface cable.	Check and correct interface settings and cables. Run COM port test. (3.4.5)
Display shows **<FATAL ERROR>** or **<FATAL FAULT>**.	Encountered unresolved internal software conflict.	Cycle power to clear. Please record conditions leading up to event including the numbers displayed when **[ENTER]** is pressed and report to **DHI** Authorized Service Provider.
Displays **<******>** where a numerical value should go.	Number to be displayed is too large for allocated space. Usually due to an erroneous setting or measurement causing an out of limit value to be calculated.	Check settings that may be causing an out of limit value and adjust if necessary. (3.2.1, 3.3.5)

Table 12. Troubleshooting Checklist (Continued)

SYMPTOM	PROBABLE CAUSE	SOLUTION
Bottom line of display has changed and you want to change it back.	The DISPLAY function has been used to change the display.	Use **[DISPLAY]** to set bottom line to desired display. (3.2.4)
Bottom line of display is blank.	DISPLAY mode is “clean”.	Operation is normal. Use **[DISPLAY]** to change bottom line display if desired. (3.2.4.6 and 3.2.4)
Measured value appears to be grossly incorrect.	Your assumption of flow in the system is grossly incorrect.	Check and adjust flow in the system. Verify that upstream and downstream conditions will permit the expected level of flow to be achieved.
Set point and/or measure value appear to be incorrect.	A K factor and/or adjustment factor are applied but are not being considered.	Use **[K]** to adjust K factor and/or **[SETUP]**, **<5adj>** to modify the adjustment function. (3.2.1, 3.3.5)
Measure indication is negative.	The flow through the MFC or MFM is reverse from the direction you expected.	Check system and correct flow.
Set point and display values have too much or not enough resolution.	Resolution setting needs to be changed.	Use **[SETUP]**, **<3res>** to change display resolution setting. (3.3.3)
Set point entry is causing an out of range error even though set point value entered is in range.	K factor and/or adjustment factors can cause the actual set point to be different from the entered set point.	Consider the active K factor and/or adjustment factors. Use **[K]** to adjust K factor and/or **[SETUP]**, **<5adj>** to modify the adjustment function. (3.2.1, 3.3.5)
Set point entry is causing the error **<MFC profile is not a controller>** to display.	Active MFC profile is for a measuring, not a controlling device. To enter and execute set points the active MFC profile must specify that the device is a controller.	Select an MFC profile for the active device channel that specifies a controller. Create the MFC profile first if necessary. (3.2.6, 3.3.1)
Would like to display set point and measurement in a unit of flow but none is available under **[UNIT]**.	The active MFC profile is default profile #1 or #2 that does not support a flow unit.	Use **[MFC]** to select a custom MFC profile that specifies the desired flow unit. Create the MFC profile first if necessary. (3.2.6, 3.3.1)
Set point entries and other settings are not having the expected effect on operation.	Incorrect active device channel. MFC-CB operates on two channels (DEV1, DEV2) and many settings and functions affect only the active channel.	Operation is normal. Observe the active channel indicator display to confirm that the expected channel is active. Check that the MFC or MFM being controlled is connected to the correct rear panel connection (DEVICE 1 or DEVICE 2). (3.1.2.4, 3.2.5)
The active device channel indicator has extra characters. For example D1, 5 instead of D1.	An MFC Switchbox has been set up for the device channel and extra characters are the selected MFC Switchbox channel.	Use **[SPECIAL]**, **<6xbox>** to deactivate the MFC Switchbox for the active channel. (3.4.6)

7. APPENDIX

7.1 CALCULATIONS

7.1.1 ELECTRICAL SET POINT AND MEASUREMENT CALCULATIONS

MFC-CB outputs electrical values in response to output commands from the user. It also measures electrical values. The output and measurement values can be adjusted by various user coefficients including the calibration coefficients (see Section 5), a K factor (see Section 3.2.1) and adjustment factors (see Section 3.3.5).

- **The electrical value to output in response to a user set point entry** is calculated following:

$$S = \frac{\left(S_{act,E} - S_0\right) \cdot m_{S,cal} + a_{S,cal}}{K} \cdot m_{S,adj} + a_{S,adj} + S_0$$

Where:

S = Electrical signal to output
$S_{act,E}$ = Set point target value entered by user and displayed by MFC-CB
S_0 = Electrical value output corresponding to zero flow
$m_{S,cal}$ = Set calibration *multiplier* (see Section 5.2.2.4)
$a_{S,cal}$ = Set calibration *adder* (see Section 5.2.2.4)
K = Gas conversion factor if active unit of measure is a flow unit (see Section 3.2.1)
$m_{S,adj}$ = Set adjustment function *multiplier* (see Section 3.3.5)
$a_{S,adj}$ = Set adjustment function *adder* (see Section 3.3.5)

- **The measured electrical value to display** is calculated following:

$$M_E = \left(\left(M_{act} - M_0\right) \cdot m_{M,cal} + a_{M,cal}\right) \cdot K \cdot m_{M,adj} + a_{M,adj} + M_0$$

Where:

M_E = Displayed electrical measured value
M_{act} = Unmanipulated electric signal reading
M_0 = Electrical value corresponding to zero flow
$m_{M,cal}$ = Measure calibration *multiplier* (see Section 5.2.2.3)
$a_{M,cal}$ = Measure calibration *adder* (see Section 5.2.2.3)
K = Gas conversion factor if active unit of measure is a flow unit (see Section 3.2.1)
$m_{M,adj}$ = Measure adjustment function *multiplier* (see Section 3.3.5)
$a_{M,adj}$ = Measure adjustment function *adder* (see Section 3.3.5)

Note that:

1. All values are device channel specific.
2. In some cases, the displayed set and measure values are in a unit of flow or %FS. In this case they must be converted to and from electrical values prior to or just after the electrical value calculations (see Section 7.1.2).
3. When the display unit of measure is *electrical* or %FS, K = 1 (has no effect).

7.1.2 CONVERTING BETWEEN ELECTRICAL UNITS AND FLOW OR %FS UNITS

MFC-CB sets and reads electrical values to and from an MFC or MFM. When a custom MFC profile is in use (see Section 3.3.1), a flow unit and range are specified in addition to the electrical unit and range. In this case, MFC-CB can accept set point entries and display measurement readings in a flow unit of measure.

- **To convert a set point entry made in a flow unit of measure to an electrical value** MFC-CB first converts the flow value into an electrical value and then follows the electrical value to output in response to a user set point entry calculation to determine the true electrical signal to output (see Section 7.1.1). The conversion of a flow unit entry into an electrical value is made following:

$$S_{act,E} = S_{act,F} \cdot \frac{S_{FS,E} - S_0}{S_{FS,F}} + S_0$$

Where:

$S_{act,E}$ = Set point electrical value
$S_{act,F}$ = Set point flow value
$S_{FS,E}$ = Electrical value output corresponding to full scale flow
S_0 = Electrical value output corresponding to zero flow
$S_{FS,F}$ = Full scale flow value

For example, if the MFC profile specifies a 0 to 5 V electrical range and a 0 to 100 sccm flow range, a set point of 20 sccm is converted to an electrical value following:

$$S_{act,E} = 20[sccm] \cdot \frac{5[V] - 0[V]}{100[sccm]} + 0[V] = 1[V]$$

or, if an MFC profile specifies a 4 to 20 mA electrical range and a 0 to 100 sccm flow range, a set point of 20 sccm is converted to an electrical value following:

$$S_{act,E} = 20[sccm] \cdot \frac{20[mA] - 4[mA]}{100[sccm]} + 4[mA] = 7.2[mA]$$

- **To convert an electrical measurement into a flow unit** MFC-CB first follows the regular electrical value to display calculation (see Section 7.1.1) and then converts the electrical value into a flow value. The conversion of an electrical value into a flow value is made following:

$$M_F = (M_E - M_0) \cdot \frac{M_{FS,F}}{M_{FS,E} - M_0}$$

Where:

M_F = Displayed flow measured value
M_E = Displayed electrical measured value
M_0 = Electrical value corresponding to zero flow
$M_{FS,E}$ = Electrical value output corresponding to full scale flow
$M_{FS,F}$ = Full scale flow value

For example, if the MFC profile specifies a 4 to 20 mA electrical range and a 500 sccm FS flow range, a reading of 12 mA is converted to a flow value following:

$$M_F = (12[mA] - 4[mA]) \cdot \frac{500[sccm]}{20[mA] - 4[mA]} = 250[sccm]$$

7.2 DEVICE CHANNEL CONNECTORS AND CABLES

Use Table 13 to wire the interfacing cable required to connect an MFC-CB DEV1 or DEV2 connector to an MFC or MFM. Section 7.2.1 provides information on some common MFC cable setups.

Table 13. MFC-CB DEV1 and DEV2 Connector Pin Out

MFC-CB DEV1, DEV2 25 PIN DSUB CONNECTOR PIN NO.	SIGNAL	SIGNAL DESCRIPTION
1	Case Ground	Earth ground for shielding.
2	Supply Common	Ground line for the MFC's power connection. It is frequently referred to as "Power Common", "Supply Common", or just "Common".
3	MFC Measure (+)	Positive Voltage signal that represents the MFC's measure. It is commonly referred to as "output" or "signal output".
4	+15 Volts	Positive MFC or MFM supply.
5	N/C	No connection, no signal.
6	N/C	No connection, no signal.
7	Set Point Sense (-)	Ground reference for the MFC set point sense. It should be connected to the same point as the MFC set point (-) line.
8	N/C	No connection, no signal.
9	N/C	No connection, no signal.
10	N/C	No connection, no signal.

Table 13. MFC-CB DEV1 and DEV2 Connector Pin Out (Continued)

MFC-CB DEV1, DEV2 25 PIN DSUB CONNECTOR PIN NO.	SIGNAL	SIGNAL DESCRIPTION
11	Valve Test	Used for direct measurement of the MFC internal valve voltage. Not available on all MFCs.
12	Current MFC Measure (+)	Only used for current controlled devices. This is the mA signal that represents the MFC's measure.
13	Current MFC Set (+)	Only used for current controlled devices. This is the mA signal that defines the desired set point for the MFC. It is frequently referred to as the "MFC control signal" or the "MFC set point".
14	MFC Set point (+)	Desired set point for the MFC. It is the signal that controls the amount of gas that the MFC will flow. Generally a 0 to 5 Volt signal where 0 V causes the valve to close (zero flow) and 5 V causes full scale flow. This signal is commonly referred to as "MFC set point", "MFC set voltage", "MFC command", or "MFC control".
15	MFC Set point (-)	Ground reference for the MFC Set point signal. It is frequently referred to as "Signal Common", or "Common".
16	MFC Measure (-)	Ground reference for the MFC measure signal. It is frequently referred to as "Signal Common", or "Common".
17	Valve Test Common	Negative –15 Volt supply for the MFC's valve test circuit. Most MFCs utilize this line by connecting it to the –15 Volt supply line.
18	N/C	No connection, no signal.
19	-15 Volts	Negative MFC or MFM supply.
20	Set Point Sense (+)	Used by the MFC-CB to detect loss along the MFC cable. Represents the positive MFC set point as seen by the MFC. This line should be connected to the same point as the MFC Set point (+) line at the MFC side of the cable.
21	N/C	No connection, no signal.
22	N/C	No connection, no signal.
23	N/C	No connection, no signal.
24	N/C	No connection, no signal.
25	N/C	No connection, no signal.

7.2.1 POPULAR CONFIGURATIONS

The following configuration can be used with most card edge style MFCs. Any differences tend to relate to the handling of the ground (common) lines (pins 2, B and C). Most cable problems can be resolved by either shorting pins B and C or by swapping the signals connected to pin 2 of the card edge connector with the signals connected to pin B of the card edge connector. The configuration below should work with the following MFCs.

- Millipore (Tylan) model FC260, 261, 262, FM 360, 361, 362
- Qualiflow AFC 260, 261, 202, 360, 361, 302
- Aera 2600, 2610, 2620, 3600, 3610, 3620
- PFD 501
- Porter 201
- Unit Instruments models UFC 1000,1020, 1100,1200, 1400, 1500

Table 14. Common MFC Connector Pin Out

MFC-CB DEV1, DEV2 25 PIN DSUB CONNECTOR PIN NO.	SIGNAL DESCRIPTION	MFC CARD EDGE CONNECTOR PIN NO.
1	Case Ground	1 (A1)
2	Supply Common	2 (A2)
3	MFC Measure (+)	3 (A3)
4	+15 Volts	4 (A4)
7	Set Point Sense (-)	B (B2)
11	Valve Test	D (Optional) (B4)
14	MFC Set point (+)	A (B1)
15	MFC Set point (-)	B (B2)
16	MFC Measure (-)	C (B3)
17	Valve Test Common	F (Optional) (B6)
19	-15 Volts	F (B6)
20	Set Point Sense (+)	A (B1)

The following configuration can be used with:

- Brooks model 5850E, and 5851E

Table 15. Brooks MFC Connector Pin Out

MFC-CB DEV1, DEV2 25 PIN DSUB CONNECTOR PIN NO.	SIGNAL DESCRIPTION	MFC CARD EDGE CONNECTOR PIN NO.	MFC 15 PIN DSUB CONNECTOR PIN NO.
1	Case Ground	1 (A1)	14
2	Supply Common	C (B3)	9
3	MFC Measure (+)	3 (A3)	2
4	+15 Volts	4 (A4)	5
7	Set Point Sense (-)	2 (A2)	10
11	Valve Test	D (Optional) (B4)	7 (Optional)
14	MFC Set point (+)	A (B1)	8
15	MFC Set point (-)	2 (A2)	10
16	MFC Measure (-)	B (B2)	10
17	Valve Test Common	F (Optional) (B6)	10 (Optional)
19	-15 Volts	F (B6)	6
20	Set Point Sense (+)	A (B1)	8

7.3 DRIVERS

The MFC-CB drivers option provides eight open collector drivers for operating external valves, solenoids, indicators, etc. When operating from the setup-driver screen (see Section 3.2.7), pressing **[ENTER]** allows the **operating** mode of the drivers to be set. The two modes of operation are Momentary and Toggle. A **momentary** driver changes state while the corresponding driver number on the keyboard is being pressed. In **toggle** mode, the driver state toggles each time the corresponding key is pressed and released.

Each output can sink 500 mA at 12 V. However, the total output of all the activated drivers cannot exceed 1 Amp. Therefore, if multiple drivers are being activated, refer to Table 16 as a guide.

Table 16. Driver Output

# OF ACTIVE DRIVERS	MAX CURRENT PER OUTPUT
1	500 mA
2	400 mA
3	275 mA
4	200 mA
5	160 mA
6	135 mA
7	120 mA
8	100 mA

The male connector (P/N 102478) for the DRIVERS port is supplied with the MFC-CB accessories if the driver option was ordered. Table 17 and Figure 7 should be used as reference when building a cable to utilize the drivers port.

Table 17. External Drivers

EXTERNAL DRIVERS		
PIN	**DESCRIPTION**	
A	D1	Driver #1 (Open Collector)
C	D2	Driver #2 (Open Collector)
E	D3	Driver #3 (Open Collector)
G	D4	Driver #4 (Open Collector)
M	D5	Driver #5 (Open Collector)
J	D6	Driver #6 (Open Collector)
K	D7	Driver #7 (Open Collector)
L	D8	Driver #8 (Open Collector)
B		Drivers (+12V)
D		Drivers (+12V)
F		Drivers (+12V)
H		Drivers (+12V)

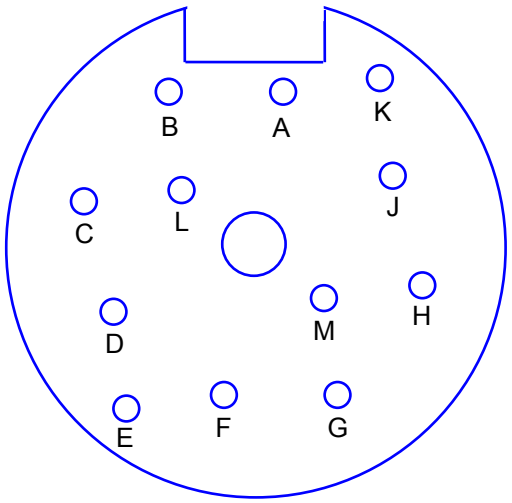


Figure 7. Driver Cable Schematic

7.4 GLOSSARY

A (*adder*)	A value that is added to a set point or measurement to offset the value.
Clean	A DISPLAY function in which the second line of the display is blank (clean) except for the active channel indicator.
DEV1&2	A DISPLAY function in which DEVICE 1 and DEVICE 2 are displayed simultaneously. DEVICE 1 set point and measurement are on the top line and DEVICE 2 set point and measurement are on the bottom line.
DEVICE 1, DEVICE 2	The two MFC-CB device channels on which analog signals can be output and measured.
Device Channel	MFC-CB's two analog output/input channels are referred to as device channels (DEV1, DEV2).
Dif (Difference)	A DISPLAY function in which the difference between the measurement of the inactive device channel and the active device channel is displayed (inactive – active).
FS	Abbreviation of "full scale". The full scale value is the maximum value or the span of a measurement range. Limits and specifications are often expressed as %FS.
K Factor	A factor representing the relationship between the process gas and a surrogate gas for an MFC pr MFM.
M (*multiplier*)	A value by which a setpoint or measurement is multiplied to change the slope of the set points or readings.
MFC	Acronym for mass flow controller, a device that sets flows in response to electrical set points.
MFC Profile	An MFC-CB on-board file that defines the electrical and corresponding flow range in which a device channel should operate.
MFM	Acronym for mass flow meter, a device that measures flow and outputs a proportional electrical signal.
Ratio	A DISPLAY function in which the ratio of the measurement on the inactive device channel and the active device channel is displayed (inactive/ active).
Set point	An analog signal sent to an MFC to cause it to set a flow.
Sum	A DISPLAY function in which the sum of the measurement on device channel 1 and device channel 2 is displayed.
Surrogate Gas	A gas whose behavior, from the standpoint of a device under test, is similar to the process gas for which the device is to be characterized and used. A surrogate gas is often used in calibration and testing when the process gas cannot be used for safety or cost reasons.
User Level	Level of security that can be set to prevent access to certain MFC-CB functions.

7.5 WARRANTY STATEMENT

Except to the extent limited or otherwise provided herein, **DH Instruments, a Fluke Company** (**DHI)** warrants for one year from purchase, each new product sold by it or one of its authorized distributors, only against defects in workmanship and/or materials under normal service and use. Products which have been changed or altered in any manner from their original design, or which are improperly or defectively installed, serviced or used are not covered by this warranty.

DHI and any of its Authorized Service Providers' obligations with respect to this warranty are limited to the repair or replacement of defective products after their inspection and verification of such defects. All products to be considered for repair or replacement are to be returned to **DHI**, or its Authorized Service Provider, freight prepaid, after receiving authorization from **DHI** or its Authorized Service Provider. The buyer assumes all liability vis-à-vis third parties in respect of its acts or omissions involving use of the products. In no event shall **DHI** be liable to purchaser for any unforeseeable or indirect damage, it being expressly stated that, for the purpose of this warranty, such indirect damage includes, but is not limited to, loss of production, profits, revenue, or goodwill, even if **DHI** has been advised of the possibility thereof, and regardless of whether such products are used individually or as components in other products.

Items returned to **DHI** under warranty claim but determined to not have a defect covered under warranty or do not have a defect at all are subject to an evaluation and shipping charge as well as applicable repair and/or calibration costs.

The provisions of this warranty and limitation may not be modified in any respect except in writing signed by a duly authorized officer of **DHI.**

The above warranty and the obligations and liability of **DHI** and its Authorized Service Providers exclude any other warranties or liabilities of any kind.

Table 18. DHI Authorized Service Providers

DH INSTRUMENTS, A FLUKE COMPANY AUTHORIZED SERVICE PROVIDERS			
COMPANY	**ADDRESS**	**TELEPHONE, FAX & EMAIL**	**NORMAL SUPPORT REGION**
DH Instruments, a Fluke Company	4765 East Beautiful Lane Phoenix AZ 85044-5318 USA	Tel 602.431.9100 Fax 602.431.9559 cal.repair@dhinstruments.com	Worldwide
Minerva Meettechniek B.V.	Chrysantstraat 1 3812 WX Amersfoort the NETHERLANDS	Tel (+31) 33.46.22.000 Fax (+31) 33.46.22.218 info@minervaipm.com	European Union
Ohte Giken, Inc. Technology Center	258-1, Nakadai, Kasumigaura-machi, Niihari-Gun Ibaraki, 300-0133 JAPAN	Tel 81.29.840.9111 Fax 81.29.840.9100 tech@ohtegiken.co.jp	Japan/Asia
DH Products Technical Service Division	National Institute of Metrology Heat Division Pressure & Vacuum Lab NO. 18, Bei San Huan Donglu Beijing 100013 PR CHINA	Tel 010.64291994 ext 5 Tel 010.64218637 ext 5 Fax 010.64218703 cxcen@mx.cei.gov.cn	Peoples Republic of China

NOTES