

BUILT-IN “ZERO-MIDSPAN-SPAN” DRIFT CHECK/CALIBRATOR

Introduction

Continuous Emissions Monitoring Systems (CEMS) have a long term stability verification requirement. Most of the equipment is verified using calibration gas sources substituted for the flue gas which it normally measures. The US EPA (40 CFR Part 60, Appendix B), requires a daily zero-span drift check which is below 25% for the zero and above 75% for the span. The system records its gas concentration once a day; a known concentration is tested at zero and span. Any drift in the gas analyzer, recording equipment, or DCS monitoring would show up as a shift in the daily zero span readings. Any significant deviations from the expected readings must be corrected or justified to the monitoring agency for their periodic audits.

To report total lb/day or Kg/day of a particular pollutant, you must know the total flow as well as the concentration of the pollutant. For the total process flow measurements, it is not practical to provide a 25% and 75% type flow signal simulation. So the EPA accepted an electronics substitution signal representing a zero and span flow. This is done as close to the front end of the flow meter as possible so the maximum amount of the signal processing chain can be checked for drift. By the late 1990's many local air quality agencies also required a middle value be added to the daily check so now we have a zero, middle and span check. The middle value makes it possible to detect non-linearity in the measurement.

How it works

In the MFT B-Series, we have an independent voltage source which can be programmed from 0 to 3.3 V and this is used to drive the 4-20 mA output where 3.3 V is FS. We also have Modbus registers of this which is in volts (0 to 3.3 V). This independent voltage source is programmable in its value for zero, mid and span and the duration of time spent holding at each value. The zero-mid-span function can be initiated as a sequence from an internal meter timer or an externally provided contact closure to one of the digital inputs. The meter also remembers the recorded values from its previous test which can be accessed through the meter's onboard menu system or through Modbus registers.

The independent calibrator is factory calibrated to better than 0.13% FS and can be used at any time to verify the proper calibration of the flow meter.

How to use it

The drift check feature must be configured for its amplitudes, duration and trigger conditions.

WARNING:

When the Drift Check is in progress, the 4-20 mA output will represent the percent of Full Scale that the Drift Check was configured, not the process flow reading or temperature..

Configurable Parameters

Auto Drift check

ON or OFF of the internal timer only. No effect on Modbus or DI triggers.

Interval Time

xx hours (internal timer trigger only)

Zero Drift Check Value

% Full Scale (4-20 mA output current)

Zero Drift Check Duration

xx Seconds

Mid Span Drift Check Value

% Full Scale (4-20 mA output current)

Mid Span Drift Check duration

xx Seconds

Span Drift Check Value

% Full Scale (4-20 mA output current)

Span Drift Check duration

xx Seconds

SETUP

A Setup Drift Check menu is available in *Program Mode*. Enter *Program Mode*, press **P**, the **654321** access code, and **E**. Press **2** to invoke the Quick Jump option entry method and select **Option #23** for the **Setup Drift Check menu**. The meter will first prompt to set the Automatic Drift Check ON or OFF. This configuration is for the internal timer to initiate the Drift Check at a specified interval. It has no effect on triggering the Drift Check function from Modbus or the digital input.

```
AUTO DRIFT CHECK
>OFF          ^v
```

Use the **^** or **v** keys to select between ON or OFF and press **E** to accept the selection. If AUTO DRIFT CHECK is set ON, the meter will prompt for a Drift Check Interval. This parameter defines the periodic interval, in hours that the Drift Check Sequence will be initiated by the internal timer.

```
DRIFT CHK INTRVL
>16              HOUR
```

The interval can be between 1 to 18000 hours. The factory default is 16 hours. Use the numeric keys to enter the desired interval and press **E** to accept the value or **P** the skip over the entry and advance to the next screen.

In the next setup screens, the meter prompts for the amplitude of the output signal and duration that the output signal is applied for each of the Drift Check test levels. The amplitude is given as a % of the FS of the independent voltage source (which is 3.3V).

```
% FS AT ZERO
>10.000
```

In the example above, 10.0% means that 0.33V (10% of 3.3V) will be applied to the 4-20mA output for the Drift Check at Zero. The duration at this voltage level is specified by the next parameter displayed by the meter. The duration is the time the 4-20mA output is at the zero value programmed above before switching to the Mid-span Drift Check value.

```
DURATION AT ZERO
>60              SEC
```

Use the numeric keys to enter a value and press **E** to accept the value or press **P** to skip over the value and advance to the next screen.

The meter repeats the prompts for the % FS (of the 3.3V voltage source) and Duration for the Mid-Span Drift Check and the Full-Span Drift Check.

```
% FS AT MID
>50.000
```

```
DURATION AT MID
>60              SEC
```

% FS AT SPAN
>90.000

DURATION AT SPAN
>60 SEC

The values are entered in the same way as the parameters for the Drift Check at Zero. After the values for the Full-Span Drift Check are entered (or skipped), the meter exits the Setup Drift Check menu and returns to the Program Mode Option Entry screen.

Triggering

There are four ways to initiate the Zero-Mid-Span Drift check. The Drift Checks can be initiated at a specified time interval, by an external digital input, through a menu option in *Extended Utilities Mode* or through a MODBUS Command. The duration of the individual zero, mid or span checks are controlled by user specified duration values.

- Periodic Zero-Mid-Span Check**
 The Zero-Mid-Span Check can be periodically triggered by the Interval Time (configurable). To select this, the Auto Drift Check must be turned ON. When it is triggered, it will perform the Zero, Mid and Span sequence. Changing the value of the Interval Time changes the frequency that the Drift Check is initiated.
- External Digital Input (MFT-B Digital Input 2)**
 This trigger does not require that the Auto Drift Check be turned ON. When the MFT-B digital input channel #2 (DI2) changes from high to low, the meter will initiate the Zero, Mid, Span Drift Check sequence. While the system is busy performing the Drift Check sequence, it will not accept another command via the digital input to perform a Drift Check. After the Drift Check sequence is complete, the meter will monitor the DI for the next request to initiate the Drift Check.

If the Auto Drift Check is ON **and** in the process of performing the Periodic Zero-Mid-Span sequence that was initiated by the interval timer **and** the external input commands a Drift Check sequence, the meter will initiate another Drift Check sequence immediately after the current (Periodic) Drift Check Sequence completes.

- Menu Option in Extended Utilities Mode**
 The Zero, Mid, Span or ALL Drift Checks can be initiated using the local keypad or remote terminal keyboard. The meter's menu system also allows the user to view the results from the last Drift Check test(s). This does not require that the Auto Drift Check be turned ON. To run the Drift Check Tests from *Extended Utilities Mode*, press **E**, the **654321** access code and **E**. Press **2** to invoke the Quick Jump option entry method. The following Table lists the option numbers used to initiate each Drift Check Test.

Option #	Menu
1	Drift Check at Zero (ZERO DRIFT)
2	Drift Check at Mid-span (MIDSP DRIFT)

3	Drift Check at Full-span (FULLSP DRFT)
4	Drift Check Cycle (all tests) (CYCLE DRIFT)

Option #4, the Drift Check Cycle performs each of the Drift Checks – Zero-Mid-Span one after the other. The following example screens demonstrate the menu system prompts to run the Zero Drift Check. At the Extended Utilities Mode Option entry screen enter '1' to request the Zero Drift Check Test.

```
Enter UTL Option
1-5>1
```

The meter prompts the user to confirm to start the Drift Check Test

```
ZERO DRIFT CHECK
START TEST> YES
```

Press **E** to start the test or use the **^** or **v** keys to change the selection to NO. If YES is selected, the meter will display a prompt indicating that the test is running

```
ZERO DRIFT CHECK
IS RUNNING...
```

When the test completes, the meter displays the percent difference between the voltage input and voltage output for the Zero Drift Check.

```
ZERO DRIFT CHECK
%DIFF = 1.091
```

The % difference displays for 3 seconds and scrolls to display the voltage input and voltage output values used in the Zero Drift Check.

```
Vin = 0.33000 V
Vout= 0.33360 V
```

Press **E**, **C**, or **P** to return to the Extended Utilities Mode Option Entry screen.

If NO is selected when the meter prompts to start the test, the meter will display %DIFF followed by Vin and Vout for the Zero Drift Check test that was last run.

- **Write Coil Command via MODBUS Protocol**

Using MODBUS Protocol, the individual Zero, Mid, Span or All can be triggered by writing a 1 to the MODBUS coil #0, coil #1, coil #2 or coil #3 (function code 05), respectively. This trigger does not require that the Auto Drift Check be turned ON. When a 1 is sent to MODBUS coil #0, coil #1, coil #2 or coil #3, the Zero, Mid, Span or Cycle (Zero-Mid-Span sequence) will trigger and start. While the meter is busy performing the drift check, it will not accept another Drift Check start command via Modbus. If the Auto Drift Check is ON and the meter is performing a periodic Drift Check and a Drift Check is requested via MODBUS, the meter will initiate another Drift Check immediately after the periodic Drift Check completes. The following are the MODBUS write coil commands:

MODBUS Coil #0 → triggers Zero drift check

MODBUS Coil #1 → triggers Mid drift check

MODBUS Coil #2 → triggers Span drift check

MODBUS Coil #3 → triggers Cycle drift check (Zero, Mid, and Span)

MODBUS Coil #4 → aborts any of the above states.

Modbus Status Registers

Status Registers are provided via MODBUS (function code 01) to indicate whether Zero, Mid and Span check are busy or idle. The following are the MODBUS status registers to indicate whether the drift check state is busy or idle:

Status Register 0 → status register for Zero drift check, 0=idle or 1= busy

Status Register 1 → status register for Mid drift check, 0=idle or 1=busy

Status Register 2 → status register for Span drift check, 0=idle or 1=busy

Status Register 3 → status register for Cycle check (Zero, Mid and Span)
0=idle or 1=busy While doing a cycle check, both the register 3 and the corresponding zero, mid or span register will be set as it does that part of the cycle. When the cycle is done, all the bits are cleared back to zero or idle.

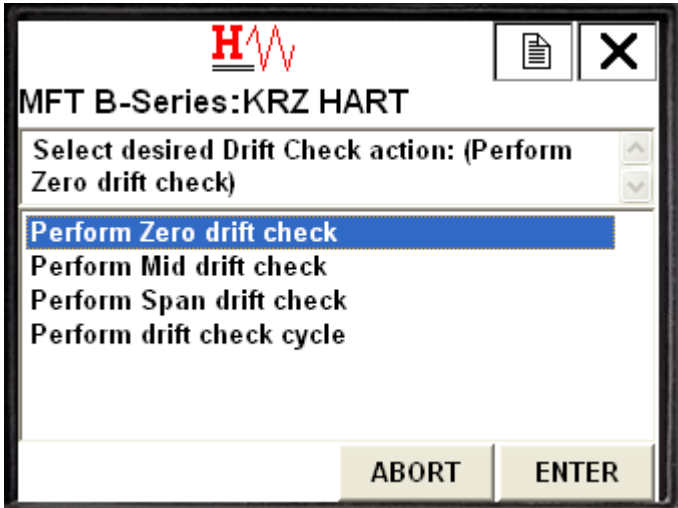
The above status bits are also at the start of the same block used to report the diagnostic errors on the flow meter, function code 02, permitting fast status polling along with the principle variable polling. See the [Modbus command section](#) for more details.

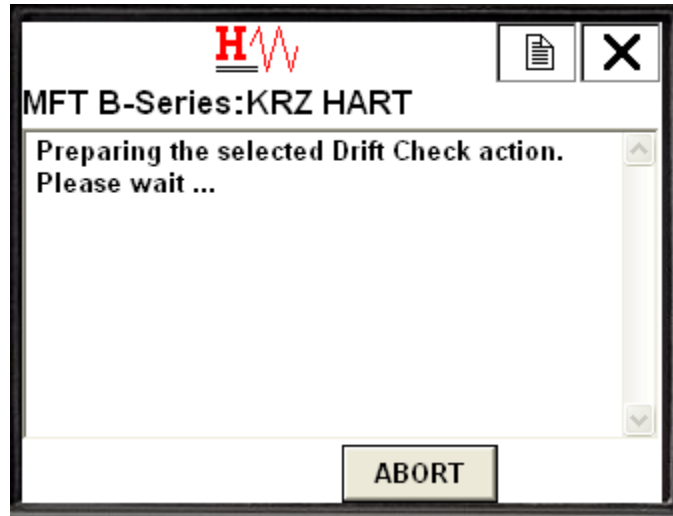
Available Modbus Commands

The triggering is a bit or coil write command with status as described above. The amplitude values (% 4-20 mA scale) for zero, mid and span as well as the duration (seconds) of each are available as read and write registers. The results from a previous drift check (Volts measured from the 3.3 V programmable reference, not 4-20 mA range) and % change are also available as read registers. See the section on [Modbus](#) for the specific function codes and registers.

HART Interface

The Zero-Mid-Span Drift tests can be initiated through the HART interface using a handheld communicator or a PC-based HART Host if the MFTB Device Descriptor (DD) is loaded into the HART Hosts memory module. The figures below are screen shots from an Emerson 475 handheld communicator showing the Drift Check menus.





Interaction with Sensor Purge

The sensor purge and the Zero-Mid-Span Drift checks are two MFT B-Series features that can be configured to automatically trigger on a user configured interval. When the timers for these two features are both operational and both are scheduled to initiate at the same time, the meter will start only one activity and start the next activity when the first one completes.

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