System Integration of Fieldbus Electric Actuators

Electric actuators or more commonly addressed in the field as Motor Operated Valves (MOV) were traditionally integrated to the system using hard-wiring which was impractical and costly, or using proprietary protocols causing costly single vendor dependency. With a standard fieldbus, this is a thing of the past. However, in the transition there has been some confusion with regards to integration of fieldbus MOV into DCS. By integrating a fieldbus MOV the way the standard intended, the loading on the bus and the system can be substantially reduced. In the course of this white paper, we will look into the Bettis™ TEC2000 electric actuator and how it can be integrated using only a single function block taking the place of all hardwired signals.

This white paper looks at how many function blocks are required to integrate an MOV to a DCS, how many function block links, how much an MOV loads the macrocycle, how many MOVs can be connected on the same fieldbus, and if a dedicated fieldbus is required solely for MOVs.

MOV I/O Signals

In an old hardwired system there could be anywhere between 6 to 15 I/O signals from each MOV depending how much of its functionality is used. This in turn would require between 6 to 15 system I/O channels per MV and a whole multi-core cable for each MOV as per table 1.

Table 1: Traditional MOV I/O count

Signal	System Hardwired I/O	Remark
Open/stop/close command	3 DO	Control
Desired valve position	1 AO	Control
Actual valve state (limit switches)	2 DI	Feedback
Actual valve position (percentage open)	1 AI	Feedback
Available for control	1 DI	Mode
Local/remote switch	1 DI	Mode
Opening	1 DI	Feedback
Closing	1 DI	Feedback
Torque switch tripped	1 DI	Diagnostics
Percentage torque	1 AI	Diagnostics
Motor thermostat tripped	1 DI	Diagnostics
Battery low	1 DI	Diagnostics

The industry trend is to have more signals per device. Not only for MOV but also for flowmeters, level transmitters, control valves, intelligent on/off valves, and gas chromatographs and so on. The average I/O count per device is today perhaps 3, no longer just one signal per device. Using fieldbus technology to reduce the wiring and complexity is therefore increasingly important.

MOV integration has evolved over the years starting from hardwired signals requiring lots of cable wire pairs, system I/O channels, and function blocks. Due to the high cost of hardwired I/O, the number of signals used per MOV was reduced to a bare minimum for operation, typically 6 system I/O. As a result, the MOV capability could not be fully utilized, and the process could thus not fully benefit.

The industry trend is to have more signals per device. Not only for MOV but also for flowmeters, level transmitters, control valves, intelligent on/off valves, and gas chromatographs and so on. The average I/O count per device is today perhaps 3, no longer just one signal per device. Using fieldbus technology to reduce the wiring and complexity is therefore increasingly important.

BETTIS™

EMERSON™
Process Management

MOV integration has evolved over the years starting from hardwired signals requiring lots of cable wire pairs, system I/O channels, and function blocks. Due to the high cost of hardwired I/Os, the number of signals used per MOV was reduced to a bare minimum for operation, typically 6 system I/O. As a result, the MOV capability could not be fully utilized, and the process could thus not fully benefit.

The first step in the digital revolution was proprietary communication protocols, unique to each MOV manufacturer. This dramatically reduced the wiring, but required gateways, intermediate Modbus networking, and proprietary configuration software. Moreover, once a plant had decided on one MOV manufacturer they could not mix other MOV on the same network. The plant became heavily dependent on a single vendor.

The next logical step in the evolution was standard protocols such as PROFIBUS-DP often used with PLC in the water & wastewater industries, and FOUNDATION fieldbus used with DCS in the oil & gas, pipeline, terminal, refining, petrochemical, and chemical industries etc. This eliminated dedicated proprietary networks, gateways, and proprietary software, enabling the MOV to share the same bus as other devices and to be managed from the same software as the control valves and transmitters. However, early implementation used as many as 6 fieldbus function blocks and block links per MOV, just like 6 function blocks had been used with hardwired signals in the past. This causes unnecessarily high loading on the fieldbus, resulting in longer macrocycle, possibly reduced device count, and challenges to put transmitters on the same bus. This is not how FOUNDATION fieldbus function blocks were intended to be used.

Single Block Integration

FOUNDATION fieldbus is not only a digital communication protocol, but also a graphical function block programming language for building control strategies. An AI function block contains the functionality associated with a transmitter, an AO block contains the functionality associated with a throttling valve, and DO block contains the functionality associated with an on/off valve, and so on. For instance, the AO and DO output blocks receive the valve setpoint control input signal, provide the actual valve position feedback output signal, and also contain parameters for mode and high level diagnostics. Therefore, a positioner for a pneumatic or electric actuator really only requires a single AO function block. Similarly, an intelligent on/off valve only requires a single DO block. The Bettis™ TEC2000 can be used in either on/off or continuous throttling applications. Detail actuator and valve diagnostics originates from the transducer block which requires no scheduling or function blocks and therefore does not load the bus macrocycle.

Figure 1. Bettis™ TEC2000 electric actuator / Motor Operated Valve (MOV)

Most of the signals which in the past could be hardwired (table 1) are diagnostic in nature and do not require corresponding DI/DO/AI/AO function blocks for FOUNDATION fieldbus. Instead, diagnostics appear as device alarms in the intelligent device management (IDM) software part of the asset management system (AMS). The mode (local/remote etc.) of the MOV is apparent from the mode parameter in the output block.
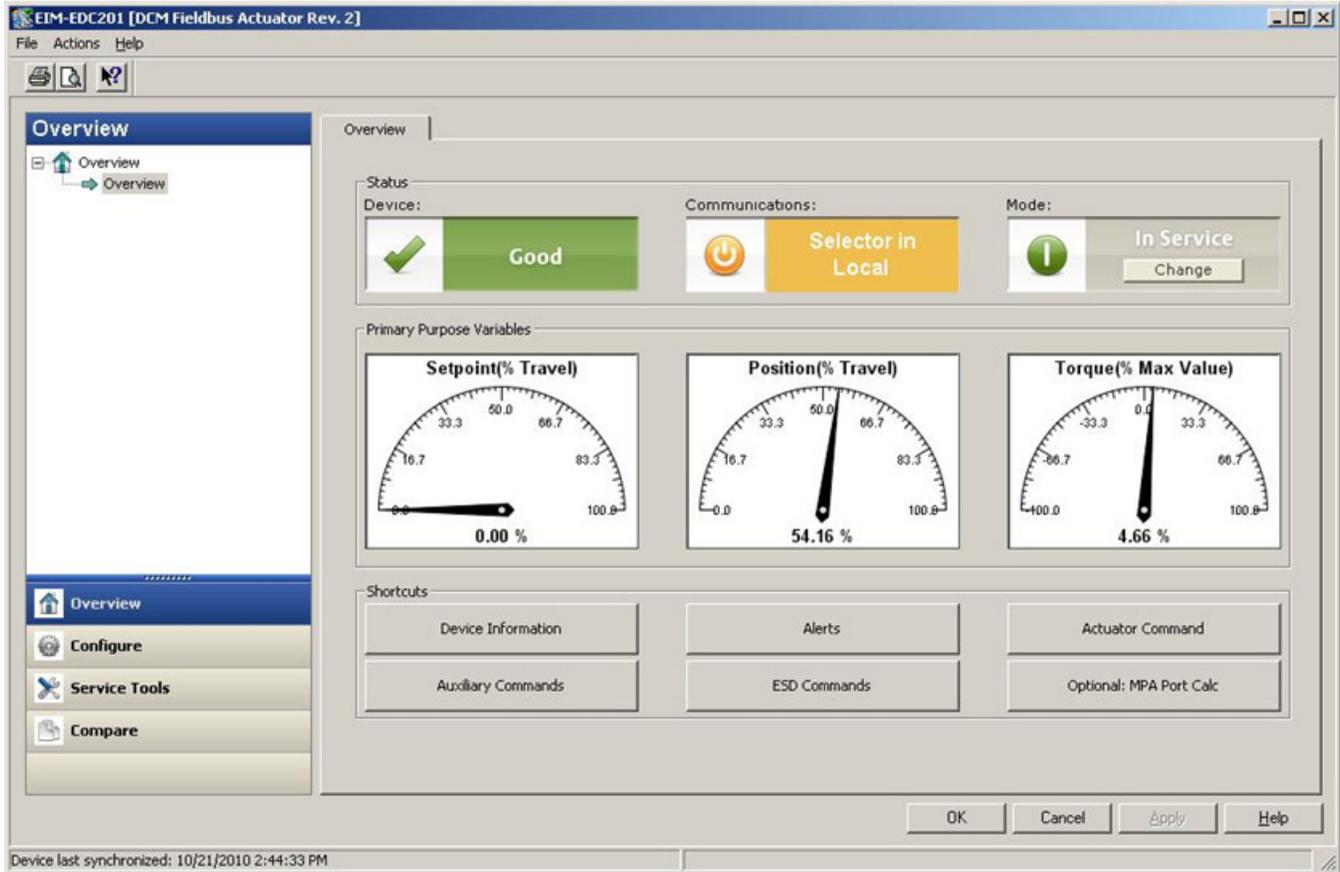
Figure 2. Operating mode, overall status, internal parameters, settings, and diagnostics is easily overviewed from the device dashboard in Intelligent Device Management (IDM) software

In other words, the MOV is no different from a fieldbus-pneumatic control valve positioner or an intelligent fieldbus on/off valve; same load: the same number of blocks, and the same number of links. This result is minimal bus loading, enabling more MOV, and other devices such as adjacent transmitters to share the same bus. There will be no need to stretch the macrocycle longer. That is, no special limitations to device count etc. for MOV. Also note, since MOV share the same fieldbus as transmitters, there will only be a few MOV per bus, not lots of valves depending on a common bus as was the case of dedicated proprietary MOV buses of the past.

On/Off Operation

A single DO block can be used to integrate the MOV in on/off operation. When the setpoint is set to 'open' the MOV opens the valve and stops by itself when it reaches fully open, and when set to 'close' it closes the valve and stops by itself when it reaches fully closed. The same DO block includes the feedback parameter. That is, a single block, with one or two block links is all it takes to operate with on/off action. There is no need for individual DO blocks for open/stop/close, and corresponding DI for the feedback.
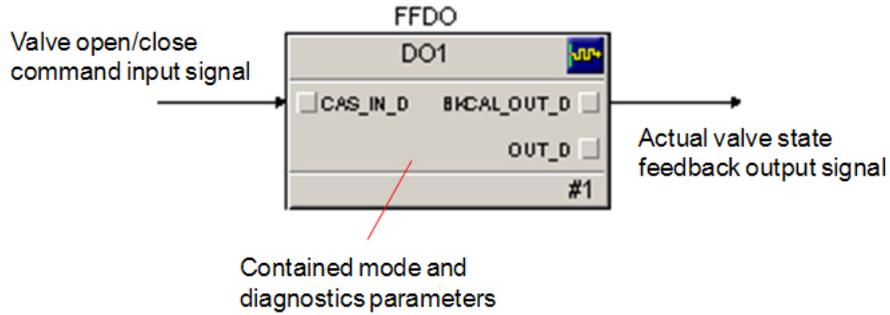
Figure 3. The standard DO function block encapsulates the functionality of an on/off valve

That is, an MOV in on/off operation uses a single DO block just like an intelligent two-wire on/off valve.

Throttling (Percentage Open) Operation

A single AO block can be used to integrate the MOV in throttling operation. When the setpoint is set to for instance 50%, the MOV moves the valve to 50% and stops by itself. The same AO block includes the feedback parameter. That is, a single block, with one or two block links is all it takes to operate in throttling applications. The feedback value has an associated status, flagging fully opened and fully closed; three signals in one. There is no need for additional AI blocks for the feedback.
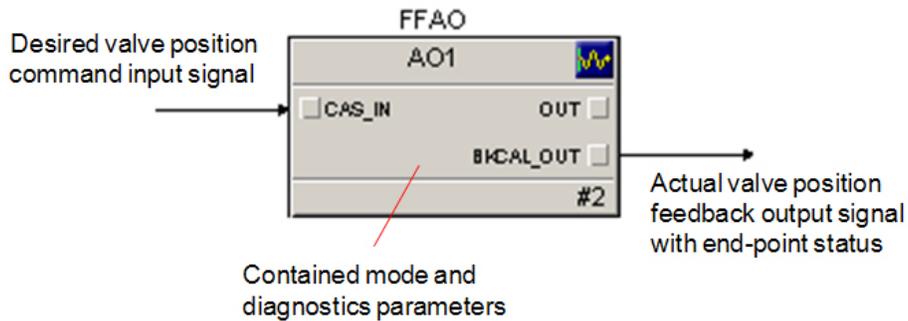

Figure 4. The standard AO function block encapsulates the functionality of a valve positioner

That is, an MOV in throttling operation uses a single AO block just like a valve positioner for a pneumatic actuator.

Multiple Block Integration

The Bettis™ TEC2000 supports many DI/DO/AI/AO/MDI/MDO blocks, enabling the various signals to be extracted as individual function blocks for projects that have decided to integrate this way.
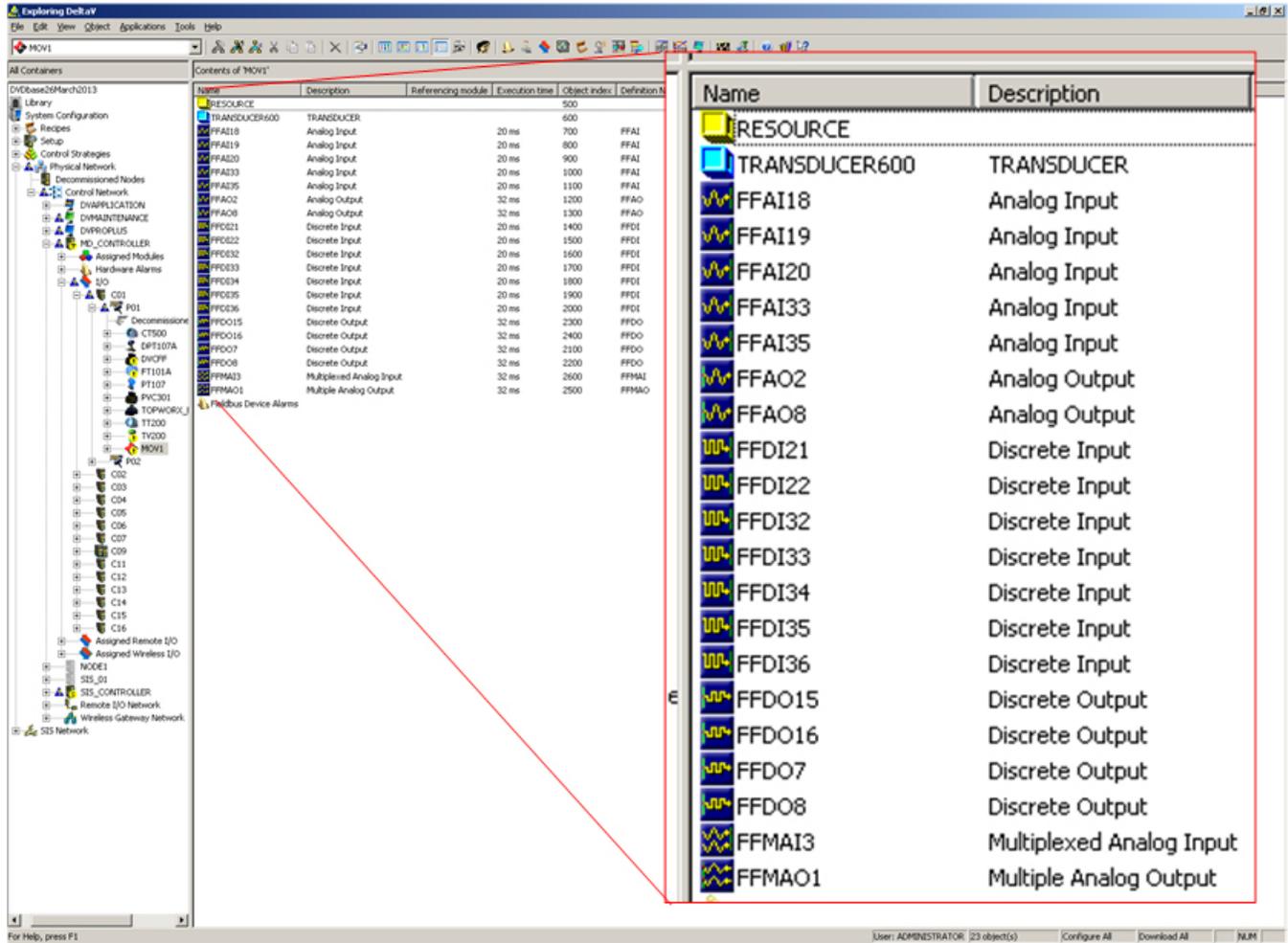
EMERSON™
Process Management

Figure 5 Bettis™ TEC2000 electric actuator supports up to 5 AI, 2 AO, 7 DI, 4 DO, 1 MAI, and 1 MAO

MOV Marshalling

A project can initially start up using only the bare minimum of control and feedback signals for the MOV in the control strategy. If additional information to or from the MOV is required in the future, this can simply be incorporated by a few clicks in the system engineering software. There is no need to run additional cables or use additional I/O card channels in the system to use the additional signals as these signals "piggy back" on the same fieldbus. That is, the same fieldbus carry multiple signals from multiple MOV and other devices on the same pair of wires.

The MOV can be changed between on/off operation and throttling operation simply by clicking in the software, without changing any wiring, or I/O card channel assignment.

The plant design can be changed from intelligent two-wire on/off valve or control valve to MOV without making changes to the signal wiring or interface card because a fieldbus MOV is connected to the bus the same way as a fieldbus on/off valve or fieldbus control valve. The only changes required are simple clicks in the system software.

BETTIS™

EMERSON™
Process Management

MOV can be added to the bus simply by running a short spur cable to the coupler in the field junction box, without the need to run additional signal wires all the way back to the marshalling cabinet.

Design Best Practice

Using hardwired signals or proprietary protocols cannot achieve the same result. Using individual function blocks for each signal cannot yield the same bus performance.

Design the system to integrate MOV using FOUNDATION fieldbus. Design the control strategies to use a single function block to handle all the signals in the MOV.

References

"The Valve Connection", Control Engineering Asia, July 2011, page 28, Jonas Berge

BETTIS™

www.bettis.com

EMERSON™
Process Management

**Emerson Process Management
Valve Automation**
19200 Northwest Freeway
Houston Texas 77065
USA
T +1 281 477 4100
F +1 281 477 2801

**Emerson Process Management
Valve Automation**
Asveldweg 11
7556 BR Hengelo (O)
The Netherlands
T +31 74 256 1010
F +31 74 291 0938

**Emerson Process Management
Valve Automation**
P. O. Box 17033
Dubai
United Arab Emirates
T +971 4 811 8100
F +971 4 886 5465

**Emerson Process Management
Valve Automation**
No. 9 Gul Road
#01-02 Singapore 629361
T +65 6501 4600
F +65 6268 0028

Bettis™ TEC2000 is sold under the name of EIM™ in North America.

EMERSON™
Process Management