

BETTIS™ 2000 Series M2CP Digital Futronic

Section 1: Introduction

The Digital Futronic module uses the latest integrated microcontroller technology to enable one electronics module to perform valve actuator modulating and positioning control from analog control signals. The control module uses BETTIS's M2CP TBM01 termination panel for interface of all analog control types. The Digital Futronic module converts 4-20mA analog input to digital for processing and from digital to 4-20mA analog output for position feedback. The Digital Futronic module controls three BETTIS motor control starter types.

- 1) Futronic II Electro-mechanical AC motor starter
- 2) Futronic III SCR Solid-state DC motor starter
- 3) Futronic IV Triac Solid-state (SSR) AC motor starter

Section 2: Features and Specifications

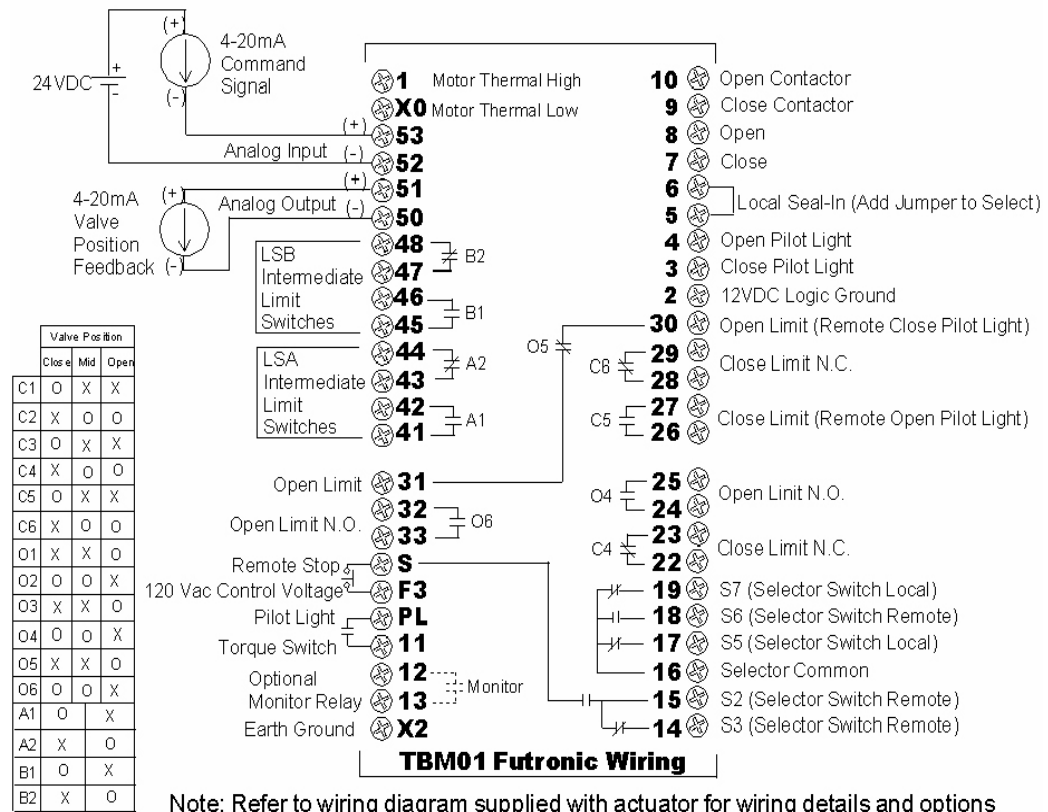
- Integral auto-tuning PID control maximizes accuracy without any user adjustments.
- Digital microcontroller adapts to any actuator and valve size, speed/stroke-time, process pressure, etc. by automatically tuning controls to obtain maximum accuracy without any user adjustments for bandwidth, delay time, etc.
- Automatic calibration of position input to valve travel limits.
- Built-in protection for motor and motor controls.
- DC motor speed control for Futronic III.
- Easy setup and calibration to user's external analog control signal input and analog feedback output. All setup and calibration adjustments by on-board DIP switches and two miniature push buttons.
- LED indicators for normal/fault operating conditions, setup mode, loss of analog signal, and solid-state motor control output.
- Isolated Analog Input: 4-20mA with 12-bit (.025%) resolution (calibration range of 0-24mA). 210 Ohms input resistance. Operates from 10V to 32V loop supply. Allows up to 750 Ohms loop resistance at 24V.
- Isolated Analog Output: 4-20mA with 16-bit (.0015%) resolution (calibration range of 0-24mA). Drive loop resistance up to 750 Ohms. True current source with internal 24VDC power supply. No external power source required to power loop. Internal automatic resetting fuse for 24VDC power supply.
- Isolation dielectric strength: 2500V AC for 1 Minute (Input to output and I/O to ground).
- Inverted Analog I/O Option: where 20mA = close valve position and 4mA = open valve position.
- Go To Default Position Option: On loss of control signal, user selected default valve position anywhere between 0 and 100%.
- Control Accuracy:
 - Futronic II mode +/- 1.0% @ 15 second stroke time or greater
 - Futronic III mode +/- 0.25% @ 15 second stroke time or greater
 - Futronic IV mode +/- 0.5% @ 15 second stroke time or greater
- Nonlinearity: <0.05% of calibrated analog input and output over full range of 0-100%.
- Operating Temperature Range: -40C to +85C (-40F to +185F),
Humidity: 10% - 95% (Non-condensate)

Section 3: Installation and Wiring

Refer to the wiring diagram supplied with the actuator for wiring details and options supplied with the system. Figure 1 below is generic and provided primarily for wiring 4-20mA analog input and output signals. Refer to Figure 1 for proper wiring of analog I/O and associated polarities relative to external equipment and power supplies. Use the following rules when wiring analog I/O signals.

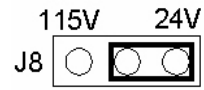
- 1) Route analog I/O cables into actuator enclosure through separate conduit entries from power wiring.
- 2) Always use twisted-pair instrumentation cable for wiring 4-20mA analog input and output signals.
- 3) Use shielded cable when analog signals are being installed in or routed through high noise areas.
- 4) If shielded cable is used, earth ground the shield by connecting only one end of the shield to earth.
- 5) Instruments or control equipment must source current to the analog input of the Digital Futronic.
- 6) Remote current source to analog input must have own power source, or an external supply is required.
- 7) Do not connect an external power source to the 4-20mA analog output of the Digital Futronic module.
- 8) The Digital Futronic module contains its own internal 24VDC power supply for the 4-20mA output and sources current to external instruments or control equipment.

Figure 1 TBM01 Futronic Wiring



Important Notice:

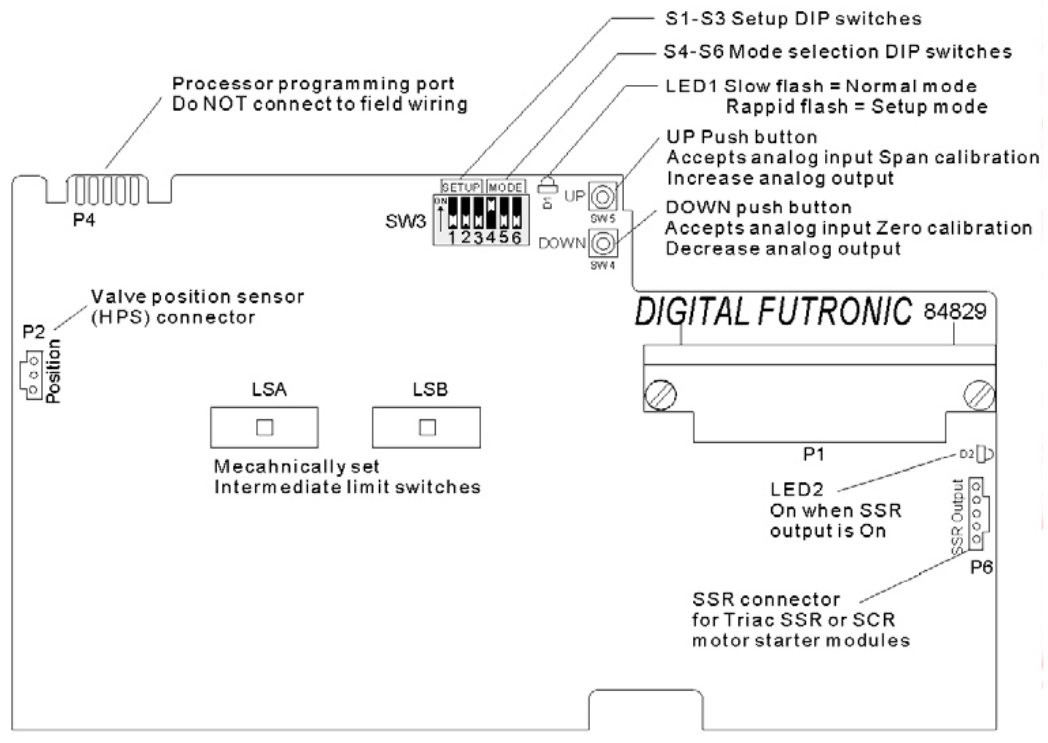
Jumper J8 located on the bottom of TBM01 must be in the 24V position before the Digital Futronic card will operate.



Section 4: Module Setup and Calibration

DIP Switch SW3 has 6 switches designated as S1-S6 for calibration and mode selection as summarized below. There are two push buttons labeled UP and DOWN. Refer to Figure 2 for location of DIP switches and push buttons.

Figure 2



4.1 Indicator Lights

4.1.1 LED 1

- Slow Flash = Normal Operating Mode.
- Rapid Flash = Setup mode (any one of switches S1 through S3 are on).
- Alternating Between Slow and Rapid Flash = Lost Analog Input (Command) Signal.
- Steady On or Steady Off = Module failure.

4.1.2 LED 2

- On when Solid State Relay (SSR or SCR) is On (control power applied to output).

4.2 Setup

4.2.1 Normal Run Mode (S1,S2,S3 OFF)

Turn off S1, S2 & S3 for Normal Run Mode - Figure 3.

Figure 3



4.2.2 Cal Analog Input (S1 ON)

Press **UP** to set Span (20mA) input - Figure 4.

Press **DOWN** button to set **Zero** (4mA) input - Figure 4.

Figure 4



4.2.3 Cal Analog Output Zero (S2 ON)

Press **UP** to increase 4mA output - Figure 5.

Press **DOWN** to decrease 4mA output - Figure 5.

Figure 5



4.2.4 Cal Analog Output Span (S3 ON)

Press **UP** to increase 20mA output - Figure 6.

Press **DOWN** to decrease 20mA output - Figure 6.

Figure 6



4.2.5 Set Modulation Delay (S1,S2 ON)

Press **UP** to select 3-Ph motor (delay = 2 sec) - Figure 7.

Press **DOWN** to select 1-Ph motor (delay = 12 sec) - Figure 7.

Figure 7



4.2.6 Set Default Position (S2 & S3 ON)

Press **UP** or **DOWN** to accept current valve position as default position - Figure 8.

Figure 8**4.2.7 Invert Analog I/O (S1,S2 & S3 ON)**

Press **UP** to Select Inverted Mode - Figure 9.

Press **DOWN** to Disable Inverted Mode - Figure 9.

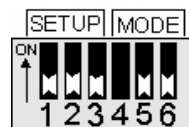
Figure 9

4.3 Mode

- S4 ON** = Go to Default Position on loss of analog input control signal - Figure 10.
S4 OFF = Stay Put on loss of analog input control signal - Figure 10.

Figure 10

- S5 OFF and S6 OFF** → Select Futronic II mode (Electromechanical motor starter) - Figure 11.

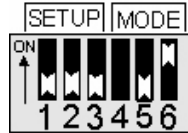
Figure 11

- S5 ON and S6 OFF** Select Futronic III mode (SCR solid-state DC motor starter) - Figure 12.

Figure 12

4. S5 OFF and S6 ON → Select Futronic IV mode (Triac solid-state (SSR) motor starter) - Figure 13.

Figure 13



4.4 Calibration Procedures

⚠ CAUTION:

Place selector switch in “OFF” position before calibrating actuator.

4.4.1 Calibrate Analog Input (Position Command Signal)

- 1) Connect 4-20mA calibration source to TBM Terminals **52 (-)** and **53 (+)**.
- 2) Set **S1** to **ON** (up) position. Apply 4mA **zero** calibration signal and then press **DOWN** push button.
- 3) Apply 20mA **full-scale** (span) calibration signal and then press **UP** push button.
- 4) Return **S1** to **OFF** (down) position.

NOTE:

When **S1** is **ON**, the analog input signal is fed to the analog output. A current meter may be connect to TBM terminals **50(-)** and **51(+)** to monitor the analog input at the output.

4.4.2 Calibrate Analog Output (Position Feedback)

- 1) Connect calibrated 4-20mA meter to TBM Terminals **50 (-)** and **51 (+)**.
- 2) Set **S2** to **ON** (up) position.
- 3) Press **UP** or **DOWN** push button to increase or decrease **zero** (4mA) analog output signal.
- 4) Return **S2** to **OFF** (down) position.
- 5) Set **S3** to **ON** (up) position.
- 6) Press **UP** or **DOWN** push button to increase or decrease **full-scale** (20mA) analog signal.
- 7) Return **S3** to **OFF** (down) position.

4.4.3 Select Modulation Delay Time

- 1) Set **S1** and **S2** to **ON** (up) position.
- 2) Press **UP** push button to select 3-Phase motor (Modulation delay = 2 seconds).
- 3) Press **DOWN** push button to select 1-Phase motor (Modulation delay = 12 seconds).
- 4) Return **S1** and **S2** to **OFF** (down) position.

Appendix A: Definitions

- 1. Command** = 4-20mA analog input position command signal generated by remote control equipment. Same as position command setpoint. Zero and Full-scale calibrated by user.
- 2. Position** = 0-5V valve position analog input signal generated by Hall-effect Position Sensor (HPS). Zero and Full-scale automatically calibrated by controller based on LSC and LSO valve travel limit switches.
- 3. Feedback** = 4-20mA analog output signal for feedback of valve position to remote control equipment. Zero and Full-scale calibrated by user.
- 4. Invert** = Inverted calibration of 4-20mA command where close position = 20mA, and open position = 4mA. Feedback is also inverted.
- 5. Deadband** = Allowable error tolerance to keep valve stopped, i.e. do not turn on motor control outputs. Deadband cannot be adjusted by the user. Deadband has a beginning default value based on selected operating mode (motor starter type) and then controller automatically adjusts the deadband to obtain the best accuracy.
Default deadband based on motor starter type:
 - Futronic II = +/-1.0% deadband
 - Futronic III = +/-0.25% deadband
 - Futronic IV = +/-0.50% deadband
- 6. Error** = Difference between Command and Position.
 $Error = Command - Position$
If not Invert and Error = Positive then open valve
If not Invert and Error = Negative then close valve
If Invert and Error = Positive then close valve
If Invert and Error = Negative then open valve
- 7. Nonlinearity** = Difference between analog input and analog output at current valve position over the full valve operating range.
- 8. Close Coast** = Difference between Position when the motor is turned off and Position when the valve stops moving in the close direction. Coast is caused by both inertia of the motor and latency of Position update due to analog input filtering. The controller measures close coast to automatically tune control for maximum accuracy.
- 9. Open Coast** = Difference between Position when the motor is turned off and Position when the valve stops moving in the open direction. The controller measures open coast to automatically tune control for maximum accuracy.
- 10. Modulation Delay** = Time between when the motor is turned off until the motor can be started again. This delay prevents excessive number of starts of the motor, preventing overheating the motor and premature burnout of the reversing contactor. Modulation delay also prevents valve plugging when the actuator reverses direction. If a three phase motor is used, the delay time is 2 seconds or 1800 starts per hour. If a single phase, capacitor start, AC motor is used, then the delay is 12 seconds or 300 starts per hour. The delay between motor control pulses while the valve is being jogged to position is automatically reduced to one second.

11. **Turn-off Delay = 10 Seconds** = Delay after motor stops before turning off Open or Close reversing contactor outputs unless a reversal in direction is required. If reversal in direction, then Modulation Delay time is used. Valid only when Futronic III or Futronic IV modes are selected. This delay prevents excessive operation of the contactor while modulating or the 4-20mA command signal is being ramped by a PID control loop.
12. **Accel** = Time required to accelerate motor speed from zero to full speed when motor is started due to Error greater than Deadband. The purpose of Accel is to soft-start the motor and to help prevent control overshoot when making small position changes. Accel is inversely proportional to Error and is automatically adjusted by the controller.
13. **Decel** = Time required to decelerate motor speed from full speed to zero while Position is approaching Command position setpoint. Valid only when Futronic III or Futronic IV modes are selected. Decel is proportional to Error. If motor is at full speed (Accel time expired) and Error is less than tuned parameter then the controller begins decelerating motor speed over a period of time where $Decel = (Error - Deadband) * T \text{ Sec.}$ Decel is activated only when Accel time has expired. This prevents motor stall when making small position changes. If Error is less than Deadband then Decel=0.
14. **DC Motor Speed Control** = Full speed of the motor is set at the factory using a potentiometer on the SCR motor control module. The Digital Futronic module regulates full speed of the motor, maintaining accurate speed/valve travel time regardless of high or low power line conditions and varying load conditions. Valid only for Futronic III.

Contact Us: Emerson Process Management, Valve Automation facilities at your nearest location:

NORTH & SOUTH AMERICA

19200 Northwest Freeway
Houston, TX 77065
T +1 281 477 4100
F +1 281 477 2801

2500 Park Avenue West
Mansfield, OH 44906
USA
T +1 419 529 4311
F +1 419 529 3688

13840 Pike Road
Missouri City, Texas 77489
USA
T +1 281 499 1561
F +1 281 499 8445

Av. Hollingsworth,
325, Iporanga Sorocaba,
SP 18087-105
Brazil
T +55 15 3238 3788
F +55 15 3228 3300

MIDDLE EAST & AFRICA

P. O. Box 17033
Dubai
United Arab Emirates
T +971 4 811 8100
F +971 4 886 5465

P. O. Box 105958
Abu Dhabi
United Arab Emirates
T +971 2 697 2000
F +971 2 555 0364

P. O. Box 3911
Al Khobar 31952
Saudi Arabia
T +966 3 814 7560
F +966 3 814 7570

P. O. Box 10305
Jubail 31961
Saudi Arabia
T +966 3 340 8650
F +966 3 340 8790

P. O. Box 32281
Doha
Qatar
T +974 4 576777
F +974 4 315448

24 Angus Crescent
Longmeadow Business Estate
East P.O. Box 6908;
Greenstone; 1616
Modderfontein, Extension 5
South Africa
T +27 11 451 3700
F +27 11 451 3800

EUROPE

Asveldweg 11
7556 BR Hengelo (O)
The Netherlands
T +31 74 256 1010
F +31 74 291 0938

Siemensring 112
47877 Willich
Germany
T +49 2154 499 660
F +49 2154 499 6613

25, Rue de Villeneuve
Silic – BP 40434
94583 Rungis
France
T +33 1 49 79 73 00
F +33 1 49 79 73 99

Via Montello 71/73
20038 Seregno (Milan)
Italy
T +39 0362 2285 207
F +39 0362 2436 55

6 Bracken Hill
South West Industrial Estate
Peterlee SR8 2LS
United Kingdom
T +44 191 518 0020
F +44 191 518 0032

2A Szturmowa Str
02-678 Warsaw
Poland
T +48 22 45 89 237
F +48 22 45 89 231

C/ Francisco Gervás, 1
28108 Alcobendas – Madrid
Spain
T +34 0913 586 000
F +34 0913 589 145

Letnikovskaya Str. 10-2
115114 Moscow
Russia and FSU
T +7 495 981 98 11
F +7 495 981 98 10

ASIA PACIFIC

No. 9 Gul Road
#01-02 Singapore 629361
T +65 6501 4600
F +65 6268 0028

9/F Gateway Building
No. 10 Ya Bao Road
Chaoyang District
Beijing 100020
P.R.China
T +86 10 8572 6666
F +86 10 8572 6888

No.1 Lai Yuan Road
Wuqing Development Area
Tianjin 301700
P.R.China
T +86 22 8212 3300
F +86 22 8212 3308

Lot 13112, Mukim Labu
Kawasan Perindustrian Nilai
71807 Nilai, Negeri Sembilan
Malaysia
T +60 6 799 2323
F +60 6 799 9942

471 Mountain Highway
Bayswater, Victoria 3153
Australia
T +61 3 9721 0200
F +61 3 9720 0588

Delphi B Wing, 601 & 602
6th Floor, Central Avenue
Powai, Mumbai – 400 076
India
T +91 22 6662 0566
F +91 22 6662 0500

Please visit our web site for up to date product data.
www.bettis.com

All Rights Reserved.

We reserve the right to modify or improve the designs or specifications of the products mentioned in this manual at any time without notice. Emerson Process Management does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Emerson Process Management product remains solely with the purchaser.

©2013 Emerson Electric Co.

BETTIS


EMERSON[™]
Process Management