EIM 2000 SERIES

M2CP

DIGITAL FUTRONIC

USER MANUAL

EIM CONTROLS

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 EIM'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 EIM 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

FEATURES AND SPECIFICATIONS

Integral auto-tuning PID control maximizes accuracy without any user adjustments.

Digital microcontroller adapts to any actuator and valve size, speed/stoke-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)

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.

Note: Refer to wiring diagram supplied with actuator for wiring details and options
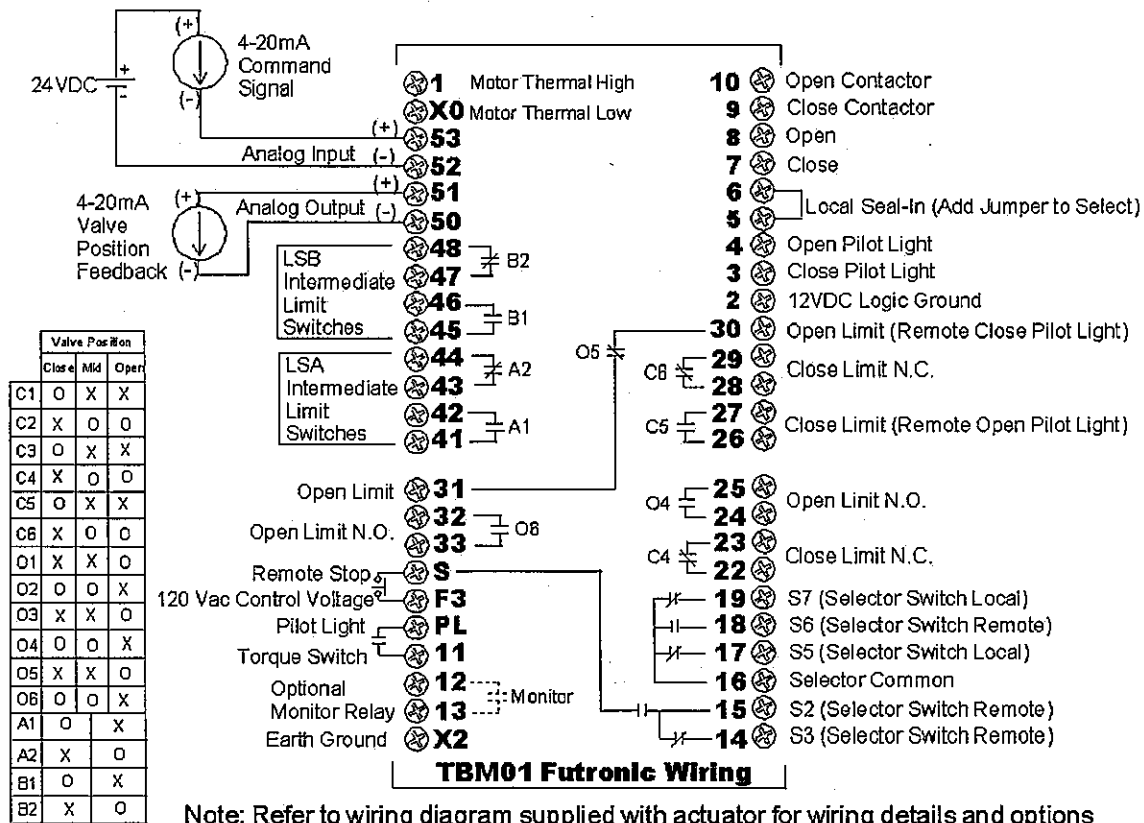
FIGURE 1

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

EIM CONTROLS
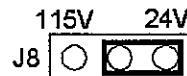
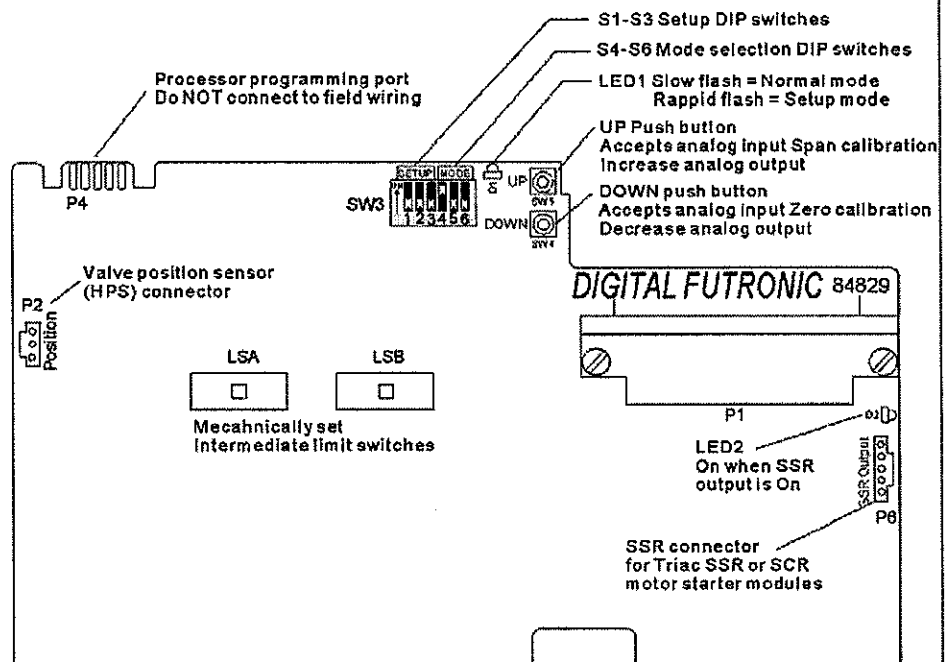## MODULE SETUP AND CALIBRATION

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.

INDICATOR LIGHTS

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.

LED2
▶ On when Solid State Relay (SSR or SCR) is On (control power applied to output).

S1-S3 Setup DIP switches
S4-S6 Mode selection DIP switches
LED1 Slow flash = Normal mode
       Rappid flash = Setup mode
UP Push button
Accepts analog input Span calibration
Increase analog output
DOWN push button
Accepts analog input Zero calibration
Decrease analog output

Processor programming port
Do NOT connect to field wiring

Valve position sensor
(HPS) connector

LSA   LSB

Mecahnically set
Intermediate limit switches

DIGITAL FUTRONIC 84829

LED2
On when SSR
output is On

SSR connector
for Triac SSR or SCR
motor starter modules

FIGURE 2

SETUP

|		
Normal Run Mode (S1,S2,S3 OFF)		Turn off S1, S2 & S3 for Normal Run Mode
Cal Analog Input (S1 ON)		Press **UP** to set **Span** (20mA) input Press **DOWN** button to set **Zero** (4mA) input
Cal Analog Output Zero (S2 ON)		Press **UP** to increase 4mA output Press **DOWN** to decrease 4mA output
Cal Analog Output Span (S3 ON)		Press **UP** to increase 20mA output Press **DOWN** to decrease 20mA output
Set Modulation Delay (S1, S2 ON)		Press **UP** to select 3-Ph motor (delay = 2 sec) Press **DOWN** to select 1-Ph motor (delay = 12 sec)
Set Default Position (S2 & S3 ON)		Press **UP** or **DOWN** to accept current valve position as default position
Invert Analog I/O (S1, S2 & S3 ON)		Press **UP** to Select Inverted Mode Press **DOWN** to Disable Inverted Mode

MODE

S4 ON = Go to Default Position on loss of analog input control signal
S4 OFF = Stay Put on loss of analog input control signal

S5 OFF and S6 OFF → Select Futronic II mode (Electromechanical motor starter)
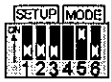
S5 ON and S6 OFF → Select Futronic III mode (SCR solid-state DC motor starter)
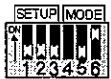
S5 OFF and S6 ON → Select Futronic IV mode (Triac solid-state (SSR) motor starter)

CALIBRATION PROCEDURES

CAUTION: Place selector switch in "OFF" position before calibrating actuator

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.

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.

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.

Enable/Disable Go-To-Position on Loss of Signal

1) Set **S4 ON** (up) to Enable Go-To-Position on loss of signal.
2) Set **S4 OFF** (down) to Disable Go-To-Position on loss of signal, i.e. Stay in last position on loss of signal.

Set Default Position (Position of valve on loss of analog input signal when S4 enabled)

NOTE: If it is desirable for the valve to move to position while setting the default position then place the selector switch in the "REMOTE" position, else leave the selector in the "OFF" position to prevent the valve from moving.

1) Connect 4-20mA calibration source to TBM Terminals **52 (-)** and **53 (+)**.
2) Set **S2** and **S3** to **ON** (up) position.
3) Apply calibration signal for the desired position (4-20mA or 0-100%).
4) Press either **UP** or **DOWN** push button to accept the analog input as the default position.
5) Return **S2** and **S3** to **OFF** (down) position.

DEFINITIONS

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.

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.

Feedback = 4-20mA analog output signal for feedback of valve position to remote control equipment. Zero and Full-scale calibrated by user.

Invert = Inverted calibration of 4-20mA command where close position = 20mA, and open position = 4mA. Feedback is also inverted.

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

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

Nonlinearity = Difference between analog input and analog output at current valve position over the full valve operating range.

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.

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.

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.

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.

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.

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 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.

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.