



C1397 Controller Board Setup and Operating Instructions

Bulletin: 01597- 11/01. This bulletin provides installation and operating information for the Bettis Controller Board C1397. Should you have any questions about the controller that are not covered under this bulletin, please contact an authorized Bettis Valve Automation Center or Bettis Electric Division, Mansfield, Ohio U.S.A., 419-529-4296.

General Description

The Bettis C1397 AC Motor Controller board is an accurate, easy to use, multi-function servo-board. So easy, the entire board can be set with a voltage supply, a small screwdriver, and one finger. No equipment is required to set the board. The basic concept of this controller is to read an external command signal and compare it to a feedback signal from a potentiometer linked to the output shaft. When the signals are not equal, the controller will energize either the clockwise or counterclockwise motor circuit. This drives the actuator in the direction that reduces the signal difference. Once the signals are equal, the controller opens the motor circuit and the actuator is positioned properly, awaiting the next external command signal change.

The controller has the following options:

- Input power: 115 Vac or 230 Vac, 50 or 60 Hz
- Input signals: 4-20 mA, 0-10 Vdc, 1-5 Vdc, or external command potentiometer
- Output signal: 4-20 mA
- Loss of command signal: fail in place, fail CCW, fail CW
- Speed Control: 1-19 times speed of actuator, independent timing for each direction
- Acting: direct acting (i.e. CW at 4 mA), reverse acting (i.e. CCW at 4 mA)
- Motor restart delay: Variable from one to thirty-two seconds
- Command sensitivity (deadband): Variable, range depends on command signal

Wiring

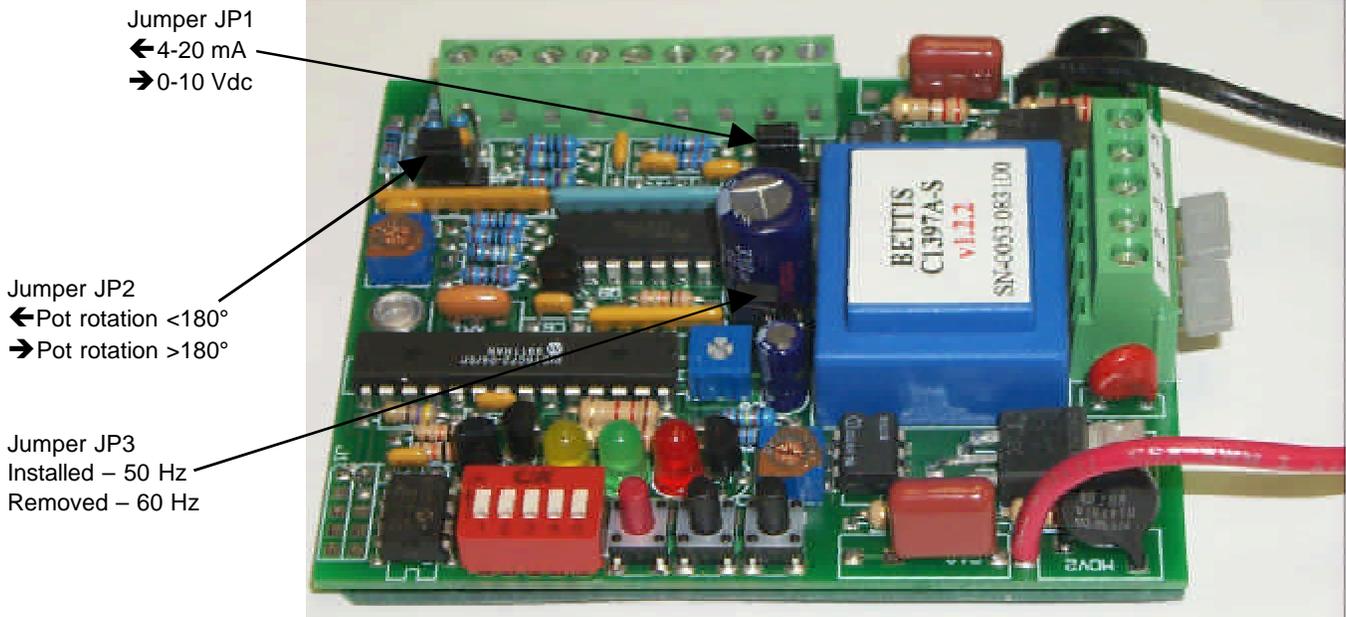
There are two terminal blocks on the controller board and two soldered wires. Terminal block TB1 is a 5 pole terminal block and is used for power terminations. Terminal block TB2 is a 9 pole terminal block and is used for all control signals. The soldered red wire is the CCW circuit to the motor, while the soldered black wire is the CW circuit to the motor. See wiring diagram under Figure WD1 below.



- | | |
|-------|--------------------------|
| TB1-1 | ➤ AC Line |
| TB1-2 | ➤ Empty |
| TB1-3 | ➤ Empty |
| TB1-4 | ➤ AC Neutral |
| TB1-5 | ➤ Motor Neutral |
| | |
| TB2-1 | ➤ Command Pot (+5 Vdc) |
| TB2-2 | ➤ 4-20 mA Command |
| TB2-3 | ➤ 0-10 Vdc Command |
| TB2-4 | ➤ Command Ground |
| TB2-5 | ➤ Potentiometer (+5 Vdc) |
| TB2-6 | ➤ Potentiometer (wiper) |
| TB2-7 | ➤ Potentiometer (ground) |
| TB2-8 | ➤ 4-20 mA Xmtr (+) |
| TB2-9 | ➤ 4-20 mA Xmtr (-) |

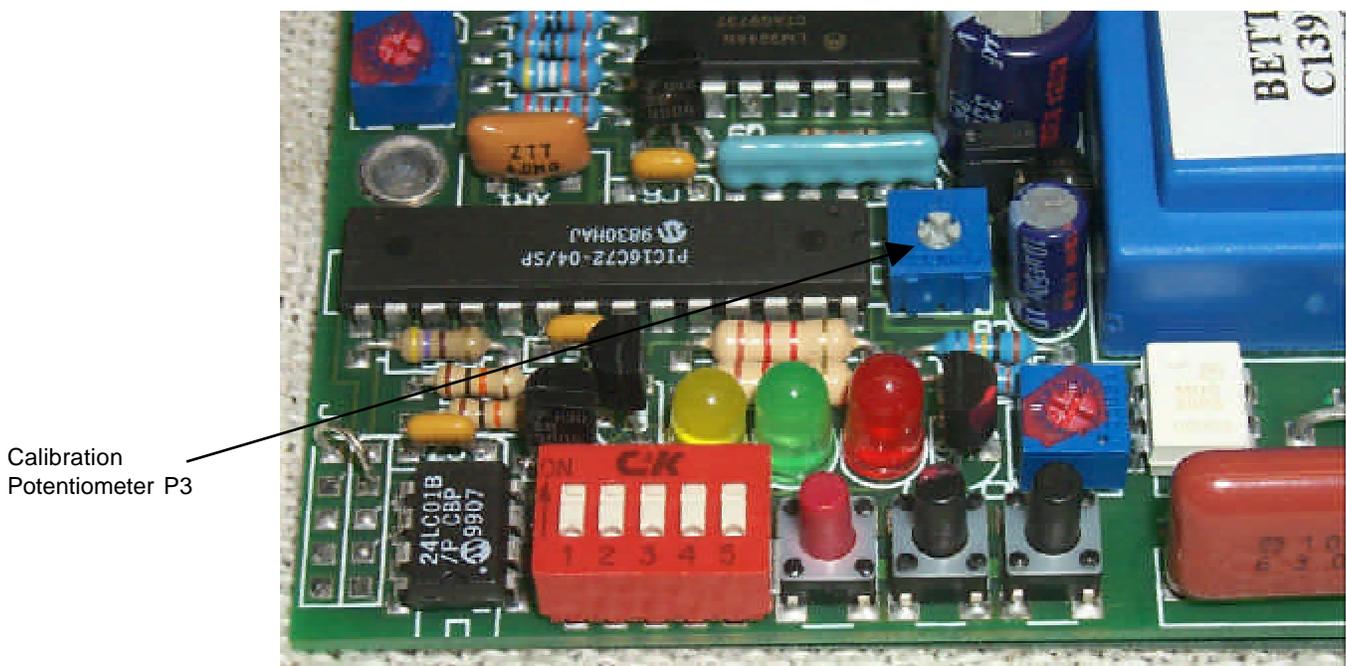
Jumpers

There are three jumpers on the controller board, JP1, JP2, and JP3 and two jumpers for the power terminal block TB1. JP1 provides the option for 4-20 mA or 0-10 Vdc command signal input. JP2 is a sensitivity jumper for the internal potentiometer. JP3 provides the option for 50 or 60 Hz input signal. The jumpers on the power terminal block TB1 provide the option for 115 or 230 Vac supply voltage.



Calibration Potentiometer

There is one potentiometer designated for use in calibrating the Speed Control, Motor Restart Delay and Sensitivity. Once the potentiometer position is stored in memory via the program pushbutton, it can be moved without changing any of the settings. This allows one potentiometer to be used for multiple settings.



Output Indicators

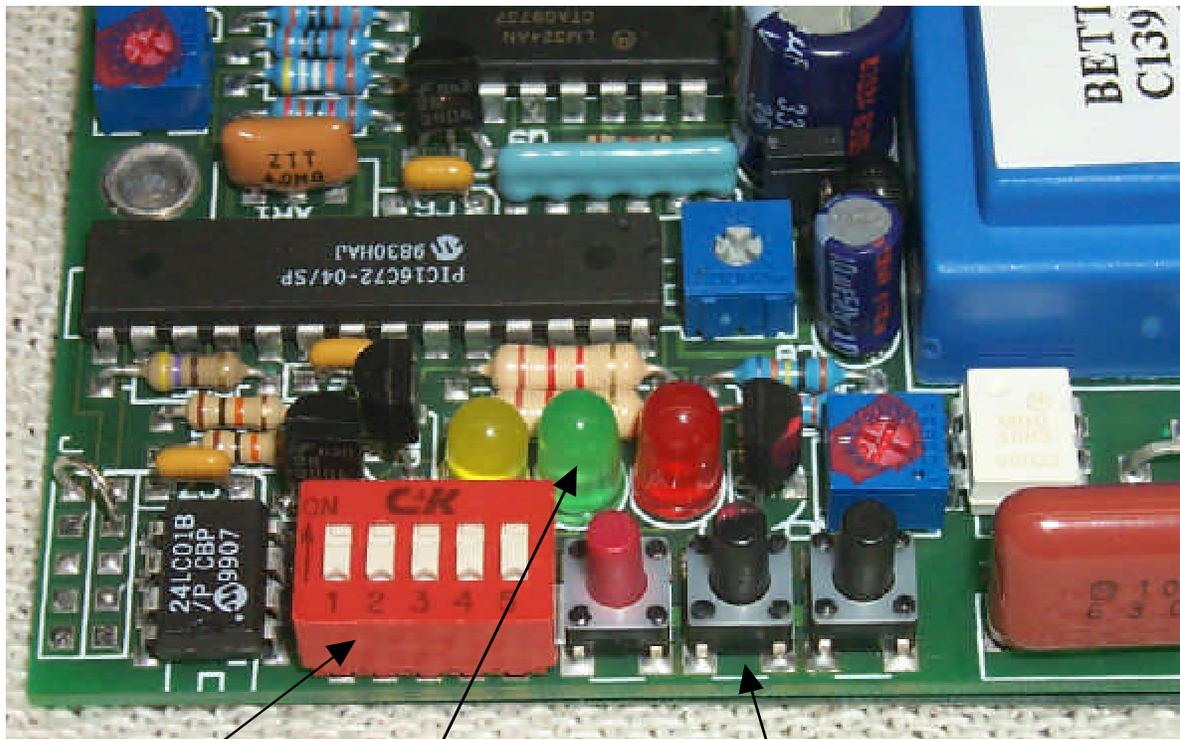
There are three LEDs for visual reference during board operation. The red LED is lit as the controller sends a signal to the motor to turn the actuator CCW or OPEN. The green LED is lit as the controller sends a signal to the motor to turn the actuator CW or CLOSED. The yellow LED is a programming LED that is lit each time a setting is saved in memory.

Push buttons

There are three push buttons on the controller board, PB1, PB2, and PB3. PB1 operates the actuator in the CCW position when the controller is in the calibration mode. PB2 operates the actuator in the CW position when the controller is in the calibration mode. PB3 is depressed each time a setting is required to be save into memory.

Dip Switches

There are five dip switches which are used to calibrate the controller.



Dip Switches
SW4 (1-2-3-4-5)

Output Indicators
Yellow – Program indication
Green – CW Indication
Red – CCW Indication

Push Buttons
PB3 (red) – Program pushbutton
PB2 (black / middle) – CW pushbutton
PB1 (black / right) – CCW pushbutton

Setup and Operation

Please note that the following installation instructions must be followed in strict accordance with the order outlined below.

1. Verify controller board is wired up properly per the wiring diagram supplied with the actuator.
2. Do not connect any command signals to the actuator at this time.
3. Verify all jumpers are set properly for your application. DO NOT change any jumpers while the power is on. This may cause damage to the controller.
4. Switch dip switch #1 to the "ON" position and dip switches #2 through #5 to the "OFF" position. This sets the controller for calibration mode.
5. Turn on the power to the actuator.
6. The next three series of steps will complete the basic setup of the controller. This entails setting the potentiometer up to provide the correct signal to the controller on the position of the output shaft along with programming the end of travel setpoints into the controller.
7. To set the potentiometer, perform the following steps in order (go to step 8 if factory equipped)
 - a) Loosen the set screw in the potentiometer gear located on the output shaft.
 - b) Using PB1 and/or PB2, position the actuator halfway between the end of travel limits.
 - c) Switch dip switch #5 to the "ON" position.
 - d) Rotate the potentiometer shaft gear until the yellow LED is lit.
 - e) Engage the potentiometer and output shaft gear teeth and tighten the gear set screws.
 - f) Switch dip switch #5 to the "OFF" position.
8. To set the end of travel CCW limit, perform the following steps in order
 - a) Using PB1, position the actuator to the CCW end of travel limit.
 - b) Switch dip switch #2 to the "ON" position.
 - c) Push PB3 to save this position in memory.
 - d) Using PB1, position the actuator to approximately 1° past the CCW end of travel limit and set the bottom cam.
9. To set the end of travel CW limit, perform the following steps in order.
 - a) Using PB2, position the actuator to the CW end of travel limit.
 - b) Switch dip switch #2 to the "OFF" position.
 - c) Push PB3 to save this position in memory.
 - d) Using PB2, position the actuator to approximately 1° past the CW end of travel limit and set the second cam up.
10. Switch dip switch #1 to the "OFF" position.

At this time, the controller is set for basic operation. The actuator is ready to be operated upon connection of an external command signal.

Additional Control
Speed Control

Speed control is performed by pulsing the signal to the motor to lengthen the stroke time by a variable factor. There are two settings that control the speed of the actuator. The “on time” setting controls the amount of time the motor is energized during each pulse but has no effect on the speed of the actuator. This setting can be set as low as 0.26 seconds to as high as 1.85 seconds. The lower the setting, the smoother each stroke becomes. The “speed reduction multiplier” setting controls the amount of time the motor is de-energized with respect to the speed of the actuator. This setting is what controls the speed of the actuator. This multiplier can be set between 1.0 and 18.875. Thus, if a 30 second actuator is using a “speed reduction multiplier” of 18.875, the total stroke time becomes 9 minutes and 26 seconds.

Note: Calculated times will not be true stroke times of the actuator. Depending on the torque of the actuator and the settings of the speed control, some stroke times may be as much as twice the calculated times. The greater the torque, the slower the motor comes up to speed during each pulse. Thus, the movement of the motor at full load at a set time is shorter than if it was pulsing at no load. The longer the “on time” is set for, the more accurate the calculation will be. Example, lets say the “speed reduction multiplier” is set at 10 for a 30 second actuator which experiences full torque throughout the 90° of travel. This would mean the calculated stroke time would be 5 minutes. However, due to the load, there is a loss of 0.12 seconds in motor startup travel time. With the “on time” set to 0.26, the motor has to start a minimum of 115 times. With a loss of 0.12 second each start, the total calculated loss would be 13.8 seconds, so the actuator would have to run approximately twice as long to cover the whole range. However, with the “on time” set to 1.85 seconds, the motor has to only start 16 times. With a loss of 0.12 second each start, the total calculated loss would be 1.92 seconds, so the actuator would have to run only slightly longer to cover the whole range.

Bettis recommends that the “on time” initially be set to the highest setting. Then, if the stroke transition is too choppy, reduce the “on time” setting to the acceptable level and adjust the “speed reduction multiplier” appropriately.

To set the on and off pulsing time, perform the following steps in order.

To set the “on time”:

- 1) Set dip switches #1, #3, #4, and #5 to the on position
- 2) Apply power to the controller
- 3) Adjust potentiometer P3 for the desired on time (ccw » 0.26 sec, cw » 1.85)
- 4) Push PB3 to store the setting in memory

To set the cw direction speed reduction multiplier between 1 and 2.875:

- 1) Set dip switches #1, #2, #3, and #4 to the on position
- 2) Apply power to the controller
- 3) Adjust potentiometer P3 for the desired multiplier (ccw » 1 mult, cw » 2.875 mult)
- 4) Push PB3 to store the setting in memory

To set the cw direction speed reduction multiplier between 3 and 18.875:

- 1) Set dip switches #1, #2, #4, and #5 to the on position
- 2) Apply power to the controller
- 3) Adjust potentiometer P3 for the desired multiplier (ccw » 3 mult, cw » 18.875 mult)
- 4) Push PB3 to store the setting in memory

To set the ccw direction speed reduction multiplier between 1 and 2.875:

- 1) Set dip switches #1, #3, and #4 to the on position
- 2) Apply power to the controller
- 3) Adjust potentiometer P3 for the desired multiplier (ccw » 1 mult, cw » 2.875 mult)
- 4) Push PB3 to store the setting in memory

To set the ccw direction speed reduction multiplier between 3 and 18.875:

- 1) Set dip switches #1, #4, and #5 to the on position
- 2) Apply power to the controller
- 3) Adjust potentiometer P3 for the desired multiplier (ccw » 3 mult, cw » 18.875 mult)
- 4) Push SW3 to store the setting in memory

To activate the variable speed control, turn on SW2 during the run mode.

Loss of Command Signal Setting (4-20 mA or 1-5 Vdc operation only)

This command works only in the "RUN" mode, i.e. when dip switch #1 is in the "OFF" position. The board can be set to transfer to the CW limit or CCW limit upon loss of the command signal. This is defined by dip switches #4 and #5.

- 1) To move the actuator to the lowest setting (i.e. 4 mA position) upon loss of signal, set both dip switches #4 and #5 to off.
- 2) To let the actuator fail in place upon signal loss, set both dip switches #4 and #5 to on.
- 3) To move the actuator to the CCW limit upon loss of signal, set dip switch #4 to on and dip switch #5 to off.
- 4) To move the actuator to the CW limit upon loss of signal, set dip switch #4 to off and dip switch #5 to on.

Direct/Reverse Acting

This command works only in the "RUN" mode, i.e. when dip switch #1 is in the "OFF" position. Under normal, or direct operation, the actuator moves CW when the command signal is decreased and CCW when the command signal is increased. This can be reversed by placing dip switch #3 to the on position. Thus a 4mA or 0Vdc signal would move the actuator to the CCW end of travel.

Motor Restart Delay

This delay can be used to smooth out or damp the response of the modulated device in a system that provides multiple command signals over a short period of time. The delay can be set from 1 second (factory setting) to 32 seconds. To change the delay, perform the following steps in order.

- 1) Set dip switch #1 and #3 only to the on position.
- 2) Apply power to the controller.
- 3) Adjust potentiometer P3 for the desired delay. Fully CCW is 1 second, fully CW is 32 seconds (the potentiometer is linear).
- 4) Push PB3 to save this position in memory.
- 5) Turn off the power to the controller.
- 6) Return dip switch #1 and #3 to the off position.

Command Sensitivity

This option is similar to that of deadband control. To change the sensitivity of the controller with respect to the necessary change in magnitude of the command signal, perform the following steps in order.

- 1) Set dip switch #1 and #4 only to the on position.
- 2) Apply power to the controller.
- 3) Adjust potentiometer P3 for the desired sensitivity. Fully CCW is maximum sensitivity while fully CW is minimum sensitivity.
- 4) Push PB3 to save this position in memory.
- 5) Turn off the power to the controller.
- 6) Return dip switch #1 and #4 to the off position.

4-20 mA Output

A 4-20 mA output can be for remote indication of the actuators position. This signal is provided across terminals 8 and 9 of terminal block TB2 of the controller.

Specifications

A.C. Power

- 115 Vac \pm 10%, 50/60 Hz or 230 Vac \pm 10%, 50/60 Hz, configured by onboard jumpers

Signal Inputs [digitized to 10 bit (1 in 1024) accuracy]

- 0-10 Vdc command input, 200 Kohm input impedance
- Command potentiometer input, 5 Vdc excitation voltage, 100 Kohm input impedance, use with 1 Kohm potentiometer.
- 1-5 Vdc command input, 100 Kohm input impedance, Loss of signal threshold is 75% of low signal.
- 4-20 mA command input, 250 ohm input impedance, Loss of signal threshold is 75% of low signal.
- Feedback input, 5 Vdc excitation voltage, 1 Mohm input impedance, used with 1 Kohm potentiometer.

Signal Output [10 bit (1 in 1024) accuracy]

- 4 to 20 mA, 300 ohm maximum load impedance.

NOTE: For optimum noise immunity, all control signals should be shielded and run in separate conduit from power wires.

AC Motor Outputs

- Maximum locked rotor load current of 5 A with less than 5/10 mA (115/230 Vac) of leakage current.

External Fuses

The AC power supply should have over current protection tailored to the demands of the actuator motor used. The rating of the fuse or circuit breaker must not exceed 5 A.

Environmental

- Operating temperature: 0°C to 70°C.
- Storage temperature: -40°C to 85°C.
- Relative humidity: 0 to 90% non-condensing.

Troubleshooting

The board does not operate when the open and close buttons are depressed.

- Verify main power to the controller is on.
- Verify the output shaft cams are engaging the limit switch toggle arms
- Verify Dip Switch #1 is in the “calibrate” or “ON” position.

The green or red light on the board is lit, but the actuator has stopped.

- Verify that the output shaft cams are about 1° outside the programmed end of travel setpoints of the controller.

The yellow LED is flashing with a shorter time on than off after the controller has been set.

- Reset the CW and CCW end of travel limits with the 4-20 mA or 0-10 Vdc signal generator wired up. The signal generator should be set on 4 mA or 0 Vdc for the CW limit and 20 mA or 10 Vdc for the CCW limit. These settings would be opposite for reverse acting applications.

The yellow LED is flashing with a shorter time off than on after the controller has been set.

- Reset the CW and CCW end of travel limits with the 4-20 mA or 0-10 Vdc signal generator wired up. The signal generator should be set on 4 mA or 0 Vdc for the CW limit and 20 mA or 10 Vdc for the CCW limit. These settings would be opposite for reverse acting applications.

The controller drives the actuator to the fully OPEN or CLOSED position without response to the command signal

- The feedback potentiometer may be wired backward. Verify the potentiometer is wired up correctly per Figure WD1 and the supplied wiring diagram.

The controller output appears erratic, sometimes moving in the wrong direction.

- The feedback potentiometer may be “wrapping around”. Verify the potentiometer has been centered correctly.
- Calibration may not have been programmed properly. Recalibrate the CCW and CW limits.

Should you have any questions, please feel free to contact our application engineers at 419-529-4296.