Accu-Dial

Accu-Dial general description

The Accu-Dial is a combination process control and display device that allows adjusting process drivers with the numerical results appearing on a 4-digit Liquid Crystal Display (LCD). A built-in 10 k-ohm potentiometer controls the process drive. A common application of the Accu-Dial is controlling the speed of a motor drive by replacing its standard speed-control potentiometer. The Accu-Dial has two modes of operation: Decimal and Time. In Decimal Mode, the display represents values in decimal digits, and in Time Mode, as units of time.
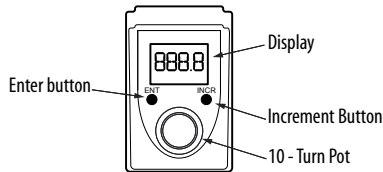

Figure 1: Accu-Dial Face Parts

Table 1: Accu-Dial Face Parts and Functions

Part	Function
Display	Displays potentiometer positions in decimal values from 0.000 to 9999, and time from 59:59 to 00:00
Enter (ENT) Button	This button enters Programming Mode for each variable, selects the digit position, and saves the numerical value for each digit position
Increment (INCR) Button	This button increments each digit from 0 to 9, positions the decimal point on the display, selects the 5-programmable variables, and exits Programming Mode
10-Turn Pot	This pot sets process driver operating voltage

Installation overview

The Accu-Dial mounts to the surface of a control panel, using supplied double-sided tape. The three potentiometer wires exit the back of the Accu-Dial through a mounting post. See Figure 2. The mounting post inserts into a 3/8-inch diameter hole in a control panel.
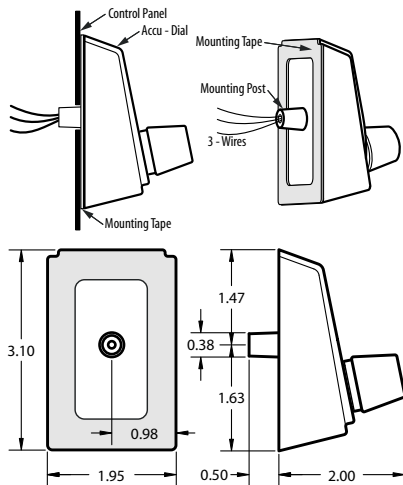

Figure 2: Accu-Dial Mounting Features and Dimensions

Mount the Accu-Dial

To mount the Accu-Dial to the control panel:
1. Clean the control panel surface with alcohol to remove any dirt, oil, or grease.
2. Thread Accu-Dial wires into the 3/8-inch diameter hole in control panel.
3. Before removing the tape's protective backing, position the Accu-Dial on the control panel to get an idea about positioning.
4. Remove the backing from the mounting tape. See Figure 2.
   Note: The mounting tape is very high bonding; after removing the protective backing from the tape, make sure nothing makes contact with the tape surface before mounting the Accu-Dial.
5. Insert the mounting post into the 3/8-inch hole and carefully position the Accu-Dial, ensuring the proper position before pressing to mount.
6. Firmly press the Accu-Dial to mount it to the control panel.

Electrical connections

CAUTION

The Accu-Dial is compatible with process drivers having pot supply voltages from 3.9 Vdc to 15 Vdc only, as measured across the pot supply's high-end to low-end terminals. Failure to observe this caution could result in damage to the Accu-Dial.

See Figure 2. Connect the Accu-Dial's two power wires and one wiper wire to the process driver's three pot supply terminals, as follows:
- Connect the Red wire to the high voltage terminal
- Connect the White wire to the wiper input terminal
- Connect the Black wire to the low voltage terminal

Definitions of variables

The Accu-Dial has 5-programmable variables: Var00, Var01, Var02, Var03, and Var04. The variables and their parameter values are described in Table 2 and Table 3.

Table 2: Operational Setup Variables

Variable	Parameter	Function
Var00	6170	<u>User Var Security</u> Prevents inadvertent programming. User must first enter 6170 into Var00 before being allowed to change the values in Var01 through Var04
Var01	1, 2, or 3	<u>Supply Voltage Select</u> Matches the Accu-Dial to the process driver's pot supply voltage level. The voltage selections are: 1 = 3.9 to 5.5 Vdc 2 = 5.5 to 10.5 Vdc 3 = 10.5 to 15 Vdc
Var02	1 or 2	<u>Display Format Select</u> Sets the mode of operation to either a Decimal or Time display format: 1 = decimal (*digits*) 2 = time (*hrs:mins or mins:secs*)

Table 3: Decimal and Time Mode Calibration Variables

Operation	Variable	#Range	Description
Decimal Mode	Var03	0.000 to 9999.	Decimal value that appears on the LCD display when the pot is at the selected low (LO) calibration position.
	Var04	0.000 to 9999.	Decimal value that appears on the LCD display when the pot is at the selected high (HI) calibration position.
Time Mode	Var03	00.00 or 00.01	Sets the Accu-Dial's low-end dead band compensation: 00.00 = disable 00.01 = enable
	Var04	59.59 to 00.00	Units of time that appear on the LCD display when the pot is at the selected calibration position.

About calibration, error messages, and alerts

In decimal mode when calibrating Var03 and Var04

1. Enter Programming Mode.
2. Set the pot to the proper CCW position.
3. Select Var03 and then enter the decimal value for this position.
4. Turn the pot CW to a desired position (¼ turn minimum).
5. Select Var04 and then enter the decimal value for this position.
6. Position the decimal point in Var04 only, if desired.
7. Exit Programming Mode.

In time mode when calibrating Var03 and Var04

1. Enter Programming Mode.
2. Select Var02 and enter 2, Time Mode.
3. Set the pot to the proper CCW position.
4. Select Var03 and enable or disable the dead band compensation.
5. Turn the pot CW to a desired position (¼ turn minimum).
6. Select Var04 and then enter the time value for this position; the decimal point is fixed at the [XX.XX] position.
7. Exit Programming Mode.

Decimal and time mode default displays

When changing from Decimal Mode to Time Mode operation, the default values for Var03 and Var04 are as follows:
- Var03 = 00.00 dead band compensation disabled
- Var04 = 05.00 representing Time (5 hrs 0 min, or 5 min 0 sec)
- The default pot position for Var03 is fully CCW
- The default pot position for Var04 is fully CW

When you change from Time Mode to Decimal Mode operation, the default values for Var03 and Var04 are as follows:
- Var03 = 0000. (0 user units)
- Var04 = 9999. (9999 user units)
- The default pot position for Var03 is fully CCW
- The default pot position for Var04 is fully CW

Error messages and alerts

Calibration error messages and how to clear them

- **Err1**: If you calibrate Var04 without turning the pot at least ¼ turn CW from the calibration position for Var03, an 'Err1' error message appears on the display, after you exit Programming Mode.
- **Err2**: If you calibrate Var03 at a pot position more CW than the calibration position for Var04, an 'Err2' error message appears on the display, after you exit Programming Mode.
- To correct either the 'Err1' or 'Err2' message, follow these steps:
  - recalibrate Var03 with the pot at the correct Var03 position
  - recalibrate Var04 with the pot at the correct position (Var04 position must be at least ¼ turn CW from the Var03 position).
  - exit Programming Mode.

Note: When recalibrating Var03 or Var04 to their same respective values, you must actually change the variable's value, and then change it back to the desired value, in order for the recalibration to be effective. (Ex: Enter the variable and use the INCR button to change the right-most flashing digit, then keep changing it fully back to your initial value).

Display mode alert messages and what they mean

- Flashing **"0000"** (Decimal or Time Mode): means the pot position in User Units value is less than 0 (*outside the displayable range*).
- Flashing **"9999"** (Decimal Mode): means the pot position in User Units value is greater than 9999 (*outside the displayable range*).
- Flashing **"59:59"** (Time Mode): means the pot position "time" value is greater than 59:59 (*outside the displayable range*).

How to set up and calibrate the Accu-Dial

To pass through User Var Security (Var00) and gain access to the programmable variables Var01 through Var04:

Var00 must be set to "6170" each time programming mode is entered.
1. Press the ENT button: Pr00 appears; this selects Var00.
2. Press the ENT button: the first digit is flashing.
3. Press the INCR button to increment the digit (0 thru 9); press the ENT button to select the next digit, saving the previous value. Do this for each digit until the "6170" password has been entered.
4. Press the ENT button until Pr00 appears on the display.

Note: If Var00 does not equal 6170, then the user is only allowed to view the values in Var01 through Var04, but not allowed to change them.

Set voltage parameter and operation mode: Var01 and Var02

To set the voltage parameter (Var01) to match the driver's pot supply voltage:

1. Press the INCR button: Pr01 appears; this selects Var01.
2. Press the ENT button: the first digit is flashing.
3. View Table 2 to select the driver's pot supply voltage range; then press the INCR button to select the digit 1, 2 or 3 that represents the correct range.
4. Press the ENT button until Pr01 appears on the display.

To set the mode of operation (Var02) to decimal or time mode:

5. Press the INCR button: Pr02 appears; this selects Var02.
6. Press the ENT button: the first digit is flashing.
7. Press the INCR button to select '1' for Decimal or '2' for Time operation.
8. Press the ENT button until Pr02 appears on the display.

Calibration procedure for decimal mode operation: Var03 and Var04

- Var03 is the LO pot position, more counterclockwise (CCW)
- Var04 is the HI pot position, more clockwise (CW)

1. Press the INCR button: Pr03 appears; this selects Var03.
2. Turn the pot to the proper CCW position. (*See Motor Drive Low-End Dead Band Compensation discussion for "proper" pot position for Var03.*)
3. Press the ENT button: the first digit is flashing.
4. Press the INCR button to increment the digit (0 thru 9); press the ENT button to select the next digit, saving the previous value. *(Do this for each digit until the entire user unit value has been entered)*
5. After entering the pot position decimal value, press the ENT button until Pr03 appears on the display.
6. Press the INCR button: Pr04 appears; this selects Var04.
7. Turn the pot CW to a desired position (¼ turn minimum).
8. Press the ENT button: the first digit is flashing.
9. Press the INCR button to increment the digit (0 thru 9); press the ENT button to select the next digit, saving the previous value. *(Do

this for each digit until the entire user unit value has been entered)

10. The last action is to set the position of the decimal point, if desired. Press the ENT button until the decimal point flashes.
11. Press the INCR button to position the decimal point.
12. Press the ENT button until Pr04 appears on the display.
13. Press the INCR button to exit Programming Mode.

Calibration procedure for time mode operation: Var03 and Var04

Note: In Time Mode operation, the decimal point position for Var03 and Var04 is fixed as shown: [XX.XX].

1. Press the ENT button, then the INCR button until Pr02 appears on the display; this selects Var02.
2. Press the ENT button: the first digit is flashing.
3. Use the INCR button to increment the digit to '2,' Time Mode.
4. Press the ENT button until Pr02 appears.
5. Press the INCR button: Pr03 appears; this selects Var03.
6. Set the pot to the proper CCW position. (*See Motor Drive Low-End DeadBand Compensation discussion for "proper" pot position for Var03.*)
7. Press the ENT button: the first digit is flashing.
8. Press the INCR button to change the digit (0 or 1).
   Notes about setting Var03 for Time Mode operation:
   - a '00.00' disables dead band compensation.
   - a '00.01' enables dead band compensation.
   - When setting Var03 to '00.01' to enable the Accu-Dial's dead band compensation, first set the pot to the proper CCW position, then change Var03 from '00.00' to '00.01'.
   - If Var03 needs recalibration later, follow these steps: First set the pot to the proper CCW position, then enter '00.00' into Var03 (clear-out the old calibration), finally change Var03 back to '00.01' (for the new calibration).
9. Press the ENT button until Pr03 appears on the display.
10. Turn the pot CW to a desired running position (¼ turn minimum).
11. Press the INCR button: Pr04 appears; this selects Var04.
12. Press the ENT button: the first digit is flashing.
13. Press the INCR button to increment the digit (0 thru 9); press the ENT button to select the next digit, saving the previous value. Do this for each digit until the time is set.
14. Press the ENT button until Pr04 appears on the display.
15. Press the INCR button to exit Programming Mode.

Decimal and time mode operation examples

Decimal example 1: Assembly line application producing widgets
• A motor drive controls the motor speed.
• The motor drive does not self compensate for low-end dead band. (*See Motor Drive Low-End Dead Band Compensation discussion.*)
• The motor drive uses a speed pot supply voltage of 10 Vdc.
• At normal speed, the line produces 500 widgets per day.
• The display shows the number of widgets produced per day.

Setup and calibration procedure for example 1:
a. Enter '2' into Var01, since pot supply voltage is 10 Vdc.
b. Enter '1' into Var02, to show the process output as decimal (*i.e., the number of widgets produced*).
c. Access Var03, and set the pot to the CCW position just short of creeping the motor. Enter '0' into Var03, and then exit Var03.
d. Access Var04, and set the pot so the motor runs at the speed that produces 500 widgets. Enter 500 into Var04, and then exit Var04.
e. Setup and calibration is complete; exit Programming Mode.

Results for example 1:

To make 500 widgets per day, turn the pot until 500 appears on the display. To make 450 widgets per day, turn the pot until 450 appears on

the display. The line runs at the displayed production rate.

Time example 2: Conveyor oven application baking pizzas
• A motor drive controls the motor's speed running the conveyor.
• The motor drive does not self compensate for low-end dead band. *(See Motor Drive Low-End Dead Band Compensation discussion.)*
• The motor drive uses a speed pot supply voltage of 10 Vdc.
• At normal speed, it takes 15 minutes and 30 seconds to send the pizza through the oven.
• The display shows time-in-process 'baking time' rather than conveyor oven speed.

Setup and calibration procedure for example 2:
a. Enter '2' into Var01, since pot supply voltage is 10 Vdc.
b. Enter '2' into Var02, to show process output as time (*i.e., how long the pizza remains in the oven at this motor speed*).
c. Access Var03, and set the pot to the CCW position just short of creeping the motor. Enter '00.01' into Var03 (to enable the Accu-Dial's dead band compensation). Then exit Var03.
d. Access Var04, and set the pot so the motor runs at the speed that sends the pizza through the oven in 15 minutes and 30 seconds. Enter 15:30 into Var04, and then exit Var04.
e. Setup and calibration is complete; exit Programming Mode.

Results for example 2:

To send the pizza through the oven in 15 minutes and 30 seconds, turn the pot until 15:30 appears on the display. To send the pizza through the oven at a slower speed for pizzas needing 17 minutes to bake, turn the pot until 17:00 appears on the display.

Note: In Time Mode, the accuracy of the Accu-Dial's displayed value is more dependent on the system's motor and drive linearity, than when the Accu-Dial is in the Decimal Mode. In Time Mode, best results are usually obtained when Var04 is calibrated at the user's most critical speed.

Motor drive low-end dead band compensation

Most motor drives have a low-end dead band where the external speed adjust pot must be turned to some position away from its CCW end point before the motor begins to turn. It is IMPORTANT to know whether your motor drive, <u>Does</u> or <u>Does Not</u>, self compensate for low-end dead band, since that will determine the best pot position at which to calibrate the Accu-Dial's Var03 for best accuracy.

Motor drives that DO NOT self compensate

If, as you slowly turn the pot the motor remains stopped until the pot passes a certain point, after which the motor smoothly starts from zero RPM *(versus suddenly jumping to some minimum speed)*, **then** that usually means the motor drive <u>Does Not</u> compensate for low-end dead band.

When programming Var03, using non-compensating motor drives:
For Decimal Mode operation:
• Set the Accu-Dial's pot to a position that turns the motor *(i.e., above the drive's low-end dead band)*. Set the value for Var03.
• Or, set the value for Var03 at a pot position just short of creeping the motor *(i.e., on the edge of the drive's low-end dead band)*.

For Time Mode operation:
• Position the Accu-Dial's pot to just short of creeping the motor *(i.e on the edge of the low-end deadband). Then change Var03 from '00.00' to '00.01' to enable the Accu-Dial's dead band compensation.

Motor drives that DO self compensate

If, as you slowly turn the pot the motor remains stopped until the pot passes a certain point, after which the motor jumps to a minimum speed; and maintains that speed until the pot passes a second point, after which the motor speed increases proportionally as you turn the pot, **then** that usually means the motor drive <u>Does</u> compensate for low-end dead band. Figure 3 is a pot position *(x)* vs. motor speed *(y)* graph; notice the self compensating stair step in the lower-left of the plot.
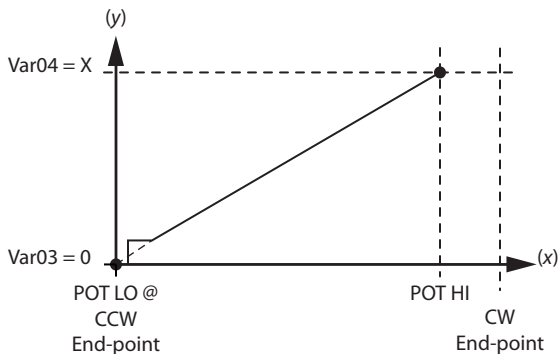

Figure 3: Pot Position for Self-Compensating Motor drives

When programming Var03, using self-compensating motor drives:
For Decimal Mode operation:
- Set the Accu-Dial's pot to a position that turns the motor *(i.e above the low-end deadband)*. Set the value for Var03.
- Or, set the pot to the maximum CCW position *(i.e., below the low-end dead band)*. Set the value for Var03 (typically set to zero in this case). See example in Figure 3.

For Time Mode operation:
- Set the pot to the maximum CCW position *(i.e below the low-end deadband)*. Then set Var03 to '00.00' to disable the Accu-Dial's dead band compensation.

If you do not know if the drive self compensates for dead band:

1. Enter the value for Var03 after doing one of the following:
   - Position the pot to max CCW. *(i.e. below the dead band)*.
   - Or, position the pot to just short of creeping the motor. *(i.e. on the edge of the dead band)*.
   - Or, position the pot so the motor turns *(i.e. above the dead band)*. (decimal mode only).
2. Choose the method that gives the best Accu-Dial performance.

LCD Self-Test and Firmware Identification
During power-up the Accu-Dial first displays "8.8.:8.8." along with the small "VAR" icon for about 3 seconds, (as a self-test of the LCD). The Accu-Dial then displays the firmware identification number in the "X.X.X.X" format, for about 2 seconds. The first two digits reflect the version number. The last two digits reflect the revision number. (e.g. "0.1.0.3." for version 01, revision 03).

Reset the variables to factory defaults
To reset the Accu-Dial to factory defaults, simultaneously press the ENT and INCR buttons while applying power to the Accu-Dial. Release the buttons only after the display shows 'rESE' (for reset). The factory defaults are:
- Var00 = 0000. (User var security enabled)
  Var01 = 0003. (10.5 to 15 Vdc pot voltage)
  Var02 = 0001. (Decimal mode format)
  Var03 = 0000. (0 user units, at pot fully CCW)
  Var04 = 9999. (9999 user units, at pot fully CW)

Specifications

Performance:
- LCD max range of '0.000' to' 9999.' for Decimal Mode operation.
- LCD max range of '59:59' to '00.00' for Time Mode operation *(hrs:mins or mins:secs)*.
- Open-loop control.
- EEPROM protects programming and calibration settings.
- Built-in 10-turn 10kΩ pot has power rating of 2W at 40ºC.
- Accuracy and resolution:
  - The built-in 10-turn 10kΩ pot is precision wire-wound with ± 0.25% linearity. The wiper of the 10kΩ pot has 5000 positions at 2Ω per position (wiper output is Accu-Dial's white wire).
  - Accu-Dial measures the 10kΩ pot's position with 12-bits of resolution (4096 positions).
  - At full-scale calibration (i.e., Var03_LO_CAL at pot max CCW, and Var04_HI_CAL at pot max CW), the Accu-Dial can resolve down to and display changes to within 0.1% of the full-scale Var04_HI_CAL user unit value. (For calibrations done at less than full-scale, the LCD's resolution may not be as tight as 0.1% of full-scale).

Mechanical packaging
- Mounts through control panel via single 3/8-inch diameter hole, using highly bonding tape
- Footprint of 1.95-inches wide *(left to right)* by 3.10-inches long

Environmental considerations
- NEMA 4 enclosure type
- Temperature range of 0ºC to 60ºC
- Humidity range of 0% to 90% non-condensing

Electrical considerations
- Compatible with process drivers having pot supply voltages from 3.9 Vdc to 15 Vdc *(as measured across the process drive's pot supply high-end to low-end terminals)*
- Compatible with process drivers using an external control voltage potentiometer of 10k ohms
- Current draw of 2.5 mA or less
- User selectable scaling matches the Accu-Dial to the process drive's pot supply voltage level. *(This makes best use of the Accu-Dial's internal 12-bit resolution, allowing accurate LCD readouts, independent of pot supply voltage levels)*

Operator interface
- Built-in 10-turn, 10k-ohm potentiometer, *(sets operating voltage for process drive)*
- Two pushbuttons: ENT and INCR *(setup and calibration)*

Configuration modes
- Display Mode: Units in decimal or as time
- Programming Mode: Variables 00, 01, 02, 03, 04

Operation modes
- Decimal based mode *(decimal digits)*
- Time based mode *(units of time in hrs:mins or mins:secs)*

I/O requirements
- Input accepts pot supply voltages from 3.9 Vdc to 15 Vdc
- Outputs are control voltages to process drives, and a potentiometer position readout to a built-in LCD display

Additional information
Accu-Dial has US Patent # 6,809,531.
To get additional technical information about the Accu-Dial, visit our website at: www.electro-sensors.com

Free Catalog and Application Assistance
1.800.328.6170
Website: www.electro-sensors.com
990-001200 Revision E