

# Universal Encoder Checker

www.UniversalEncoderChecker.com



## Operation Manual Version 1.2

Read this operation manual and understand how to use this instrument prior to operation

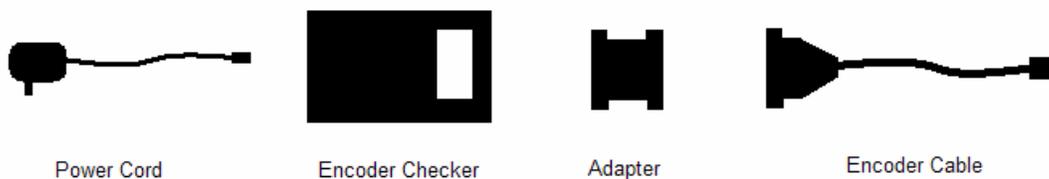
## Universal Encoder Checker

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## Description

The Universal Encoder Checker (UEC) will test both absolute and incremental encoders from 5 to 24 volts. The UEC checks the incremental encoder outputs A, B, (with or without Z) and their complements for Duty Cycle, Phase, Pulses per Revolution, and Voltage Level. The UEC displays the binary value of an absolute encoder with up to 16 outputs and can check the analog voltage of each output sequentially.

## Components



The components of the UEC are shown above. The Encoder Checker will test basic 5 volt encoders, and an adapter is necessary for 12 or 24 volt encoders or encoders requiring pull-ups and pull-downs like open collector or line driver encoders. See Appendix C for acceptable power supplies.

## Encoder Checker and Adapter Connections

All connections marked Reserved should be left unconnected.

Pin	Incremental Encoders	Absolute Encoders
1	Phase A Complement	Bit 0
2	Phase B Complement	Bit 1
3	Phase Z (or Index) Complement	Bit 2
4	Phase A	Bit 3
5	Phase B	Bit 4
6	Phase Z (or Index)	Bit 5
7-16	Reserved	Bit 6 through Bit 15
17-19	Reserved	Reserved
20	Encoder Voltage Supply	Encoder Voltage Supply
21	Reserved	Reserved
22	Reserved	Reserved
23	Reserved	Reserved
24	Encoder Ground	Encoder Ground
25	Reserved	Reserved

## Warning: High Temperature Generation

The UEC internal power supply can get very hot under certain conditions. The UEC uses an adjustable linear voltage regulator to produce the voltage needed to power the Encoder. The larger the difference between the supply voltage to the UEC and the encoder operating voltage, the more power is dissipated as heat; for example, using a 24VDC power supply for the UEC while testing a 5VDC encoder can dissipate a large amount of heat. **Recommend use of the UEC is to disconnect the encoder from the UEC or disconnect the power supply to the UEC when not performing a test.** Reducing the voltage of the power supply to the UEC can also reduce the heat generated.

## Basic Setup

1. Power down machinery to which the Encoder is connected.
2. Disconnect the Encoder from machinery so the encoder can be turned freely.
3. Disconnect the Encoder from any electrical connections.
4. Connect the UEC Cable to the Encoder using the specifications for your Encoder.
5. Connect the UEC Cable to the UEC, with an Adapter\* if necessary.
6. Connect the Power Supply to the UEC.
7. Plug in the Power Supply.

\* Adapter: See Appendix A for specifications on Adapter types available.

## Menu Navigation

Basic menu navigation consists of three buttons including “Up”, “Down”, and “Select” button. Use the middle and right buttons to scroll “Up” and “Down” through the menu options. Press the left “Select” button to either drill down into another menu or to activate that feature. Pressing and holding the “Select” button for two seconds will reset the UEC.

## Basic Operation

### *Select Mode of Operation*

Prior to selecting a mode of operation, change any settings necessary to reflect the current encoder to be tested. See the “Setup UEC Parameters” section of the manual for details.

Several modes of operation allow testing of the encoder to verify each aspect of encoder functionality.

If any Errors are encountered while performing any of the Mode tests, refer to the “Troubleshooting Errors” section.

## Mode: Auto

Encoder Type: Incremental with Z (Index) pulse Only

Purpose: To automatically calculate the Pulses per Revolution (PPR) parameter, and to verify a consistent number of A and B pulses between Z pulses.

Procedure:

1. Select "Mode" and then select "Auto".
2. Start turning the encoder Clockwise (CW) slowly by hand when the display reads "Turn encoder", and do not turn Counter Clockwise (CCW) until test is complete.
3. If after several full rotations the screen still only reads "Turn encoder", the Z pulse has not been detected by the UEC.
  - a. Check to see if the Encoder has a Z pulse output; use Mode "Manual" if not.
  - b. Check to see if the Encoder Z pulse is connected correctly to the UEC.
  - c. The Z pulse from the Encoder may not be functioning correctly.
4. Continuing turning the encoder slowly by hand when the display reads "Keep Turning".
5. Displayed is the calculated PPR, then the current A&B pulse count total, followed by the level of the Z to reset the pulse count: H for High, L for Low.
6. Continue turning the encoder for at least 10 revolutions. These revolutions can be faster than the previous.
7. The screen will indicate if an error is ever detected, otherwise, the CW direction passed the test.
8. Press "Select" to return to the main menu.
9. Repeat steps 1 through 7, but only rotate the encoder in the CCW direction, and do not rotate in the CW direction at all during the test.
10. Press "Select" to return to the main menu.

## Mode: Manual

Encoder Type: Incremental without Z (Index) pulse Only

Purpose: To show the angular position of the Encoder relative to the position at the start of the Manual test. The position is calculated by incrementing or decrementing a counter every time there is a state change on the A and B encoder outputs. The counter is reset to zero when the PPR is passed; the counter is not affected by a Z pulse if present.

Procedure:

1. Set the PPR using the procedure described in the "Setup UEC Parameters" section.
2. Physically mark the current position on the encoder shaft and body to visually compare the encoder position to the display, and do not turn until after step 3.
3. Select "Mode", and then select "Manual".
4. Turn the encoder by hand CW (or CCW, whichever produces an incrementing value on the screen).
5. The count on the screen will increment until the PPR value is reached, reset to 0, and then continue counting up again.
6. If the counter does not increment and decrement as the encoder is turned:
  - a. Check to make sure the Phase A and B outputs of the encoder are connected.
  - b. The Encoder may not be functioning correctly.
7. Every time the PPR resets to zero, the physical mark on the encoder shaft and body should line up. If the two physical marks appear to drift further and further apart as the encoder shaft is rotated:
  - a. Confirm the PPR setting in the UEC matches the PPR of the Encoder.
  - b. Check the Encoder to UEC connections.
  - c. Ensure encoder rotation is at a slow speed to ensure the UEC sees all pulses.
  - d. The Encoder may not be functioning correctly.
8. Press "Select" to return to the Main Menu.

## Mode: DRO

Encoder Type: Incremental Only

Purpose: To show the angular position as a Digital Read Out (DRO) of the Encoder relative to the position at the start of the DRO test without resetting each revolution. The position is calculated by incrementing or decrementing a counter every time there is a state change on the A and B encoder outputs. The counter is not affected by a Z pulse if present.

Procedure:

1. Select "Mode" and then select "DRO".
2. Turn the Encoder by hand.
3. The value on the screen will increment with the Encoder position in one direction, and decrement with the Encoder position in the other direction.
4. If the counter does not increment or decrement as the encoder is turned:
  - a. Check to make sure the Phase A and B outputs of the encoder are connected.
  - b. The Encoder may not be functioning correctly.
5. Press the "Select" button when done to the Main Menu.

Note: Pressing down on the down button will zero the current encoder position.

## Mode: Phase for Output A, B, or AB

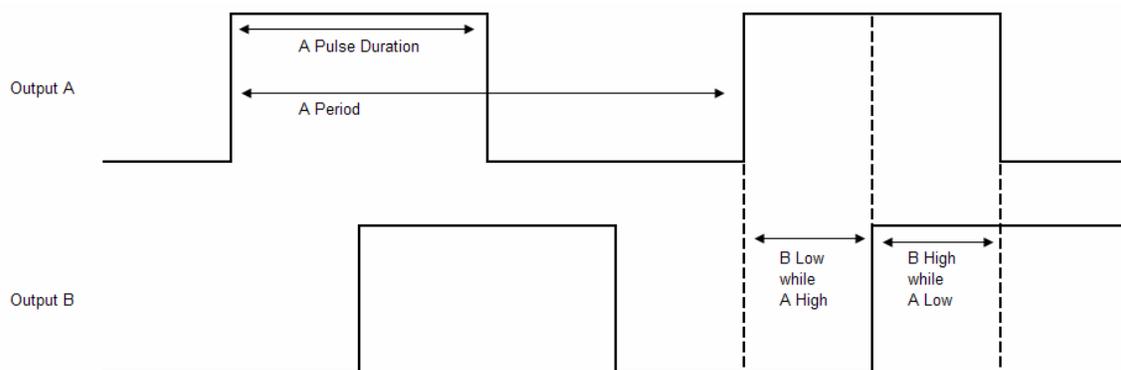
Encoder Type: Incremental Only

Purpose: To verify the duty cycle of the encoder outputs A and B, and the phase difference between outputs A and B.

Details: The farther the duty cycle of a single output is from 50% (high half of the time and low half of the time), the more likely machine reading the encoder's output will have problems at higher speeds. The farther the phase between A and B outputs is from 50% (one output high half of the time and low half of the time while the other output is a single state), the more likely machine reading the encoder's output will have problems at higher speeds.

Procedure:

1. Select "Mode", and then select "Phase".
2. Select either "A Duty", "B Duty", or "AB Phase".
3. The display will indicate "Turn encoder".
4. Rotate the Encoder Clockwise (CW) by hand rapidly, and record the duty cycle indicated while rotating.
5. Rotate the Encoder Counter Clockwise (CCW) by hand rapidly, and record the duty cycle indicated while rotating.
6. If while rotating the Encoder the display does display a duty cycle:
  - a. Ensure the encoder was turned fast enough. "Turn Encoder" is redisplayed after the encoder rotation has stopped or is too slow since both conditions can not accurately reflect a correct duty cycle.
  - b. Check to make sure the Phase A and B outputs of the encoder are connected.
  - c. The Encoder may not be functioning correctly.
7. Press the "Down" button and repeat steps 2 through 7 for other two "Phase" modes remaining.
8. Press the "Select" button when done to return to the Main Menu.



Duty Cycle of A is "A Pulse Duration" over "A Period"; 50% Duty Cycle Shown

B is 90° out of phase with A; B is low 50% of the time A is high.

## Mode: ANALOG for Incremental

Encoder Type: Incremental

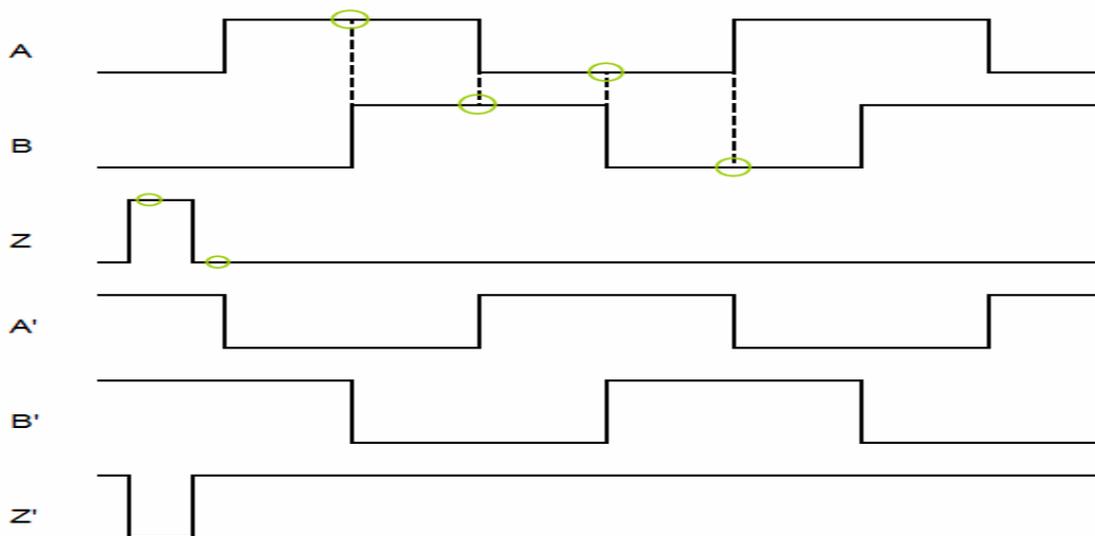
Purpose: To view the analog value on the Encoder outputs at the loads cited by its specifications. If an Encoder can not produce the voltage levels at current loads listed in its data sheet, it may produce unreliable results during operation.

Procedure:

1. Ensure the UEC Load parameter is set to "Y" unless not necessary.
2. Select "Mode", and then select "Analog".
3. Notice a "# # LS" where #s are numbers, L is a letter for output, S is either a + or - indicating either an encoder output or the complement output is displayed, respectively.
4. Use the "Up" and "Down" push button to select which Encoder output to view.
5. Rotate the Encoder by hand; if the Load is set to "Y", the pull-ups and pull-downs will be pulsed (to minimize component heating) while taking the analog measurement.
6. The two numbers, regardless of order displayed, indicate the low and high value for that Encoder output. If incorrect readings are displayed,
  - a. Cycle UEC power; the adapter voltage is only checked upon start up.
  - b. Check UEC to Encoder connections and confirm correct adapter used.
  - c. Encoder may not be functioning correctly.
7. Use the "Up" or "Down" button to select another output, and repeat step 4 through 6.
8. Press the "Select" button when done to return to the Main Menu.

The A and B ( and A' and B') output measurements are taken on the state change of other output. The high A reading is taken when B changes while A is High. The high B reading is taken when A changes while B is High. The low A reading is taken when B changes while A is Low. The low B reading is taken when A changes while B is Low.

The Z (and Z') output (if present) measurement is only updated once per revolution. The encoder may need to be rotated slower for the Z pulse measurement since the Z pulse width is smaller than A or B. The Z (and Z') measurements are taken approximately 20us after the change in state; see figure below.



## Mode: ANALOG for Absolute

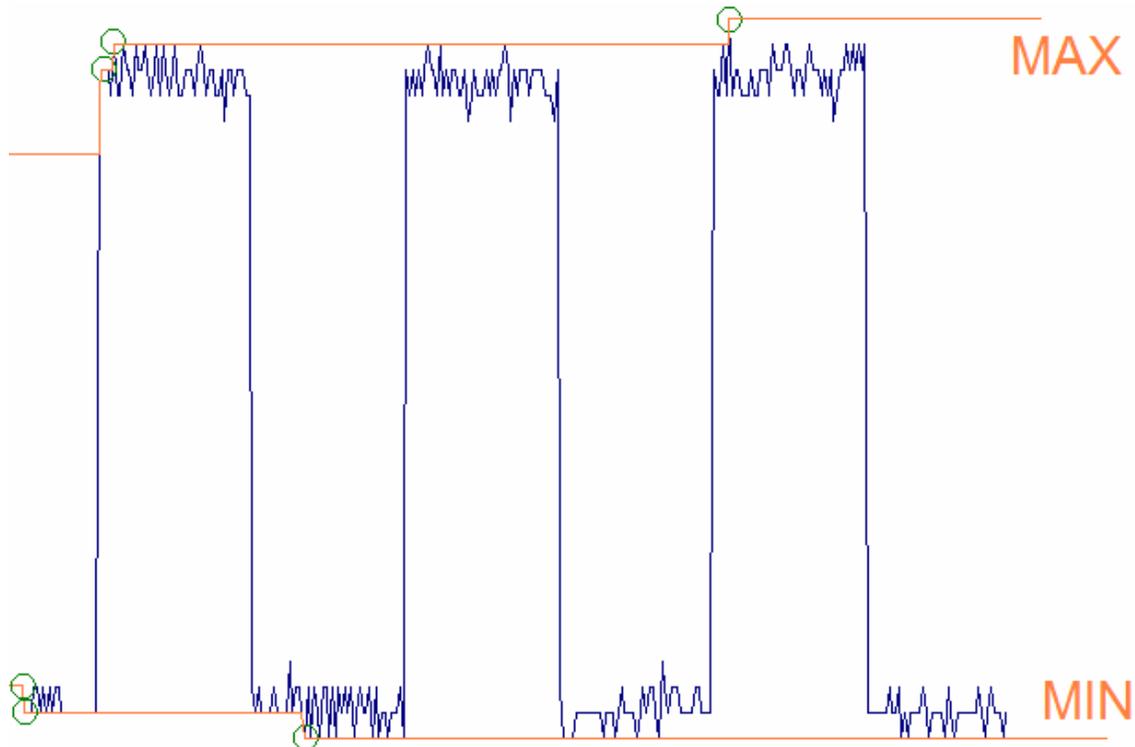
Encoder Type: Absolute

Purpose: To view the analog value on the Encoder outputs at the loads cited by its specifications. If an Encoder can not produce the voltage levels at current loads listed in its data sheet, it may produce unreliable results during operation.

Cable: A general purpose or un-terminated cable is required to test more than one output.

Procedure:

1. Connect the Encoder output to be checked to the UEC pin 4.
2. Select "Mode", and then select "Analog".
3. Notice a "## LS" where #s are numbers, L is a letter for output, S is either a + or - indicating either an encoder output or the complement output is displayed, respectively.
4. Scroll "Down" until mM (for minimum/Maximum) is displayed on the right.
5. Press the "Down" button once to reset the values displayed.
6. Rotate the Encoder by hand.
7. The two numbers, regardless of order displayed, indicate the minimum and maximum value for that Encoder output since the last mM reset (step 5). See figure below.
8. Disconnect from current Encoder output and connect the next Encoder output to be checked to the UEC pin 4, and repeat steps 5 through 7.
9. Press the "Select" button when done to return to the Main Menu.



## Mode: ABS

Encoder Type: Absolute or Incremental

Purpose: To display the outputs from the Encoder as the digital states 1 or 0.

Procedure:

1. Set the number of outputs from the Encoder as number of Bits. Refer to the "Setup UEC Parameters" section for details.
2. Select "Mode", and then select "ABS"
3. Turn the Encoder slowly by hand.
4. The value displayed on the screen will indicate the current Encoder position in binary.
5. If any of the bits never seem to change, or change unexpectedly,
  - a. The number of Bits in the UEC parameters needs changing.
  - b. The UEC to encoder connection needs to be checked.
  - c. The Encoder may not be operating properly.
6. To toggle between binary and decimal (of natural binary), press the "Down" button.

Reading Binary Numbers: Various binary number systems exist for various reasons. Below is a table of some of the common binary number systems for quick reference.

Decimal	Natural	Gray Code	BCD
0	000000	000000	00000000
1	000001	000001	00000001
2	000010	000011	00000010
3	000011	000010	00000011
4	000100	000110	00000100
5	000101	000111	00000101
6	000110	000101	00000110
7	000111	000100	00000111
8	001000	001100	00001000
9	001001	001101	00001001
10	001010	001111	00010000
11	001011	001110	00010001
12	001100	001010	00010010
13	001101	001011	00010011
14	001110	001001	00010100
15	001111	001000	00010101
16	010000	011000	00010110
17	010001	011001	00010111
18	010010	011011	00011000
19	010011	011010	00011001
20	010100	011110	00100000
21	010101	011111	00100001
22	010110	011101	00100010
23	010111	011100	00100011
24	011000	010100	00100100
25	011001	010101	00100101
26	011010	010111	00100110
27	011011	010110	00100111
28	011100	010010	00101000
29	011101	010011	00101001
30	011110	010001	00110000
31	011111	010000	00110001
32	100000	110000	00110010
33	100001	110001	00110011

## **Setup UEC Parameters**

### **Setup: Single Out**

Encoder Type: Incremental Only

Purpose: Setting this parameter to N for No indicates there are complementary outputs for each Encoder output: A, A', B, B', (Z), (Z'). Setting this parameter to Y for Yes indicates there are not complementary outputs, only A, B, (Z).

Procedure:

1. Scroll "Down" to "Setup" and "Select".
2. Press the "Select" button to toggle between Y and N.
3. Make other Setting changes or scroll "Down" to "Return" and "Select".

### **Setup: Load**

Encoder Type: Absolute or Incremental

Purpose: Setting this parameter to Y for Yes turns on any strong pull-ups or pull-downs in an attached Adapter while running the Encoder Analog test. Otherwise, these loads are turned off when not in use to reduce component heating. Setting this parameter to N for No will prevent both the strong pull-ups and pull-downs in adapter from being activated.

Procedure:

1. Scroll "Down" to "Setup" and "Select".
2. Scroll "Down" to "Load" and "Select".
3. Press the "Select" button to toggle between Y and N.
4. Make other Setting changes or scroll "Down" to "Return" and "Select".

## Setup: PPR

Encoder Type: Incremental Only

**Purpose:** PPR stands for Pulses per Revolution. This setting is necessary for encoders that do not have a Z (or Index) pulse output so the UEC can accurately display the current Encoder position as a single value referenced from the Encoder position at the start of the test in Manual mode. The maximum PPR is 99999.

**Procedure:**

1. Scroll "Down" to "Setup" and "Select".
2. Scroll "Down" to "PPR", and "Select".
3. The Most Significant Digit is edited first.
4. Using the "Up" and "Down" arrows, adjust the digit, and then press "Select".
5. The next digit is ready to be edited.
6. Repeat steps 4 and 5 until the cursor is under "Done".
7. To continue editing, press "Select"; if finished, press either "Up" or "Down".
8. Make other Setting changes or scroll "Down" to "Return" and "Select".

**Note:** The PPR for the UEC is defined as the total number of both A and B state changes per revolution; this is sometimes referred to as "x4". A "x2" count of PPR would only count the number of state changes on a single output per revolution, which would be half as much as the "x4" method. A "x1" count of PPR would only count the number of changes of a single output from a low state to a high state (or vice versa); this count would be 1/4 the count as defined by the "x4" method. If there is a difference between the UEC PPR and the encoder specification's PPR, this may be the reason.

## Setup: ABS BITS

Encoder Type: Absolute Only

**Purpose:** This parameter allows the UEC to ignore floating pins which might corrupt the displayed encoder position.

**Procedure:**

1. Scroll "Down" to "Setup" and "Select".
2. Scroll "Down" to "ABS Bits".
3. Press the "Select" button to change the number of bits for the Absolute Encoder.
4. Make other Setting changes or scroll "Down" to "Return" and "Select".

## *Adjust Contrast of Display Screen*

**Purpose:** Depending on the viewing angle of the screen, the contrast may need to be adjusted.

**Procedure:**

1. Scroll "Down" to "Contrast" and select.
2. Press the "Up" and "Down" buttons to adjust the Contrast.
3. Press the "Select" button when finished.

## Troubleshooting Errors

"ERROR - COUNT": The measured PPR of the last revolution did not match the set PPR.

This error can only occur during a Mode: Auto test. This error indicates an inconsistent number of pulses from the Encode A and B outputs between Z pulses.

1. Retry the Mode: Auto test but rotate the encoder a little slower by hand to make sure it was not the UEC that missed a pulse.
2. During the retest, make sure the encoder is only turned in a single direction.
3. Ensure the Z pulse and complement, if present, are connected correctly.
4. A repeat of the same error may indicate the Encoder is not performing correctly.

"ERROR - OVRFLW": The measured PPR has exceeded the set PPR. This error can only occur during a Mode: Auto test. This error indicates an inconsistent number of pulses from the Encode A and B outputs between Z pulses.

1. Retry the Mode: Auto test but rotate the encoder a little slower by hand to make sure it was not the UEC that missed a pulse.
2. During the retest, make sure the encoder is only turned in a single direction.
3. A repeat of the same error may indicate the Encoder is not performing correctly.

"ERROR - POL A": The UEC has detected the same voltage on input A and A' (complement) when it was expecting a difference.

1. Check to make sure the Encoder has complementary outputs.
  - a. If the Encoder has complementary outputs, ensure Single Out in the UEC settings is set to "N".
  - b. If the Encoder does not have complementary outputs, ensure Single Out in the UEC settings is set to "Y".
2. Check the Encoder connections to the UEC.
3. Repeat the test which caused the error.
4. A repeat of the same error may indicate the Encoder is not performing correctly.

"ERROR - POL B": The UEC has detected the same voltage on input B and B' (complement) when it was expecting a difference.

1. Check to make sure the Encoder has complementary outputs.
  - a. If the Encoder has complementary outputs, ensure Single Out in the UEC settings is set to "N".
  - b. If the Encoder does not have complementary outputs, ensure Single Out in the UEC settings is set to "Y".
2. Check the Encoder connections to the UEC.
3. Repeat the test which caused the error.
4. A repeat of the same error may indicate the Encoder is not performing correctly.

"ERROR - POL Z": The UEC has detected the same voltage on input Z and Z' (complement) when it was expecting a difference.

1. Check to make sure the Encoder has complementary outputs.
  - c. If the Encoder has complementary outputs, ensure Single Out in the UEC settings is set to "N".
  - d. If the Encoder does not have complementary outputs, ensure Single Out in the UEC settings is set to "Y".
2. Check the Encoder connections to the UEC.
3. Repeat the test which caused the error.
4. A repeat of the same error may indicate the Encoder is not performing correctly.

## Appendix A: Adapter Types

Adapter modules are available for 5, 12, and 24 volt encoders with testing loads of 1, 20, 40, and 100mA loads. Open-collector type encoders require special modules due essential nature of the pull-ups constant nature. **Contact us for more details on any of these or other special module requests.**

The specific adapter is selected by the voltage of the encoder and the size of the pull-up and pull-down loads needed to meet the Encoder specifications. Adapters with both pull-ups and pull-downs should work for an encoder which requires only one or the other or neither. An adapter with 16 bit Absolute Encoder support will also work for 8 bit Absolute Encoders.

Selecting the right adapter for voltage is critical to ensure no damage to either the encoder under test or the UEC. The adapter both selects the voltage and steps it down for the UEC. First, the adapter sets the voltage produced by the UEC for the encoder; with no adapter, the UEC produces 5 volts for the encoder. Second, the adapter steps down each encoder output to a safe voltage level for the UEC inputs.

Selecting the right pull-up loads or pull-down loads are important to fully test an encoder since equipment to which it may normally be connected may draw the full load. If an encoder is malfunctioning at full load, it may still appear to function correctly with little or no load.

The voltage levels may shift from full scale with the specified load, but they typically remain within certain ranges. All following examples are given for 5VDC Encoders. Typical Encoder reading machinery reads a digital high with the voltage remaining above 2.7V and a digital low with the voltage below 0.9V. A typical Line Driver Encoder with full load may pull the voltage as low 3.0V for a digital high, and pull the voltage as high as 0.5V for a digital low. Line Driver Encoders may operate with loads anywhere from 20mA to 100mA. Encoders with outputs of Open Collector (the Encoder allows the output to float high) or compatible with TTL circuits (the Encoder will pull the line both low and high) often remain above 4.5V for a digital high and below 0.1V for a digital low. These types of encoders typically only allow a couple mA of load.

## Appendix B: Cable Types

Custom cables are available upon request. Simply supply the encoder pin out and connector type or other details necessary. Please contact for pricing and lead time.

There are three standard general purpose cables available.

**General Purpose Small Socket Cable:** The General Purpose Socket cable has a DB-25 Male Connector on one end and individual wires terminated with small, insulated sockets on the other end. These small sockets fit over the pins on many common encoder connectors.

**General Purpose Large Socket Cable:** The General Purpose Socket cable has a DB-25 Male Connector on one end and individual wires terminated with large, insulated sockets on the other end. These small sockets fit over the pins on many common encoder connectors.

**Un-terminated Cable:** The Un-terminated cable has a DB-25 Male Connector on one end and individual un-terminated, un-stripped wires on the other end. This cable is best for encoders connected to terminal blocks. Simply strip the wires necessary and connect.

## Appendix C: Power Supplies

Use only power adapters listed below.

Model Number	Part Number	Manufacturer
KA12D240040045U	DPD240040-P6P-TK	CUI INC
48-24-400	DPD240040-P6P-SZ	CUI INC

## Appendix D: Cable Color Chart

Pin	Incremental Encoders	Absolute Encoders	Wire Color
1	Phase A Complement	Bit 0	Blue w/ Black Stripe
2	Phase B Complement	Bit 1	Red w/ Black Stripe
3	Phase Z (or Index) Complement	Bit 2	Green w/ Black Stripe
4	Phase A	Bit 3	Blue w/ White Stripe
5	Phase B	Bit 4	Red w/ White Stripe
6	Phase Z (or Index)	Bit 5	Green w/ White Stripe
7	Reserved	Bit 6	White w/ Black Stripe
8	Reserved	Bit 7	Orange w/ Black Stripe
9	Reserved	Bit 8	Black w/ White Stripe
10	Reserved	Bit 9	Blue w/ Red Stripe
11	Reserved	Bit 10	White w/ Red Stripe
12	Reserved	Bit 11	Orange w/ Red Stripe
13	Reserved	Bit 12	Black w/ Red Stripe
14	Reserved	Bit 13	Red w/ Green Stripe
15	Reserved	Bit 14	Orange w/ Green
16	Reserved	Bit 15	Green
17-19	Reserved	Reserved	n/a
20	Encoder Voltage Supply	Encoder Voltage Supply	Red
21	Reserved	Reserved	n/a
22	Reserved	Reserved	n/a
23	Reserved	Reserved	n/a
24	Encoder Ground	Encoder Ground	Black
25	Reserved	Reserved	n/a