Incremental Encoder Testing Instrument

Operator's Instructions Part No: ENC-IET05

Released December 2008

Function Outline

The PCA Encoder Tester is designed to provide a simple means for service personnel and encoder assemblers to test all types of incremental encoders. Once the encoder is attached to the tester, all important parameters are displayed simultaneously on a large back lit LCD screen. Data available at one glance is;

1. The count per turn of all three output channels: either true or complementary simultaneously Max 600kHz.
2. Current draw of the encoder 10 to 150mA.
3. A/B Phase relationship of the two output signals.
4. RPM of the shaft or kilohertz of the output signal.
5. The applied voltage 5, 12 or 24.
6. The one revolution reference method for the test.

There are two methods of wiring termination for the encoder under test: spring loaded wiring terminals for quick cable termination or a nine pin D type plug for connecting adaptor leads to standard plugs or other input methods. Adaptor leads for any type of encoder plug can be made to allow quick and simple testing of a wide range of products.

When testing an encoder it is essential to have one pulse per turn reference point for each rotation of the shaft. This is normally achieved by either using the zero or marker pulse in the encoder under test, or by connecting an external signal from the mechanical rig driving the encoder. This information is used to determine the PPR (pulses per revolution) of the encoder, however in some instances it may be impossible to obtain such a pulse. The tester provides the user with a mode where a count value can be loaded into the tester and used to compare the count values from each encoder channel.

Explanation of the LCD display panel

1. Output A: Five-digit display for encoder "A" output – Range 1 to 99,999

2. Output B: Five-digit display for encoder "B" output – Range 1 to 99,999

3. Output O: One digit display for encoder "O" output – Range 1 to 9 Normal count one ONLY.

4. Stop: Missing pulse detector displays an S when the input pulse rate drops below 10 pulses per second.

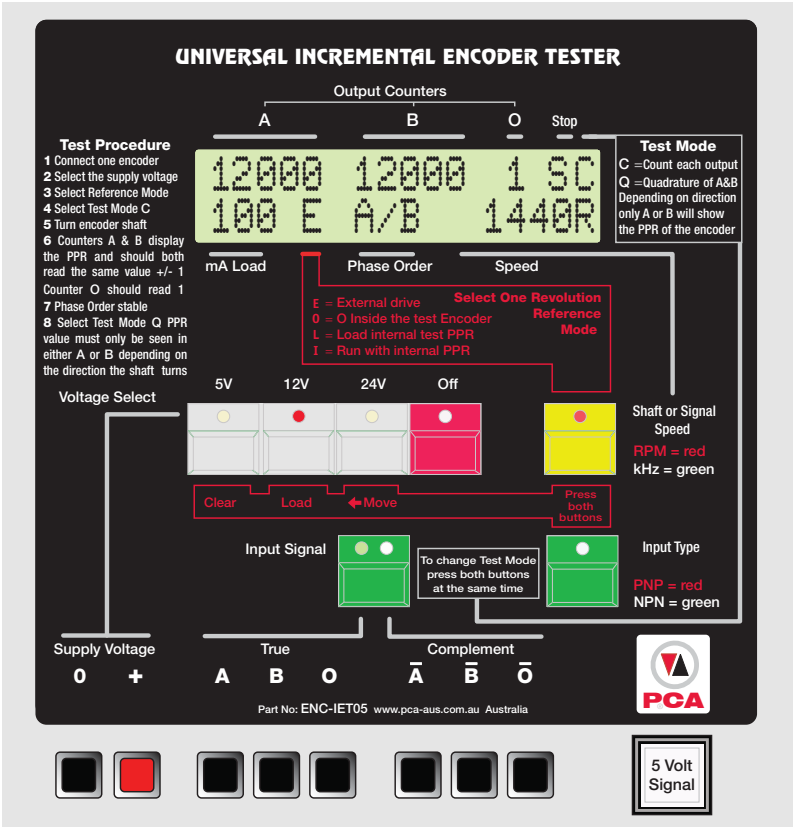
5. Test Mode: C = The output counters display simultaneously the pulses per revolution of each encoder output channel. Q = Displays the quadrature signal on either A or B counter only . The other counter must always read O - which one displays the PPR is determined by the direction of the shaft.

6. mA Load: Measures the encoder power supply current – Range 10 to 150mA short circuit protected.

7. Revolution Reference: The method being used to provide the once per turn reset pulse. - *See note 1*

8. Phase Order: Shows the phase relationship between the A and B output channels. - *See note 2*

9. Shaft or Signal Speed: Displays either revolutions per minute of the shaft or kilohertz of the A or B output from the encoder. – *See note 3*



Explanation of the operator press buttons and LED indicators:

10. Three Power Selection Press Buttons: This group of white buttons have a dual function. They are used to select the voltage applied to the encoder under test, and to select the correct mode of operation for the one revolution reference method.

Function 1 (White Text): Used to select the voltage to be applied to the encoder under test: No power is applied until one of the voltage buttons is pressed.
The power turns off automatically, when the encoder is removed, the "OFF" button pressed or the load current of 150mA exceeded.

The illuminated press button next to the wiring terminal posts is used to test encoders which have a fixed 5 Volt output signal regardless of the supply voltage. When the button is illuminated, the tester will read as valid 5 Volt signals with 12 or 24 volts selected for the encoder supply voltage. This would normally be off to test most encoders.

This feature is designed to prevent an encoder being accidentally connected to the wrong supply voltage. The power can be removed at any time without disconnection of any lead, by pressing the red "OFF" button. There is an LED indicator in each button which illuminates when the button is pressed. This keeps the user informed of the voltage currently applied to the encoder under test.

Function 2 (Red text) Used to select the Revolution Reference Mode: To initiate this change of mode, both the "Speed Selection" and "Input Type" buttons must be pressed simultaneously. Each operation of both buttons indexes the alpha numeric display one place, a full outline is provided in explanation Note 1.

11. **Input Signal:** Used to switch the three input signals displayed between the True and Complementary outputs of the encoder; the green LEDs in the button will illuminate to show the operator which output group currently is being viewed.

NOTE: There is an output signal located in the 4 pin DIN plug which gives the position of the true/complement selector switch. This can be used by encoder assemblers to switch the input signals to an oscilloscope, between the true and complementary channels of an encoder, without the need to change any wiring. The NPN transistor output signal is current limited to 1 mA, load voltage 5 to 25 volts.

12. **Input Type:** Operation of this button switches the power side of the 4.7K input load resistors from positive, for NPN input, to negative, for the PNP input encoders. Line Driver or Push Pull output encoders have switching transistors, which alternately switch the encoder output signal to either the positive or negative supply. To test these encoders fully, select both NPN and PNP operations; the encoders should count correctly with both input types.

13. **Test Mode:** The selection is made by operating both green buttons simultaneously.

Mode C: All three output channels of the encoder are individually counted and displayed with each revolution of the shaft, at the same time the phase monitor will show the relationship of A and B.

Mode Q: One counter A or B will show the correctly processed quadrature count value, and the other the fault signals where the A/B phase relationship is not correct. The encoder is faulty if there is NOT zero on either the A or B counters, which one displaying zero is determined by the rotation direction of the shaft, this will swap over when the shaft direction is changed.

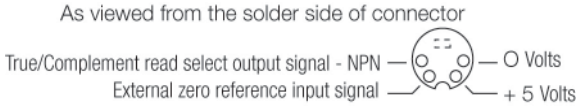
Revolution Reference - Note 1 Red Text

Note: This needs to be set each time the power is applied.

This character displays the revolution reference mode being used for the encoder under test; To change the mode press both the “Speed” and “Input Type” buttons at the same time. The alpha numeric display character advances one step with each simultaneous operation of the two buttons.

Mode E: External pulse generated by a transducer fitted to the motor tuning the encoder. Access to this external signal is provided through a plug on the side of the test box. The plug provides + 5V and O volts and an input from an optical transducer.

To use this input it is necessary to connect a switching device, which will give an input signal for each rotation of the shaft. Care must be take to ensure that the response of the signal is not less than the maximum frequency of the tester 600khz. Most commercially available proximity and photoelectric products are unable to reach any where near the switching speed required, however for a very slow speed test they will perform satisfactorily.



The input signal connects to a voltage input of a comparator that will switch as the signal passes the 2.5 Volt level. Care should be taken to ensure that this reading circuit will respond faster than the maximum frequency of the encoders you plan to test.

Mode O: In this mode the Zero pulse built inside the encoder under test is used; it is best to always use this mode for very high PPR encoders.

Mode L and I: This mode provides a test method when there is no once per turn reset pulse available, as defined for either modes E or O. In place of the normal reset pulse, an internal counter is loaded with a value approximately equal to the expected PPR of the encoder under test. The counter reads the signals from input A, when the preset value is reached a reset signal is generated to simulate the normal once per turn reset pulse, normally provided when operating with selection of modes E or O.

In mode **L** the function of the four voltage selection switches changes to that written in red text beneath the buttons. Pressing and holding the “Load” button rolls the right digit of the A counter display through 0 to 9, when the button is released the number remains. Next, the “Move” button is used to move the digit one place to the left. Pressing the “Load” button again will now change the selection for the next digit. This process is repeated until the desired value is entered. To reset the display to zero, press the “Clear” button. Once the loading process is complete, the mode selection buttons,(press both the “Speed” and “Input Type” buttons simultaneously) are once again pressed, moving the Mode indicator one more step to show the I selection.

Now in Mode **I** the encoder is ready for testing. This method does not tell you the true PPR of the encoder in the manner that the other two modes achieve, nor does the RPM measure correctly unless the correct number of increments are entered. However it will tell you if the two outputs A and B are remaining synchronised and the frequency of operation. The A and B outputs must display the same count value. During this test also take note of the A/B Phase indication, if it displays a ? or oscillates between A/B and B/A the encoder phase shift is faulty.

Phase Order - Note 2

The A/B indication measures the phase relationship between the A and B incremental output channels; this offset is set mechanically at the time the encoder is assembled. With some old encoders, the mark space ratio can deteriorate beyond workable limits, but the incremental count can still appear to be correct. If this indication shows either a “?” or oscillate between A/B and B/A, the encoder is faulty.

Shaft or Signal Speed - Note 3

The RPM/kHz reading shows either the revolutions per minute or the kilohertz of the A output signal, the red/green indicator in the button shows the parameter being displayed. The red illumination means the numerical value is RPM, green illumination means the display will be kilohertz.

Power supply: Power pack part number ENC-PS-27V has an input range of 100 to 240 Volts AC and a regulated output of 27.5 Volts DC output for the control box. The AC input plug is a standard appliance plug found on computers and other electrical equipment around the world.
NOTE: The earth pin must not be connected to the output voltage.

Test input plug. Standard 9 Pin D type; both the sockets and the wiring terminals on the front of the test instrument are all in parallel, there is no electronic processing between the three points. These three methods are provided to give the option of testing both wire and plug-in type encoders, as well as connection to an oscilloscope, without the need for changing any terminations. One metre adaptor leads are available to provide connection to all our standard plugs. Below are the wiring details for the nine pin D type sockets.

1. O Volts
2. + Volts: value determined by the selection switches 5, 12 or 24 Volts, current limited to 150mA
3. A
4. B
5. O
6. /A
7. /B
8. /O
9. Not used

Warning: *Connect only one encoder at the same time.*

Input Signal Level Test: All output signals from the encoder are also monitored for a reasonable voltage swing, as it is possible to have an encoder which produces the correct wave form but the voltage swing is not adequate for reliable operation.

The actual voltage swing required for a valid reading is set at, logic Low signal less than 33% of the applied voltage, and a logic High is a signal greater that 66% of the applied voltage. Product made for the European market have a variation to this for the 5 Volt supply, these testers will read a logic High as any voltage greater than plus 2.4 Volts, the other two supply voltages are set the same as normal.

Test Procedure

Step 1: Apply the AC power to the instrument.

Step 2: Determine the revolution reference mode to be used, NOTE; This must be set each time the power is applied.

Step 3: Connect the encoder to either the wiring terminals on the front panel, or one of the 9 Pin D plugs on the sides. Warning: do not connect two encoders at the same time.

Step 4: Connect a motor drive to the shaft of the encoder. This can be a variable speed hand drill, bench drill press or lathe, but make sure the housing of the encoder is held steady, as any movement in the body can cause some incorrect information to be displayed. It is desirable to be able to turn the encoder in both directions and at a speed greater than your application requires, this way you can be confident that the encoder performs correctly for your installation.

Step 5: Select the minimum operating voltage for the test encoder, 5, 12 or 24 Volts. Press the iluminated 5 Volt Signal switch if the encoder has a fixed 5 volt output signal.

Step 6: Select the **C** Test mode and then rotate the encoder, Output A and B counters should be equal +/- 1, Output O counter should read only 1, and the "Phase Order" indication must be stable.

Note: The "Phase Order" indicator does not work with a single output encoder, nor will output counters B or O show any values. Some times, especially with high PPR encoders, it is normal to see a difference of 1 between Output A and B counters at higher speeds.

Step 7: Select the **Q** test mode by pressing both green buttons at the same time. In this mode either output counter A or B will display the correct increments per revolution. The other counter must always be zero, it will only display a value if there are any faults with the A/B phase relationship.

Step 8: If you have the manufacturer's data sheet showing the maximum speed, increase the speed to the highest RPM or kHz the manufacturer specifies, then ensure that the encoder outputs remain stable at this speed. If this is not known measure the speed of the equipment driving the encoder, then select the RPM measurement on the test instrument, then increase the drive speed of the encoder to about 25% greater than that measured. The test will now have a reasonable margin for satisfactory operation.

Step 9: If the encoder has both true and complementary outputs, be sure to check both outputs by operating the "Input Signal" button, this will change over the signals the counters are reading from the true to the complementary outputs from the encoder.

Step 10: If you have access to the encoder manufacturer's data sheet, check that the load current is in the same order as that displayed in the mA Load reading.

Step 11: Repeat the test for both shaft directions, and the full voltage range of the encoder, as encoders may not always work at the voltages specified. During the tests make sure that the Input type button is correct NPN, PNP or in the case of line driver or push pull, all tests should be made for both types as these have both NPN and PNP switching functions.

NOTE: This tester provides a full test of almost all the characteristics of an incremental encoder. If your encoder tests correctly with this tester, it is very unlikely to fail in your installation. However for encoder assemblers, and instrumentation departments, there are further tests available, but they require the connection of an oscilloscope to one of the 9 pin D plug input connectors.

First there is the mark space ratio of the A and B outputs, it should be as close as possible to 1:1. This can usually be changed by a trim pot inside the encoder. However the Phase Order detector would, normally detect the effects of an operational fault of this nature.

The second parameter is the phase angle between the A and B signals. The process of turning the encoder at 25% over maximum application speed, then observing the stability of the counters and the A/B Phase Order indication is normally sufficient. But the actual angle can be measured with an oscilloscope and should be close as possible to ninety degrees, however this relationship is set at the time of assembly and cannot be changed by the user.

Calibration document: Sheet No. ENC-IET05-Calibration

Specification Summary

Input supply voltage . .	100 to 240 AC using power pack part number ENC-PS-27V
Power supply input . . .	27.5 - 30 Volts DC 500mA
Power Connection	Circular 2.5 ID X 5.5 OD
Case Size	Height at the back 150mm Width 187mm Height at terminals 23mm
Weight	850g + 500g for power pack
Output Voltage	5, 12 or 24 DC
Output Current	150mA short and open circuit protected
Signal Counters	Maximum frequency 600 kHz Output A: 0 to 99,999 Output B: 0 to 99,999 Output O: 0 to 9
Character Size	5 x 7 Dot matrix - 5x8mm
Test Supply Current . . .	10 to 150mA: Auto turn off below 10mA or above 150mA
Signal Input Load	4.7k Fitted to plug in socket
Connection method . . .	Two 9 Pin D type sockets In parallel and eight spring loaded press open for wiring terminals
Frequency Meter	10 to 600kHz
RPM Meter	600 to 10,000

PLANT CONTROL AND AUTOMATION PTY LTD
PO Box 121 Hornsby Sydney 2077 Australia
sales@pca-aus.com.au www.pca-aus.com.au
Ph. +61 2 9482 3733