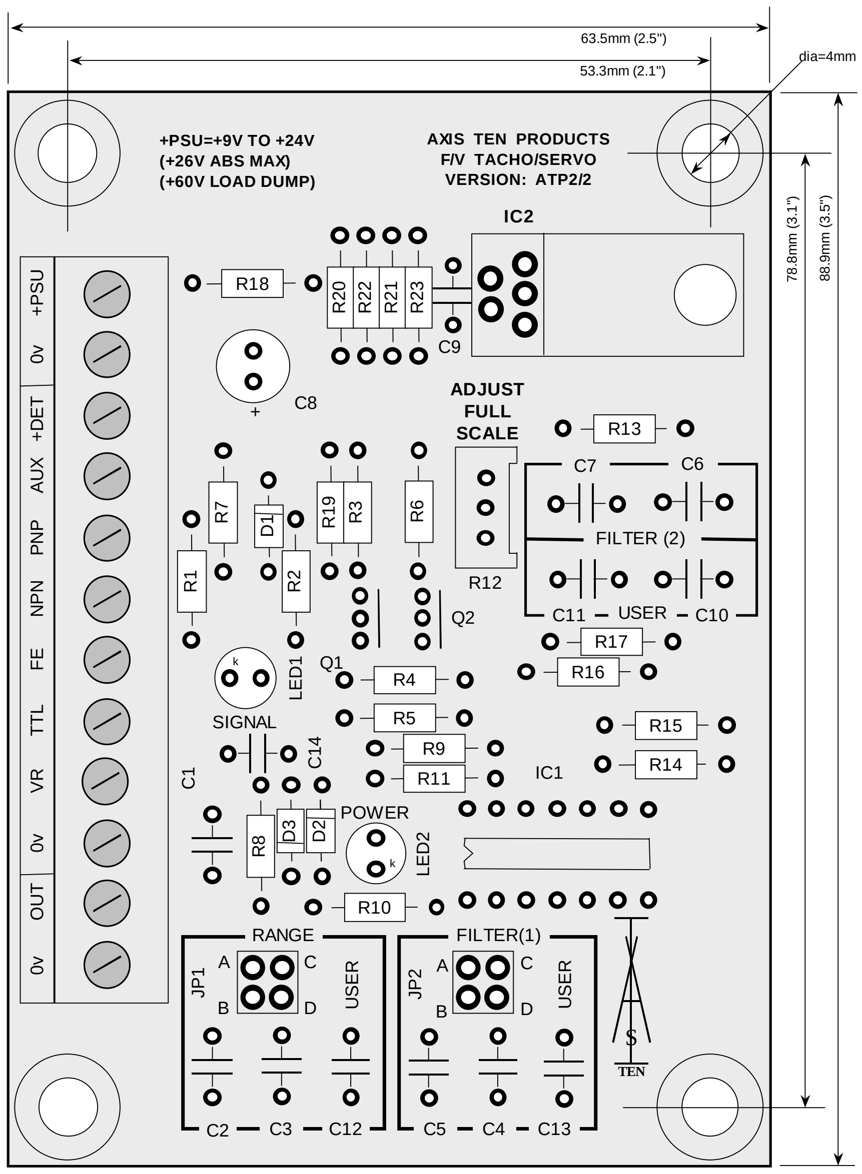
AXIS TEN PRODUCTS

Industrial Building Block

Frequency to Voltage Converter ~ ATP2/2
FEC Order Number ~ 179932

General Description

This product is a versatile Frequency-to-Voltage converter and Tachometer. It finds applications in many industries ranging from Automobile R&D to Ship building and Mining. It is used in anything from closed-loop servo control to simple monitoring and display systems. Conveyor or drive shaft speed control and monitoring are typical industrial applications. To enable trouble-free and rapid commissioning, popular signal sources and their recommended connection scenarios are shown as circuit diagrams over-leaf. The circuit is specified to work at frequencies up to 70kHz, and needs just two capacitors selecting or inserting to make it work.
(Continued over leaf.)



Top two Terminals are Power in, $V_{(PSU)}$ = +9V to +24V dc (+26V Abs. Max.) at <20mA plus Detector supply current. Circuit can with-stand +60V transients (load dumping) from poorly regulated supplies.

Central eight Terminals are Signal in. The most common Signal sources are listed below:

- Hybrid Sensors - open collector PNP output
- Hybrid Sensors - open collector NPN output
- TTL - open collector NPN output
- TTL - standard Totem-pole output
- Basic Variable Reluctance
- AC derived from a Transformer Winding

See over page for detailed connection scenarios for each of the above signal sources.

Bottom two Terminals are Signal out; $V_{(out)}$ = +5V Full Scale. Measure using a device with $Z_{(in)}$ > 10k.

Making it work in 3 steps

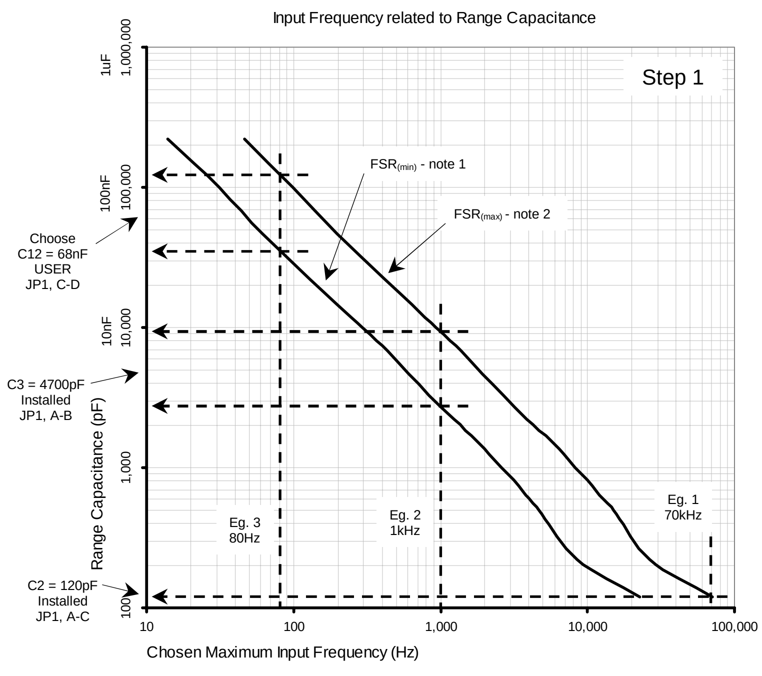
Step 1 ~ Fix the Input Frequency Range

From a knowledge of the signal source, determine the maximum source frequency, $f_{(in)(max)}$. Look at the graph - Input Frequency related to Range Capacitance, and find $f_{(in)(max)}$ on the x-axis. Trace up to both data-lines and across to the y-axis. Read off the Range Capacitance from anywhere between the two y-axis intercepts.

Example 1 - find $f_{(in)(max)}$ = 70kHz on the x-axis. Trace up to both data-lines and across to the y-axis. Read off the Range Capacitance from anywhere between the two y-axis intercepts; the only possible value here is 120pF. This capacitor is pre-installed; select with JP1 in position A-C. Step 1 complete.

Example 2 - find $f_{(in)(max)}$ = 1kHz on the x-axis. Trace up to both data-lines and across to the y-axis. Read off the Range Capacitance from anywhere between the two y-axis intercepts; a good choice here is 4700pF. This capacitor is pre-installed; select with JP1 in position A-B. Step 1 complete.

Example 3 - find $f_{(in)(max)}$ = 80Hz on the x-axis. Trace up to both data-lines and across to the y-axis. Read off the Range Capacitance from anywhere between the two y-axis intercepts; a good choice here is 68nF. Solder this capacitor (see note 7) into position C12; select with JP1 in position C-D. Step 1 complete.



Step 2 ~ Fix the Filtering

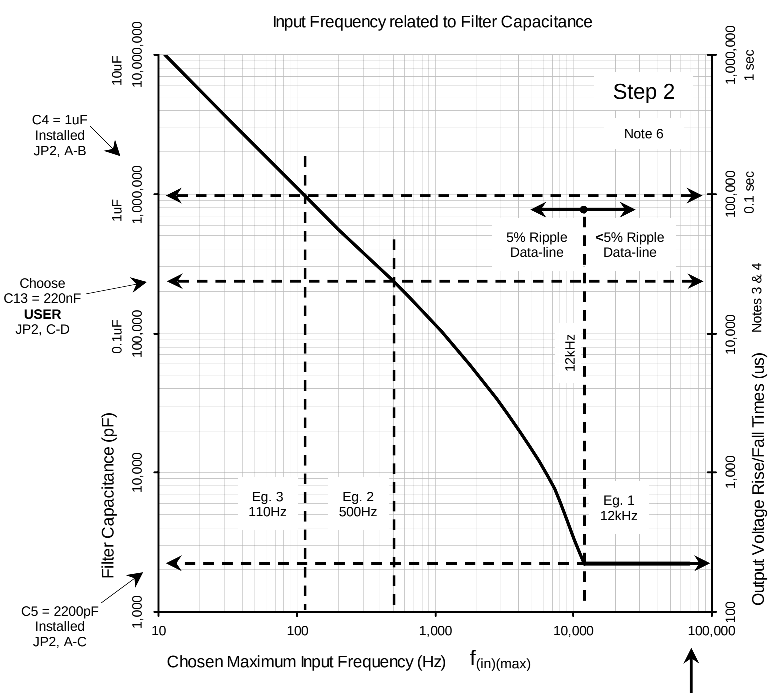
The value of $f_{(in)(max)}$ will be known from step one above. This same value is now used to determine the minimum Filter capacitance needed to keep Output Voltage Ripple at or below 5% or $250mV_{(pk-pk)}$ (see note 5). Look at the graph - Input Frequency related to Filter Capacitance (see note 6). Find $f_{(in)(max)}$ on the x-axis. Trace up to the data-line and across to both y-axes. From the primary y-axis, read off the minimum Filter capacitance. From the secondary y-axis, read off the Output Voltage Rise and Fall Times (see notes 3 & 4).

If the indicated minimum Filter capacitance does not fall on a preferred value, choose the next larger value. The absolute minimum Filter capacitance is set at 2200pF (installed), so all values of $f_{(in)(max)}$ above 12kHz will always have <5% Output Voltage Ripple, and Output Voltage Rise/Fall Times of 250us (0.25ms). Note, there is no maximum value of Filter capacitance, it may be increased without bound.

Example 1 - find $f_{(in)(max)}$ = 12kHz on the x-axis. Trace up to the data-line and across to both y-axes. From the primary y-axis, read off the Filter capacitance - 2200pF or 2.2nF. This capacitor is pre-installed (C5); select with JP2 in position A-C. From the secondary y-axis, read off the Output Voltage Rise and Fall Times - 220us or 0.22ms. Step 2 complete.

Example 2 - find $f_{(in)(max)}$ = 500Hz on the x-axis. Trace up to the data-line and across to both y-axes. From the primary y-axis, read off the Filter capacitance - 220,000pF, 220nF or 0.22uF. Solder this capacitor (see note 7) into position C13, and select with JP2 in to position C-D. From the secondary y-axis, read off the Output Voltage Rise and Fall Times - 22,000us or 22ms. Step 2 complete.

Example 3 - find $f_{(in)(max)}$ = 110Hz on the x-axis. Trace up to the data-line and across to both y-axes. From the primary y-axis, read off the Filter capacitance - 1uF. This capacitor is pre-installed (C4); select with JP2 in position A-B. From the secondary y-axis, read off the Output Voltage Rise and Fall Times - 100,000us, 100ms or 0.1sec. Step 2 complete.



$f_{(in)(max)}$

Note: $f_{(in)(abs.max)}$ = 70kHz

Step 3 ~ Connect-up

Continue over page and make all electrical connections. When powered, use the Adjust Full Scale potentiometer to fine tune the Output Voltage.

Note 1: $FSR_{(min)}$ is $f_{(in)}$ with **Adjust Full Scale** potentiometer set fully clockwise & $V_{(out)}$ = 5V.
Note 2: $FSR_{(max)}$ is $f_{(in)}$ with **Adjust Full Scale** potentiometer set fully anti-clockwise & $V_{(out)}$ = 5V.
Note 3: Rise & Fall Times are 10% to 90% & 90% to 10% respectively of $V_{(out)}$ when $V_{(out)(max)}$ = 5V.
Note 4: Rise & Fall Times are measured using $f_{(in)}$ = 70kHz with 100% A.M. at $f_{(in)}$ / 1000 with a 1:1 M/S ratio.
Note 5: Output Ripple Voltage is measured pk-pk & Steady-State (no modulation).
Note 6: This graph shows values of $f_{(in)(max)}$ when $V_{(out)(ripple)}$ = 5% of $V_{(out)(ave)}$ (250mV pk-pk), and $V_{(out)(ave)}$ = 5V.
Note 7: Choose capacitors from FEC/Wima Polypropylene FKP2 series, or second choice from FEC/Wima Polyester MKS2 series.

General Description (Continued)
This circuit is made up of three functional sections - input signal conditioning, followed by signal conversion, and ending with signal filtering and the output driver. The front-end (FE) signal conditioning copes with signals from a variety of sources, the six most common of which are detailed below. The signal converter is designed around the LM2907N, which is a frequency-doubling charge-pump device. The Full Scale Input frequency is simply set using just one capacitor (see Step 1 on front of leaf), and the degree of Signal Filtering is also accomplished with just one capacitor (see Step 2 on front of leaf). The output driver is an emitter follower, producing <15mV of output offset for an input frequency of zero Hertz. Linearity is excellent at better than +/-1%, and the whole circuit consumes less than 20mA.

In setting-up the on-circuit filter, one must remember that Output Voltage Response times are inextricably linked to Output Voltage Ripple. To be precise, increasing Filter capacitance reduces ripple voltage but increases response times. For most engineers then, there is a minor dilemma - rapid Output Voltage Response times cannot be achieved without some degree of Output Voltage Ripple.

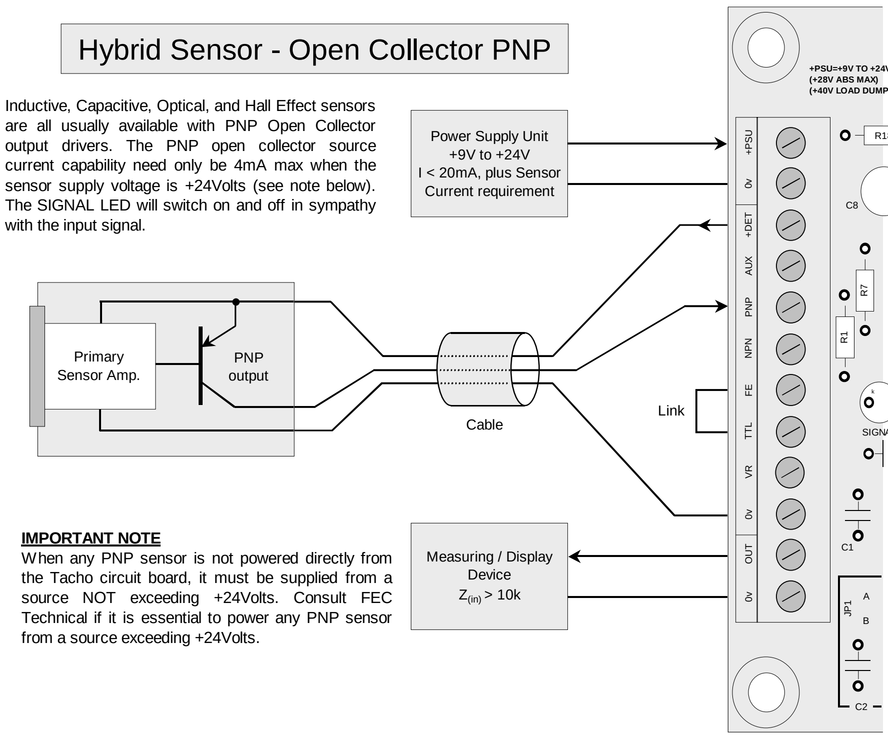
For example, it is impossible to arrange Output Voltage Response times of 5ms for an input frequency of 50Hz. This is because a frequency of 50Hz has a period of 20ms, which is longer than the desired rise and fall times of 5ms. The output voltage will, therefore, be all-but unfiltered, rising and falling between 0V and +5V in delayed sympathy with the input signal. To avoid this problem, a graph is presented (front of leaf) linking these four variables - 'Filter Capacitance', 'Full Range Input Frequency', 'Output Voltage Ripple (at 5%)', and 'Output Voltage Response Time'.

From the graph, it is easy to determine both the smallest acceptable amount of Filter capacitance, and the resulting Output Voltage rise and fall (response) times. Note - the smallest acceptable amount of Filter capacitance is defined here as - the smallest value of Filter capacitance that will keep the Output Voltage Ripple at, or less than, 5% (250mV$_{(pk-pk)}$) of the full scale output voltage (5Volts) for a particular Full Scale Input Frequency. As a result, the supplied graph delivers a Filter capacitance that optimises the two Output Voltage variables of Ripple and Response time. Note however, there is effectively no upper limit to the amount of Filter capacitance, it can be increased without bound to reduce Output Voltage Ripple.

Step 3 ~ Connect-up (continued)

Hybrid Sensor - Open Collector PNP

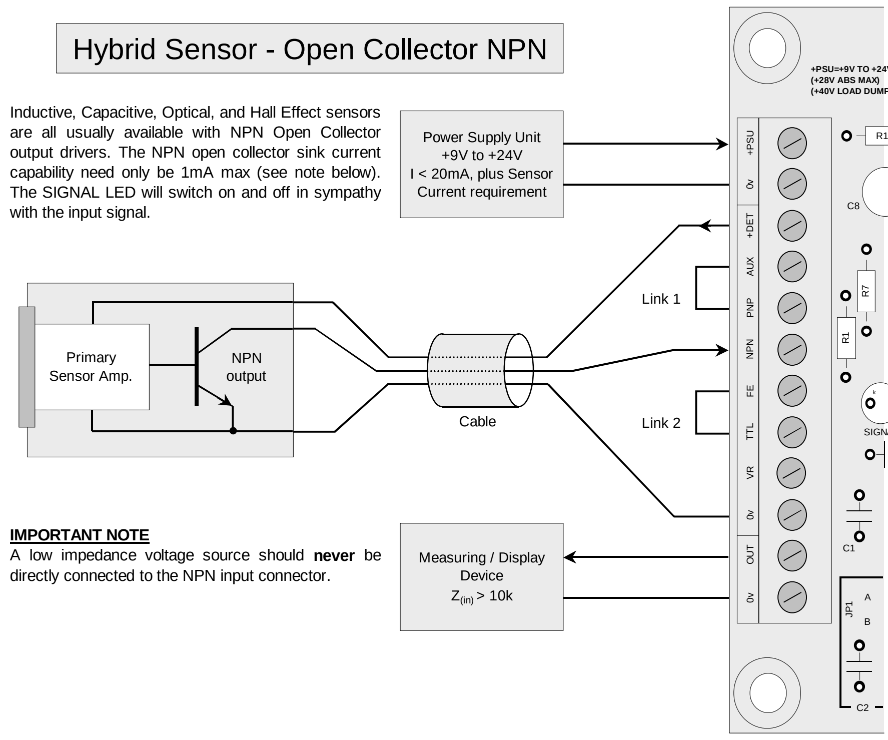
Inductive, Capacitive, Optical, and Hall Effect sensors are all usually available with PNP Open Collector output drivers. The PNP open collector source current capability need only be 4mA max when the sensor supply voltage is +24Volts (see note below). The SIGNAL LED will switch on and off in sympathy with the input signal.



IMPORTANT NOTE
When any PNP sensor is not powered directly from the Tacho circuit board, it must be supplied from a source NOT exceeding +24Volts. Consult FEC Technical if it is essential to power any PNP sensor from a source exceeding +24Volts.

Hybrid Sensor - Open Collector NPN

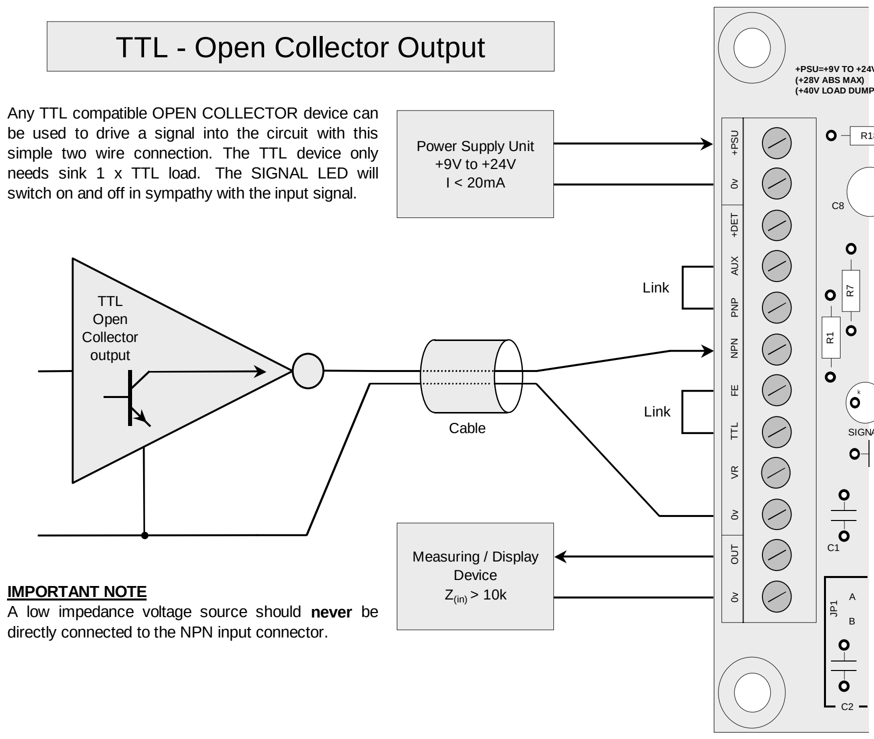
Inductive, Capacitive, Optical, and Hall Effect sensors are all usually available with NPN Open Collector output drivers. The NPN open collector sink current capability need only be 1mA max (see note below). The SIGNAL LED will switch on and off in sympathy with the input signal.



IMPORTANT NOTE
A low impedance voltage source should **never** be directly connected to the NPN input connector.

TTL - Open Collector Output

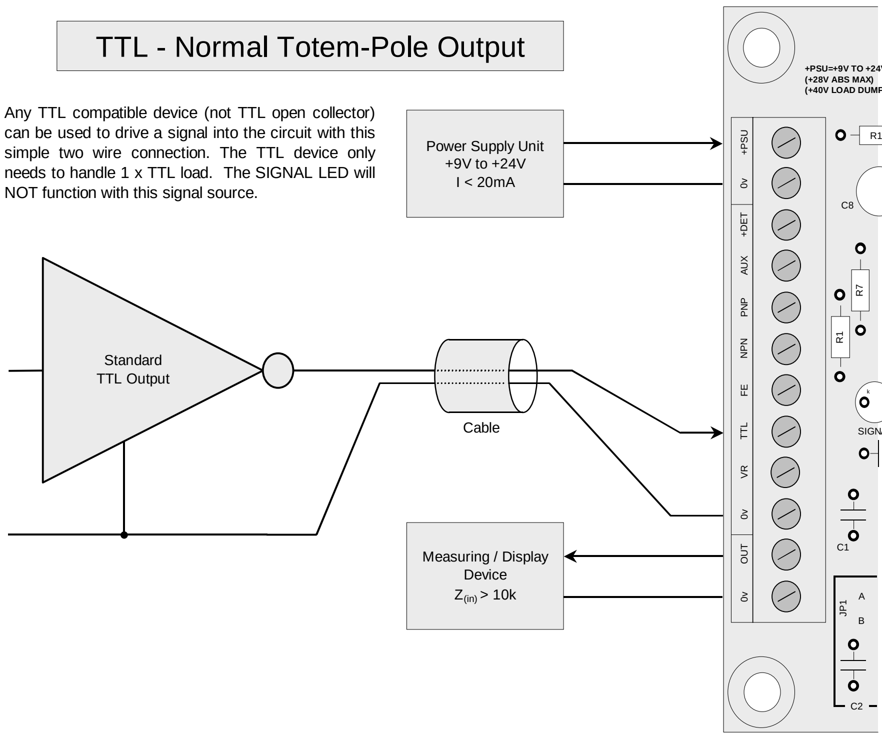
Any TTL compatible OPEN COLLECTOR device can be used to drive a signal into the circuit with this simple two wire connection. The TTL device only needs sink 1 x TTL load. The SIGNAL LED will switch on and off in sympathy with the input signal.



IMPORTANT NOTE
A low impedance voltage source should **never** be directly connected to the NPN input connector.

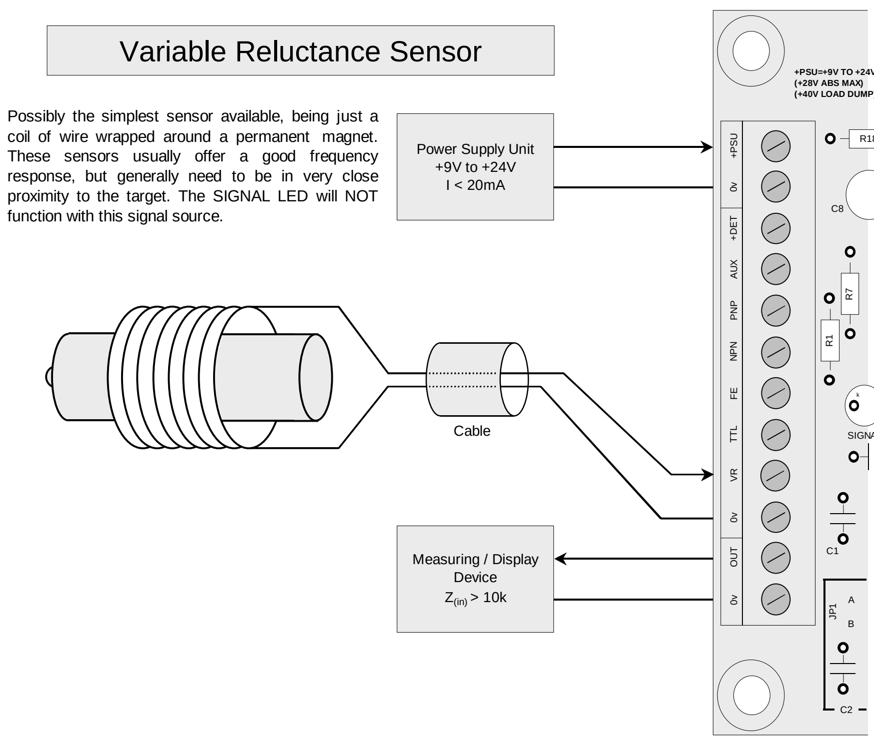
TTL - Normal Totem-Pole Output

Any TTL compatible device (not TTL open collector) can be used to drive a signal into the circuit with this simple two wire connection. The TTL device only needs to handle 1 x TTL load. The SIGNAL LED will NOT function with this signal source.



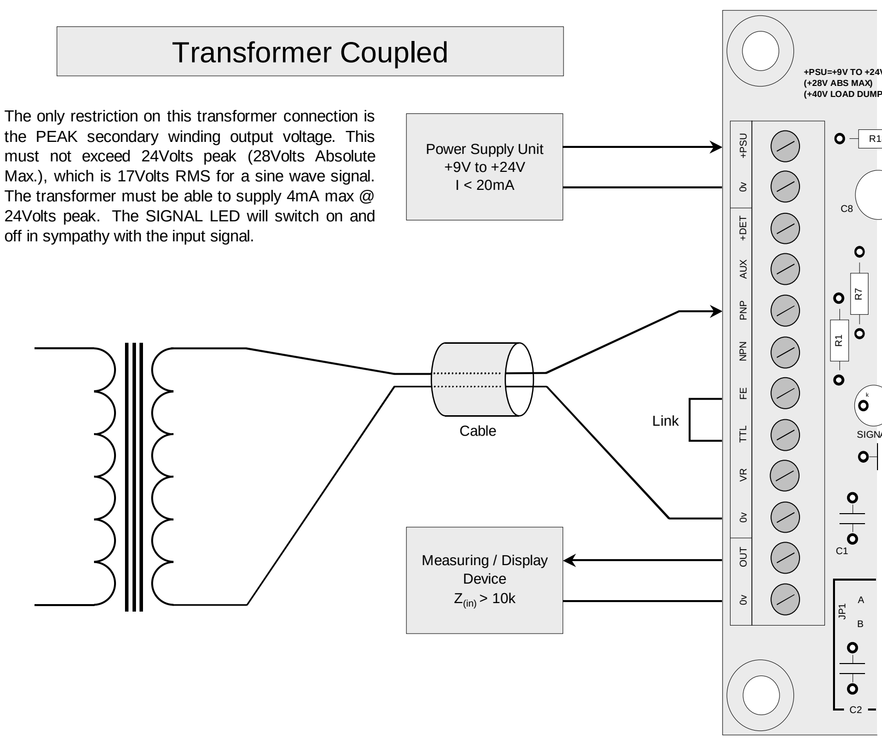
Variable Reluctance Sensor

Possibly the simplest sensor available, being just a coil of wire wrapped around a permanent magnet. These sensors usually offer a good frequency response, but generally need to be in very close proximity to the target. The SIGNAL LED will NOT function with this signal source.



Transformer Coupled

The only restriction on this transformer connection is the PEAK secondary winding output voltage. This must not exceed 24Volts peak (28Volts Absolute Max.), which is 17Volts RMS for a sine wave signal. The transformer must be able to supply 4mA max @ 24Volts peak. The SIGNAL LED will switch on and off in sympathy with the input signal.



TEN

IMPORTANT
Every care has been exercised in the design of this product. It has been designed and constructed with electrical robustness and reliability in mind.
However, incorrect connection to power sources, signal sources and measuring devices may stress the circuit to the point of damage.
Always double-check before powering this circuit and other connected devices. All circuit boards are 100% tested.