AXIS TEN PRODUCTS

Fully Tested

Date: 28 AUG 07
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Industrial Building Block

RoHS - Yes

Frequency to Voltage Converter ~ ATP3/1, ATP3/1M & ATP3/1M2

Features

- **Easy to use**
- **Max Full Scale: 100kHz @ 10V Out**
- **Min Full Scale: 10Hz @ 10V Out**
- **Matched to many Input Devices**
- **Hysteresis on Inputs**
- **One Capacitor to set Full Scale**
- **Three Capacitors to set Filtering**
- **Three Status LED's**
- **Over Range Output**
- **Excellent Linearity**
- **10Volt Industry Standard Output**
- **Mains 110/115v or 230/240V**
- **...or DC Powered, 12v to 24V**

General Description

This product is a versatile Frequency to Voltage converter and Tachometer. It is made up of four functional sections - input signal conditioning, signal conversion, signal filtering, and an output driver. The input signal conditioning copes with a variety of industrial signal sources, the most common of which are detailed later. The signal converter is designed around a frequency-doubling charge-pump device, with the "Full Scale Input Frequency Range" simply set using just one capacitor, C5, and easily trimmed using a ten turn potentiometer, VR1. Signal filtering (smoothing) is accomplished using an active second-order low-pass filter; the degree of filtering is simply set using just three equal value capacitors. Capacitor values for both Range setting and Filtering are easily derived from one of two supplied tables, and the output driver delivers an industry standard 10Volt output signal.
(Continued over leaf.)

Applications

- **Shaft Speed Control**
- **Conveyor Speed Control**
- **Closed loop Control Systems**
- **Monitoring and Speedometers**
- **Frequency to Voltage Conversion**
- **In Automobile R&D**
- **In Mining**
- **In Ship Building**
- **In Paper Making ...and more**

BOARD LAYOUT & DIMENSIONS

RANGE/C5
End-user capacitor position for Range configuration via "Step 1".

FILTER/C10/C11/C7
End-user capacitor positions for Filter configuration via "Step 2".

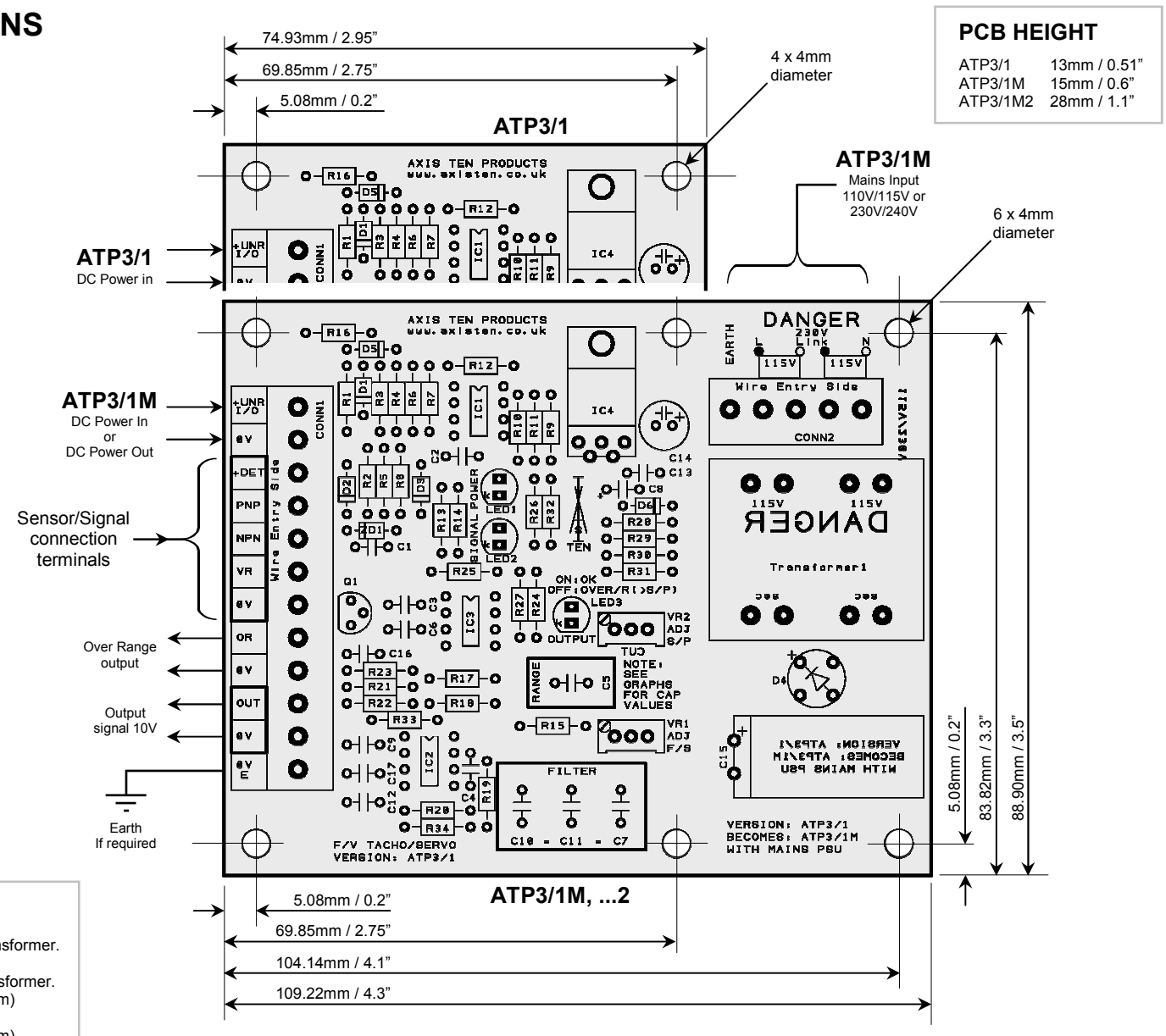
VR1
Fine Adjust for Output Voltage

VR2
For Future Use

LED1
Power (Red)

LED2
Signal (Red)

LED3
Over Range (Green)



PCB HEIGHT

ATP3/1	13mm / 0.51"
ATP3/1M	15mm / 0.6"
ATP3/1M2	28mm / 1.1"

FACTORY SETTINGS

- No additional capacitors are required for operation between 30kHz (approx) and 100kHz. Note: Output Voltage Rise/Fall times are 520µs (see page 2 & Step 2)
- All units are fully tested at: $f_{(in)}$ = 100kHz, with 100% 1:1 Modulation at 200Hz.
- Units can be supplied fully configured and setup to customer specification.

ORDERING

Part no: ATP3/1M	Ext. DC or AC Mains with ½VA Transformer. (Stock part)
Part no: ATP3/1M2	Ext. DC or AC Mains with 2VA Transformer. (To special order and 25 off minimum)
Part no: ATP3/1	Ext. DC Powered only. (To special order and 25 off minimum)

IMPORTANT

Axis Ten Products reserve the right to make changes to this product without giving prior notice. See www.axisten.co.uk for possible updates. Every care has been exercised in the preparation of this product. It has been designed, constructed and tested with electrical robustness and reliability in mind. However, incorrect connection to power supplies, signal sources and measuring devices may stress the circuit beyond tolerance. Always double-check before powering this circuit and any other connected devices. All circuit boards are 100% tested.

	ELECTRICAL CHARACTERISTICS—SIGNAL INPUTS				
	PARAMETER		**PNP**	**NPN**	**VR**
ATP3/1, ...M, ...M2	Input Frequency - max	$f_{(in)(max)}$	100kHz	100kHz	100kHz
	Input Voltage - max	$V_{(in)(max)}$	50V @ <5mA	50V @ 0mA	28V
	Input Voltage - Rising Trigger Point	$V_{(in+)}$	8.5V @ <0.5mA	1.5V @ <-1.6mA	40mV Max
	Input Voltage - Falling Trigger Point	$V_{(in-)}$	7.5V @ <0.5mA	1.1V @ <-1.6mA	-40mV Min
	Input Voltage - Hysteresis	$V_{(in)(hyst)}$	1V	0.4V	80mV
	Input Voltage - min	$V_{(in)(min)}$	-50V @ 0mA	-0.6V @ <-2mA	-28V
	Input Current - Input connected to 0V	$I_{(in)}$ @ 0V	0mA	<-1.6mA	$Z_{(in)}$ = 11k
	Terminal Voltage - Connected to DVM	Input open	0V	4.5V	0V
	Input Signal - Min MARK width	$t_{(in)(mark)}$	5µs (50% at 100kHz)	5µs (50% at 100kHz)	x
	Input Signal - Minimum SPACE width	$t_{(in)(space)}$	4µs (40% at 100kHz)	4µs (40% at 100kHz)	x

	ELECTRICAL CHARACTERISTICS—OTHER			
	PARAMETER	**TERMINAL**	**VALUES**	**COMMENTS**
ATP3/1, ...M, ...M2	Output Voltage - Full Scale	OUT	10V	See graph 1
	Output Voltage - Zero Input	OUT	<20mV	$f_{(in)}$ = 0 Hz
	Output Source Current - max	OUT	3.3mA	$V_{(out)}$ = 10V (External Load = 3k)
	Output Current - Limited	OUT	<20mA	Output Connected to 0V
	Output Voltage - Noise pk-pk (excl. ripple)	OUT	<5mV	$f_{(in)}$ = 100 kHz, $V_{(out)}$ = 10V
	Output Voltage - Minimum Rise Time	OUT	520µs	See graph 2
	Output Voltage - Minimum Fall Time	OUT	520µs	See graph 2
	Input/Output Linearity	OUT	Better than ±0.5%	Full Scale
	Over Range 'OR' Maximum Voltage	OR	30V dc	Open Collector Output OFF
	Over Range 'OR' Minimum Voltage	OR	<0.1V @ 100mA (max)	Open Collector Output ON
ATP3/1M, ...2	Input Voltage - DC Powered	+UNR I/O	12V to 24V (26V max) @ <25mA	<60mA with o/p s/c to 0V
	Input Voltage - Load Dump Protection	+UNR I/O	+60V	See LM2931 Data Sheet for more details
	Input Voltage - Reverse Transient Protection	+UNR I/O	-50V	
	Input Voltage - AC Powered	$V_{(AC)}$	110/115V or 230/240V	Fusing ~ 100mA - see Note1
	Typical DC Output Voltage - Rectified DC	+UNR I/O	17V (...M) & 23V (...M2)	No External Load, <150mV ripple
	Available DC Output Current - Rectified DC	+UNR I/O or +DET	12mA @ 12V (<200mV ripple)	**ATP3/1M** - 0.5VA Transformer
	Available DC Output Current - Rectified DC	+UNR I/O or +DET	120mA @ 12V (<600mV ripple)	**ATP3/1M2** - 2VA Transformer

Note 1: Installation of this product must comply with local regulations, and in ALL cases, external fault protection must be provided such as a fuse.

General Description (Continued)

In setting-up the on-circuit filter, one must remember that Output Voltage Response times are inextricably linked to Output Voltage Ripple; for most engineers, this amounts to a minor dilemma. The choice is between ***increasing*** Filtering to ***reduce*** Output Voltage Ripple, and ***reducing*** Filtering to ***reduce*** Output Voltage Response times. 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 in delayed sympathy with the input signal. To avoid this problem, tables are presented (step 1) linking these four variables - Full Range Input Frequency, Filter Capacitance, Output Voltage Ripple (at 5%), and Output Voltage Response Time.

From the table (step 1), it is easy to determine the smallest acceptable amount of Filter capacitance. Note, the smallest acceptable amount of Filter capacitance is defined here as that which will keep the Output Voltage Ripple <= 5% (500$mV_{(pk-pk)}$) of the full scale output voltage (10Volts) for a particular Full Scale Input Frequency. As a result, the supplied table delivers a Filter capacitance (used three times over on the PCB: FILTER, C10, C11, C7) 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.***

OVER RANGE OUTPUT (OR) TRUTH TABLE			
Input Signal % of F.S.	>=105%	<105%	<<105%
"Output" LED3 (Green)	OFF	OFF ON	ON
NPN Transistor	OFF (1)	OFF ON	ON (0)
OR output	HIGH (1)	OFF ON	LOW (0)
Conversion Status	**Over Range**	OK	OK

Making it work in 2 steps

Step 1

Objective
To determine the Range Capacitance and minimum Filter Capacitance needed to set the amplitude of the Full Scale Output Voltage to 10Volts, with less than 5% ripple, for any chosen value of $f_{(in)(max)}$.

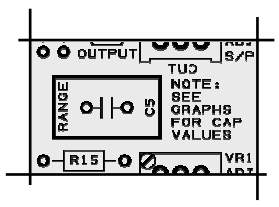
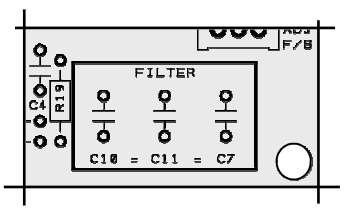
Instruction by worked example, 1. →

- Find the row in the table opposite for $f_{(in)(max)}$ = 27kHz. (This value is between 16kHz & 51kHz, so the indicated row is selected).
- Move right to the RANGE C5 column and read off the value of C5. In this case, C5 = 120pF, and a suitable part can be obtained from FEC using Stock Code 113-8908.
- Move right again to the "FILTER, C10, C11, C7" column and read off the minimum value for these capacitors. In this case, no capacitors need adding in order to keep the full scale output voltage ripple below 5%.

Instruction by worked example, 2. →

- Find the row in the table opposite for $f_{(in)(max)}$ = 45Hz. (This value is between 40Hz & 125Hz, so the indicated row is selected).
- Move right to the RANGE C5 column and read off the value of C5. In this case, C5 = 100nF and a suitable part can be obtained from FEC using Stock Code 116-6036.
- Move right again to the "FILTER, C10, C11, C7" column and read off the minimum value for these capacitors. In this case, three capacitors of value 330nF need adding in order to keep the full scale output voltage ripple below 5%; suitable parts can be obtained from FEC using Stock Code 116-6040.

Input Frequency related to RANGE & FILTER Capacitors

For a chosen Input Frequency $f_{(in)(max)}$ anywhere between these values:	Set RANGE C5 to this value	And set all three FILTER C10, C11, C7 to this MINIMUM value or more
31kHz & 100kHz	X	X
16kHz & 51kHz	120pF (113-8908)	X
8.9kHz & 28.5kHz	330pF (113-8914)	X
3.5kHz & 11.1kHz	1nF (116-6063)	X
1.2kHz & 3.7kHz	3.3nF (116-6066)	3 x 10nF (116-6055)
410Hz & 1.3kHz	10nF (116-6055)	3 x 33nF (116-6045)
180Hz & 600Hz	22nF (116-6044)	3 x 68nF (116-6035)
125Hz & 400Hz	33nF (116-6045)	3 x 100nF (116-6036)
40Hz & 125Hz	100nF (116-6036)	3 x 330nF (116-6040)
20Hz & 55Hz	220nF (116-6039)	3 x 680nF (116-6042)
12Hz & 35Hz	330nF (116-6040)	3 x 1µF (116-6043)
(4Hz) 10Hz & 12Hz	1µF (116-6043)	3 x 1µF (116-6043)
Conditions: $V_{(out)(ave)}$ = 10Volts.		

Important Note

The first table above only suggests minimum values for "FILTER, C10, C11, C7"; these values will keep the Output Voltage ripple below 5%.

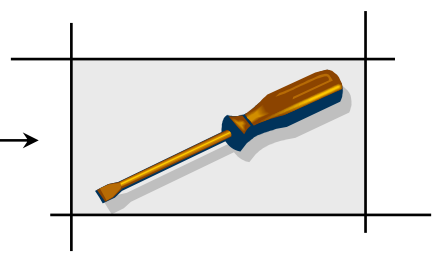
There is however, no maximum value for these three Filter capacitors; they may be increased without bound to reduce Output Voltage ripple and increase response time. See General Description on page 2.

The second table to the right shows how Output Voltage rise and fall times can be fixed by choosing appropriate values for FILTER C10, C11, C7.

Filter Capacitors related to Actual Output Voltage Rise & Fall times

For chosen Output Voltage Rise & Fall times of:	Set all three FILTER capacitors C10, C11, C7 to this value:
0.52ms	X
0.66ms	3 x 1nF (116-6063)
1ms	3 x 3.3nF (116-6066)
2ms	3 x 10nF (116-6069)
6ms	3 x 33nF (116-6072)
14ms	3 x 68nF (116-6060)
28ms	3 x 100nF (116-6061)
120ms	3 x 330nF (116-6053)
300ms	3 x 680nF (116-6042)
500ms	3 x 1µF (116-6043)
See Notes 3 & 4	See Note 6

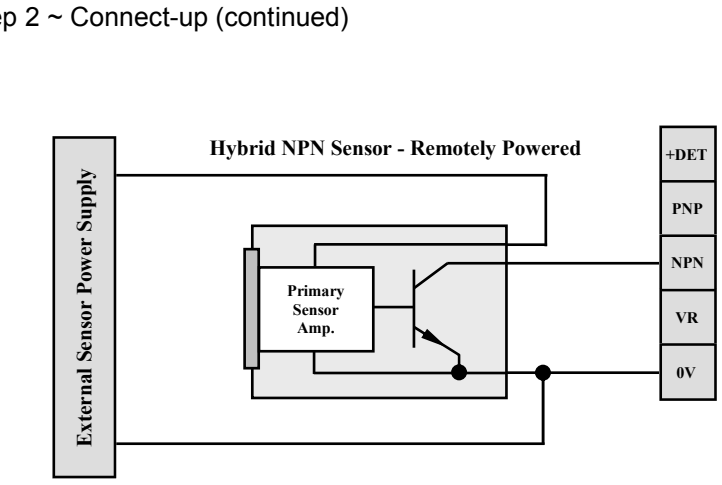
Step 2 →

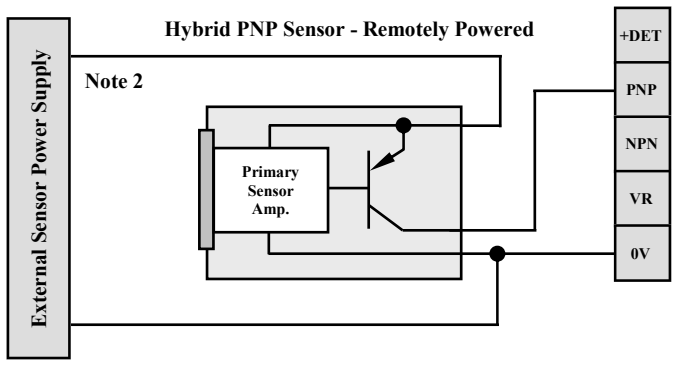


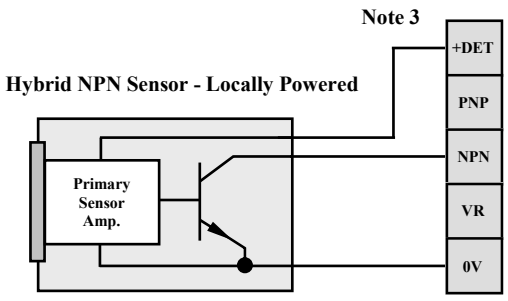
Continue over page and make all electrical connections. When powered, use the Adjust Full Scale potentiometer VR1 to fine tune the Output Voltage.

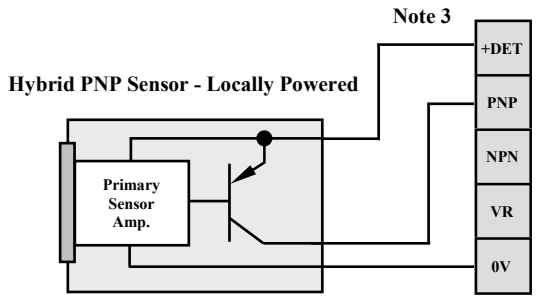
Note 1: $FSR_{(min)}$ is $f_{(in)}$ with **Adjust Full Scale** potentiometer VR1 set fully clockwise & $V_{(out)}$ = 10V.
Note 2: $FSR_{(max)}$ is $f_{(in)}$ with **Adjust Full Scale** potentiometer VR1 set fully anti-clockwise & $V_{(out)}$ = 10V.
Note 3: Rise & Fall Times are 10% to 90% & 90% to 10% respectively of $V_{(out)}$ when $V_{(out)(max)}$ = 10V.
Note 4: Rise & Fall Times are measured using $f_{(in)}$ = 100kHz with 100% A.M. with a 1:1 M/S ratio.
Note 5: Output Ripple Voltage is measured pk-pk & Steady-State (no modulation).
Note 6: Choose capacitors from FEC/BC: 2222 470 Polyester Series (Example 1uF FEC part no: 116-6043).

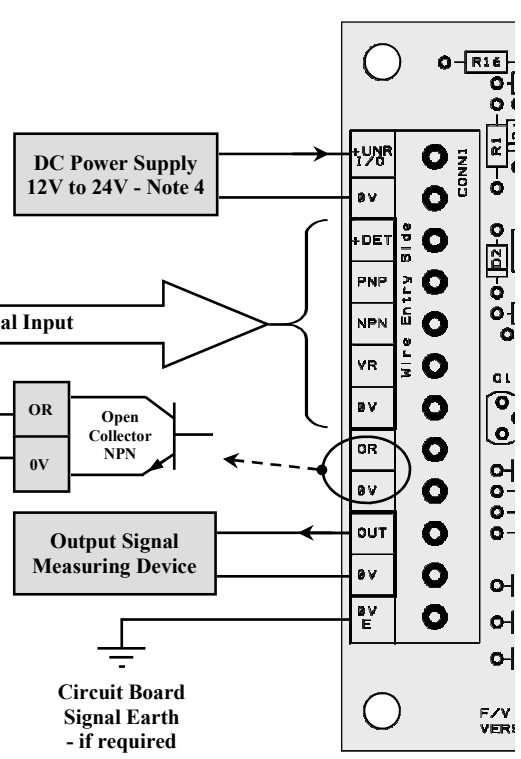
Step 2 ~ Connect-up (continued)

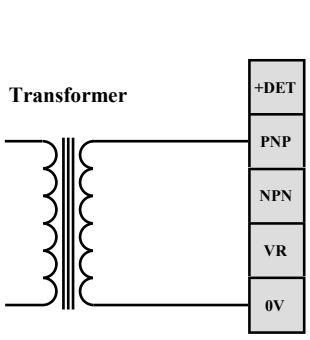


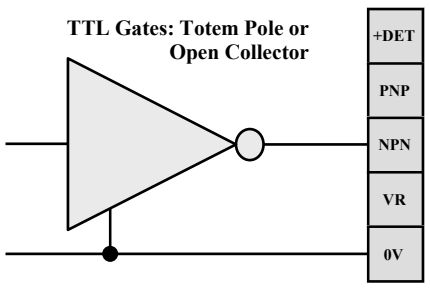


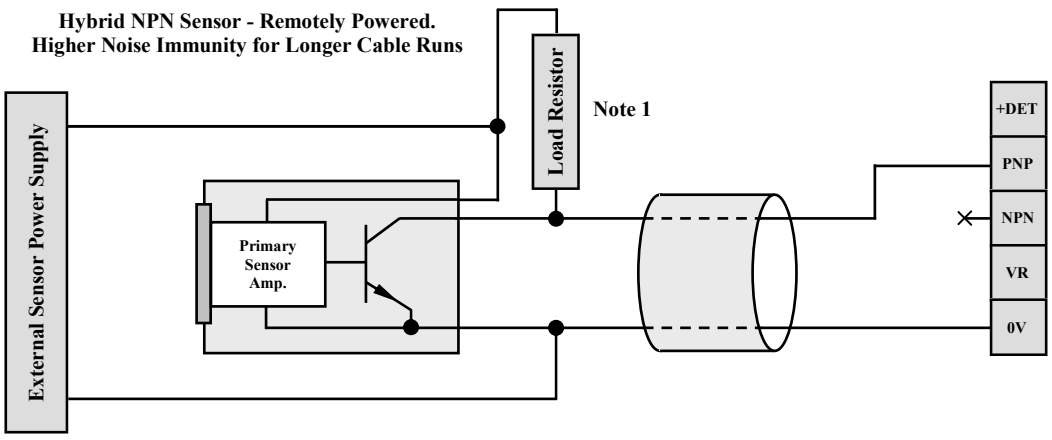


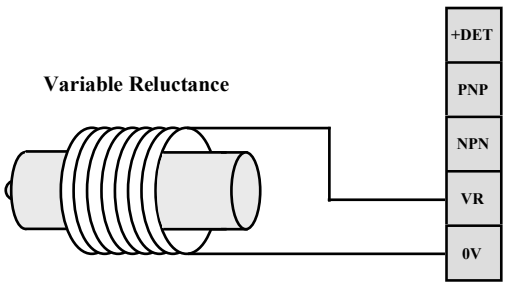












Comments & Notes

- The circuits outlined above do not represent an exhaustive range of connection scenarios.
- The circuits outlined above, and any others under consideration, should be considered in parallel with the Electrical Characteristics detailed on page 2.
- **Units can be supplied fully configured and setup to customer specification.**

Note 1:
The specific value of this Load Resistor will depend upon the External Sensor Power Supply Voltage , the Sensor Load Current capacity, and the ATP3/1 Input Current requirement as specified in the Electrical Characteristics on page 2.

Note 2:
The maximum External Sensor Power Supply Voltage for PNP Sensor configurations must not exceed that specified for the PNP input in the Electrical Characteristics on page 2.

Note 3:
The Sensor Supply Current drawn from ATP3/1M (and ...2) must not exceed that specified in the Electrical Characteristics detailed on page 2

Note 4:
ATP3/1M (and ...2) should not be energized simultaneously from both Mains and DC power. However, either Mains or DC power can be used at any time as needs dictate.