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MODEL RMX - RATE MULTIPLIER

APPLIES SCALE FACTOR CORRECTIONS TO PROVIDE ACCURATE, DIRECT READOUT ON ANY RLC COUNTER

IDEAL FOR:

- *SENSOR APPLICATIONS WITH ARBITRARY PULSE/UNIT RELATIONSHIPS, SUCH AS TURBINE FLOWMETERS, ARCJ MAG-PICKUP ADAPTERS, ETC.*
- *QUICK AND EASY COUNTER RESCALING WHEN SENSOR PULSES/UNIT RELATIONSHIP IS ALTERED BY GEARING CHANGES, PULL-ROLL OR PRINTING CYLINDER DIAMETER CHANGES, ETC.*
- *WHEEL-WEAR COMPENSATION OR CORRECTION FOR MATERIAL COMPLIANCE WHEN USING LENGTH SENSORS*
- *ENGLISH/METRIC CONVERSIONS*

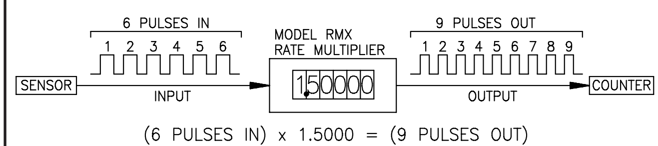
DESCRIPTION

In many machine/counter applications, arriving at a sensor arrangement that provides the proper ratio of pulses/unit-of-measure can be difficult, if not impossible. For example, turbine flowmeters normally have odd calibration factors such as 235 pulses/gallon. Applying such a pulse train directly to a counter input would require all readings or preset values to be divided by 235 to arrive at gallons. There are many other situations in which odd pulse rates such as 472 pulses/yard or 3.728 pulses/centimeter arise, and there are other cases where the pulse-rate varies with changes in machine set-up or as a result of other factors.

The **Model RMX, RATE MULTIPLIER**, solves these problems easily. It accepts an odd input pulse train and converts it to a new pulses/unit basis that allows direct counting in terms of the units of interest. In the turbine flowmeter example cited in the previous paragraph, the **RATE MULTIPLIER** could be used to *"multiply"* the incoming 235 pulses/gallon by the reciprocal *(1/235 = 0.004255)* to deliver 1 pulse/gallon to the counter for direct reading in gallons. Entering a *"multiplier"* of 100 times the reciprocal *(0.4255)* would yield 100 pulses/gallon, and would produce a direct counter readout in hundredths of gallons.

The **Model RMX** has a multiplier coefficient range of X.0001 to X1.9999 settable on the front panel thumbwheel switches. In addition, internal pre-scaling multipliers can be selected via program switches on the rear to extend this range by an additional X0.1 or X0.01. This permits the full range of significant figures on the thumbwheels to be used when very high input pulse rates must be reduced to substantially lower output pulse rates. Other features include, 2 modes of remainder cancellation, 3 selectable output pulse widths, and an input circuit that can be configured by set-up switches to accept a wide variety of sensor outputs.

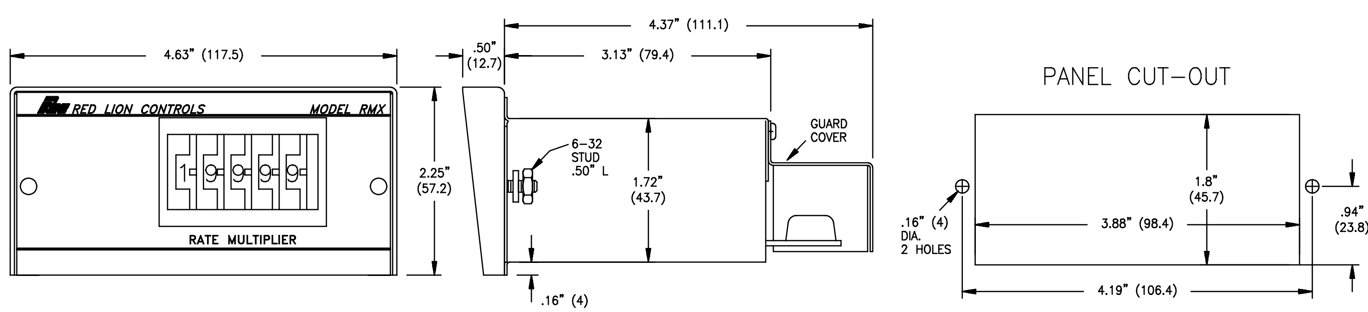
FIG. 1: SIMPLIFIED ILLUSTRATION SHOWS HOW RMX OPERATES



SPECIFICATIONS

1. **PRIMARY SUPPLY VOLTAGE:** 12 VDC ±25% @ 20 mA
   Note: The counter or rate indicator using the RMX output normally supplies power to the RMX as well as the sensor being used. Check SENSOR OUTPUT POWER Specifications of the counter or rate indicator being used.
2. **SIGNAL INPUT:** 50 KHz max. Input Frequency.
3. **OUTPUT:** Current Sink, NPN O.C. transistor, current limited to 40 mA. Output is a *"pull-down"* pulse train with selectable pulse widths of 15 µsec, 50 µsec, or 5 msec, ±20% tolerance. V_{OL} = 1 V max. @ 40 mA.
4. **OPERATING TEMPERATURE RANGE:** -20° to +50° C
5. **CONSTRUCTION:** Steel case, aluminum bezel and front panel, black epoxy paint finish. Connections on rear via pressure-clamp, screw terminals that accept stripped wires without lugs.
6. **WEIGHT:** 14.5 oz (0.4 kg)

DIMENSIONS In inches (mm)



DESCRIPTION OF OPERATION

The number of output pulses delivered by a **Model RMX** is the product of the number of input pulses, times the multiplier coefficient entered on its Thumbwheel *(T.W.)* switch. The basic multiplication scheme is shown in Fig. 2A. The input signal is conditioned by the input circuit and then separated into two process streams. The first of these processing streams is the 1X1 circuit which receives an input only when the first significant digit of the T.W. switch is *"1"*. This circuit responds to the leading *(positive-going)* edge of the input pulse and delivers an output pulse for every leading edge input on a *"1 for 1"* basis. The 1X1 output pulse is generated concurrently with the leading edge of the input pulse.

The second processing stream is the Remainder Accumulator, controlled by the 4 least significant digits of the T.W. switch. This circuit consists of a 4-decade accumulator, and responds only to the trailing *(negative-going)* edge of the input waveform. A trailing edge input causes the number entered in the last four digits of the T.W. switch, to be added to the accumulator. Successive trailing edges cause successive additions to the accumulator. When the sum added in the accumulator exceeds .9999, a *"carry-out"* signal *(overflow)* generates an output pulse to the Pulse Combiner, concurrently with the trailing edge of the input pulse.

The Pulse Combiner adds the pulses from each of the two processing streams together, interleaving the leading edge pulses from the 1X1 circuit with the trailing edge pulses from the remainder accumulator. The process is shown in a pulse-by-pulse sequence in Fig. 2B for the situation where an incoming pulse train is multiplied by a coefficient of 1.3750. The process is identical to multiplication by successive addition.

FIG. 2A - BASIC MULTIPLICATION CIRCUIT

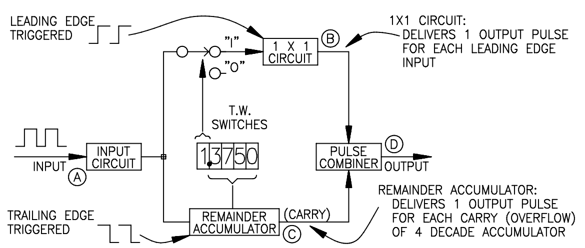
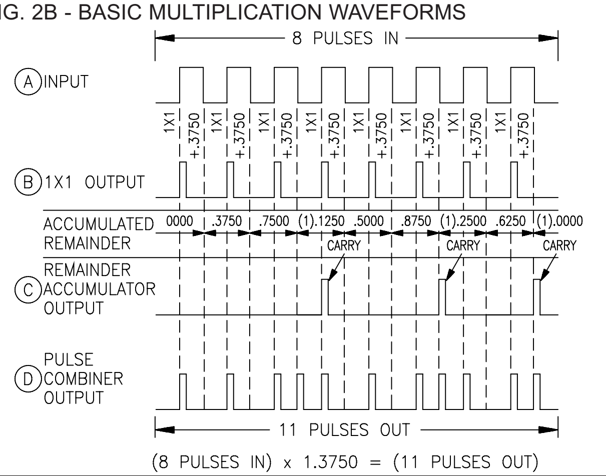


FIG. 2B - BASIC MULTIPLICATION WAVEFORMS



The complete **RMX** circuit is shown in Fig. 3. In addition to the basic multiplication circuit described above, the **RMX** includes the following functional circuits:

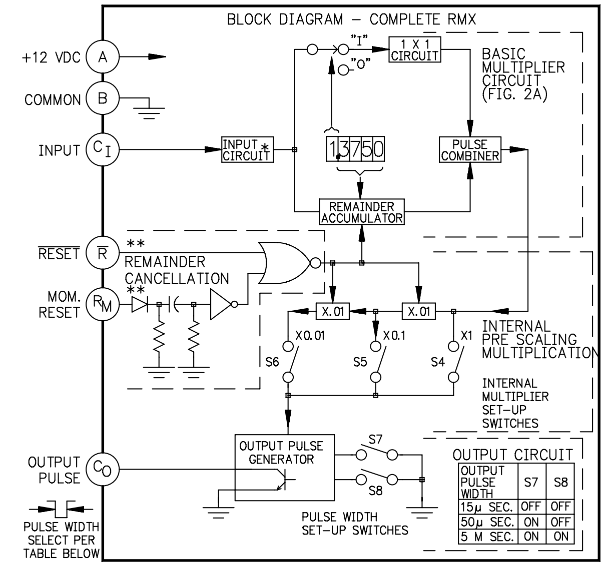
INTERNAL PRESCALING MULTIPLIERS: Prescaling Multipliers can be selected by *"set-up"* switches on the rear in steps of X0.1 and X0.01. They are useful when large number of input pulses are to be *"multiplied-down"* to a small number of output pulses. In this type of application, the Prescale Multipliers effectively move the decimal point of the coefficient to the right to converse significant figures. For example; if 1 output pulse is required for every 377 input pulses, a coefficient of 1/377 or 0.002653 would be required. Since the front panel has only 4 digits to the right of the decimal point this coefficient would have to be rounded off to 0.0027, thereby losing a great deal of accuracy.

Using Internal Prescale Multiplication of X0.01 effectively moves the T.W. switch decimal point 2 places to the right, allowing a coefficient of 0.2653 to be entered, and high accuracy is retained. Mathematically this can be interpreted as:

$$K = 0.002653 = \underline{0.2653} \times \underline{0.01}$$

T.W. Switch Setting — Prescale Multiplier (S6 ON)

FIG. 3



* See "SENSOR INPUT CONNECTIONS & INPUT CONFIGURATION SWITCH SETUP" (Switches S1, S2 & S3) on preceding page for more details.

** Reset or Momentary Rest Inputs used only if Remainder Cancellation is required.

REMAINDER CANCELLATION: From the foregoing description of operation, it is obvious that a count cycle can end leaving a remainder in the **RMX**. When a new count cycle begins, this *"held-over"* remainder will add on to the new cycle. In most cases, the remainder is so small with respect to the total number of pulses in a count cycle that its existence is insignificant. However, in applications where the remainder is appreciable, and exact repeatability is required from one count cycle to the next, the **RMX** can be cleared of remainders in either of two ways:

R (RESET) - Pulling this input low to common, resets all registers and accumulators to zero, clearing out all remainders. The **RMX** stays in the Reset mode and will not deliver output counts as long as the R input is held low. The R input can be connected to the R input of the counter to clear the remainder of the **RMX** when the counter is reset.

Rm (MOMENTARY RESET) - This input resets all registers and accumulators, when the leading edge of a positive going +12 V pulse is applied. The **RMX** remains in the reset condition for a period of 20 µsec after receiving the leading edge input, and then is ready to accept new input pulses. This input is intended primarily for the positive going O_{SRC} output of SC Series Preset Counters operating in MODE-3, RESET and RUN. This arrangement cancels remainders the instant a count cycle is concluded, making the **RMX** ready to accept count pulses for the next cycle within 20 µsec.

OUTPUT PULSE GENERATORS: Multiplication within the RMX is accomplished with very narrow pulses. To be compatible as inputs to various RLC counters and other circuits, these narrow internal pulses are *"stretched"* by the Output Pulse Generator into wider *(longer)*, current-sinking, output pulses. The output pulse-width is selectable in three different pulse-widths by setting switches S7 and S8 as shown.

The selected output pulse-width, T.W. switch setting, and Prescaling Multipliers determine the maximum input frequency and minimum input pulse width to the RMX as shown in the table and notes below.

INPUT FREQUENCY RESTRICTIONS VS. OUTPUT PULSE WIDTH

OUTPUT PULSE WIDTH	P.W. SW. SETTING		PRESCALE MULTIPLIER	MAX. INPUT FREQ.	
	S7	S8		*K<1.0	*K>1.0
15 µsec	OFF	OFF	X1.0 (S4 ON)	30 KHz	15 KHz
			X0.1 (S5 ON)	50 KHz	50 KHz
			X1.0 (S6 ON)	50 KHz	50 KHz
50 µsec	ON	OFF	X1.0 (S4 ON)	10 KHz	5 KHz
			X0.1 (S5 ON)	50 KHz	50 KHz
			X0.01 (S6 ON)	50 KHz	50 KHz
5 msec	ON	ON	X1.0 (S4 ON)	100 Hz	50 Hz
			X0.1 (S5 ON)	1 KHz	0.5 KHz
			X0.01 (S6 ON)	10 KHz	5 KHz

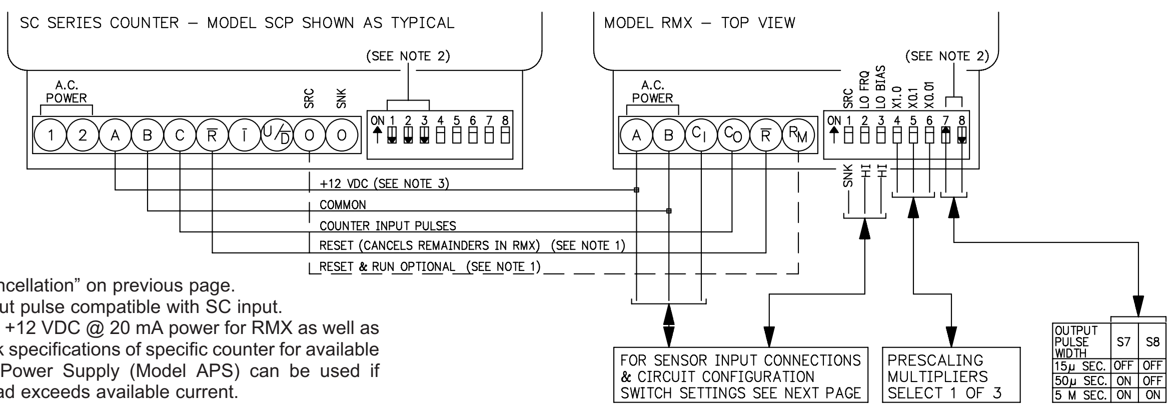
*K is the multiplier coefficient set on the front panel Thumbwheel (T.W.) Switches.

NOTES:

1. RMX input pulse-width and minimum separation between adjacent input pulses must be at least 2X the RMX output pulse-width.

2. Rate Multiplication can be used with Quadrature Signal Applications only when using dual input counters (See Series 600 Application literature).

MODEL RMX CONNECTIONS & PROGRAMMING SWITCH SET-UP



NOTES:
1. See "Remainder Cancellation" on previous page.
2. Set for 50 μsec output pulse compatible with SC input.
3. SC Counter supplies +12 VDC @ 20 mA power for RMX as well as sensor power. Check specifications of specific counter for available current. Accessory Power Supply (Model APS) can be used if Sensor and RMX load exceeds available current.

MODEL RMX APPLICATIONS DETERMINING THE COEFFICIENT (T.W. SWITCH SETTING)

The RMX obeys the following operation equation:
(INPUT PULSE-RATE) X *"K" = (OUTPUT PULSE-RATE)*
,where "K" is the coefficient set on the T.W. Switch.

In any given application the existing pulse-rate *(Input)* and the desired pulse-rate *(Output)* is known. To determine the coefficient *"K"* setting, this operational equation can simply be rewritten, solving for *"K"*.

$$\text{"K"} = \frac{\textbf{Desired Pulse–Rate (Output)}}{\textbf{Existing Pulse–Rate (Input)}}$$

EXAMPLE 1

A 17-inch circumference pull-roll is driven by a 35-tooth, timing-belt *"gear"*, which detects passing gear teeth by a proximity sensor. Material passing through the pull-rolls is to be measured in inches. Find the value of *"K"* to be set into the RMX T.W. Switch:

$$\text{Existing Pulse-Rate (Input)} = \frac{\text{35 Pulses/Rev}}{\text{17 Inches/Rev}} = \text{2.0588 Pulses/In.}$$

$$\text{Desired Pulse-Rate (Output)} = \text{1 Pulse/Inch (To "COUNT" Inches)}$$

$$\text{"K"} = \frac{\text{Desired Pulse–Rate}}{\text{Existing Pulse–Rate}} = \frac{1}{2.0588} = 0.4857$$

EXAMPLE 2: USING PRESCALING MULTIPLIERS

The pull-roll system in Example 1, is now to be used to measure out material in Meters. Find the new value of *"K"*.

$$\text{Pull-Roll Circumference In Meters} = \frac{\text{17 Inches}}{\text{39.37 In/Meter}} = \text{0.4318 Meters}$$

$$\text{Existing Pulse-Rate (Output)} = \frac{\text{35 Pulses}}{\text{0.4318 Meter}} = \text{81.056 Pulses/Meter}$$

$$\text{Desired Pulse-Rate (Input)} = \text{1 Pulse/Meter (To "COUNT" Meters)}$$

$$\text{"K"} = \frac{\text{Desired Pulse–Rate}}{\text{Existing Pulse–Rate}} = \frac{1}{81.06} = 0.012337$$

Since the T.W. Switch has only 4 decimal places to the right of the decimal point, the coefficient must be rounded off to .0123, dropping the last two significant figures, and compromising accuracy. Using an internal prescaling multiplier of X0.01 allows the decimal point of the coefficient set on the T.W. Switch to be moved two places to the right to retain as any significant figures as possible.

$$K = 0.012337 = \underbrace{\underline{1.2337}}_{\text{T.W. Switch Setting}} \times \underbrace{\underline{0.01}}_{\text{Prescale Multiplier (S6 ON)}}$$

EXAMPLE 3: COMPENSATING FOR COMPLIANCE STRETCH) IN ELASTIC MATERIALS

A continuous measurement is desired of the amount of elastic material being wound on a roll as it leaves a processing machine. The measurement desired is in tenths of feet in a *"relaxed"* condition. However, the roll is being wound under tension, with the material in a *"stretched"* condition, and cannot be measured directly by conventional means. A 10 pulse/ft length sensor and a Model SCT totalizer is installed together with an RMX to correct for the *"stretched"* readout.

To calibrate the system, the RMX coefficient is set at 1.0000 to ripple-through 10 pulses/ft to the counter. A length of material is run through the machine and wound until the counter reads 1000 *counts (100.0 ft length under tension)*. This material is then unwound on the floor and its relaxed length is measured at 88.5 ft. What should the RMX coefficient be set at to provide readout of relaxed length in feet?

$$\text{Desired Readout (Output)} = \text{885 Pulses (or 88.5 ft)}$$

$$\text{Actual Readout (Input)} = \text{1000 Pulses (or 100.0 ft)}$$

$$\text{100.0 ft (actual)} \times \text{"K"} = \text{88.5 ft (desired)}$$

$$\text{"K"} = \frac{88.5}{100.0} = 0.8850$$

EXAMPLE 4: COUNTING PRODUCTION PARTS

A gasket die-cutting machine is already equipped with an ARCJ C-Flange adapter sensor mounted on the gear-motor and a DT3D to indicate production rate. It is then later decided to add an SCT totalizing counter to count total parts on a production shift basis. Since absolute accuracy is not required and direct sensing, the cut gasket is impractical, the magnetic pickup output signal from the ARCJ Adapter Ring is to be used for counting. The machine set-up is such that 1.25 shaft revolutions of the drive motor produces 3 gaskets. *(The ARCJ produces 60 pulses/motor rev.)* An RMX is to be used to convert the ARCJ output pulse rate to 1 pulse/gasket for counting.

$$\text{Desired Pulse-Rate (Output)} = \text{1 Pulse/Gasket}$$

$$\text{Actual Pulse-Rate (Input)} = \frac{\text{60 Pulses/Rev.} \times \text{1.25 Revs.}}{\text{3 Gaskets}}$$

$$= \text{25 Pulses/Gasket}$$

$$\text{"K"} = \frac{1}{25} = 0.0400$$

(Use of prescaling multiplier is not needed here since no significant figures are lost in setting the coefficient 0.0400 on the T.W. Switch.)

Note: In this application, a Model ASTC preamplifier was used to accept the magnetic pickup signal and develop a current sinking output signal compatible with inputs of both the DT3D and the RMX. The A (+12 VDC) and B (Common) terminals of the DT3D, and SCT were connected together to parallel their internal power supplies and share the load for the RMX and ASTC.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
RMX	Pulse-Rate Multiplier	RMX00000
For more information on Pricing, Enclosures & Panel Mount Kits refer to the RLC Catalog or contact your local RLC distributor.		

MODEL RMX, RATE MULTIPLIER

SENSOR INPUT CONNECTIONS & INPUT CONFIGURATION SWITCH SET-UP

The schematic diagram at right shows the details of the RMX count input circuit, the terminals used for sensor connection and the configuration set-up switches. These switches are always the first three switches in the switch bank and are designated S1, S2 and S3 from left to right. The functions of these switches are as follows:

S1 - ON (SRC): Provides 3.9 K Pull-down load for sensors with sourcing outputs. *(Max. sensor current, 3 mA)*

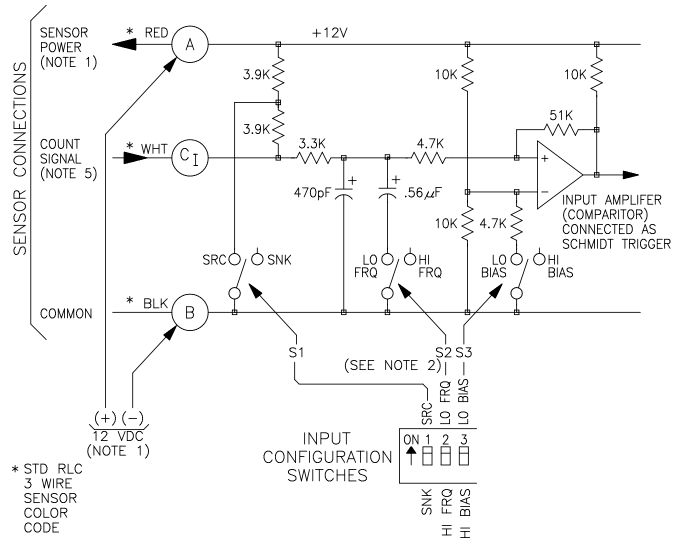
OFF (SNK): Provides a 7.8 K Pull-up load for sensors with sinking outputs. *(Max. sensor current, 1.6 mA)*

S2 - ON (LO FRQ): Connects damping cap for switch contact debounce. Limits count speed to 100 cps maximum. Minimum count pulse ON/OFF times-5 msec. *(See Note 2)*

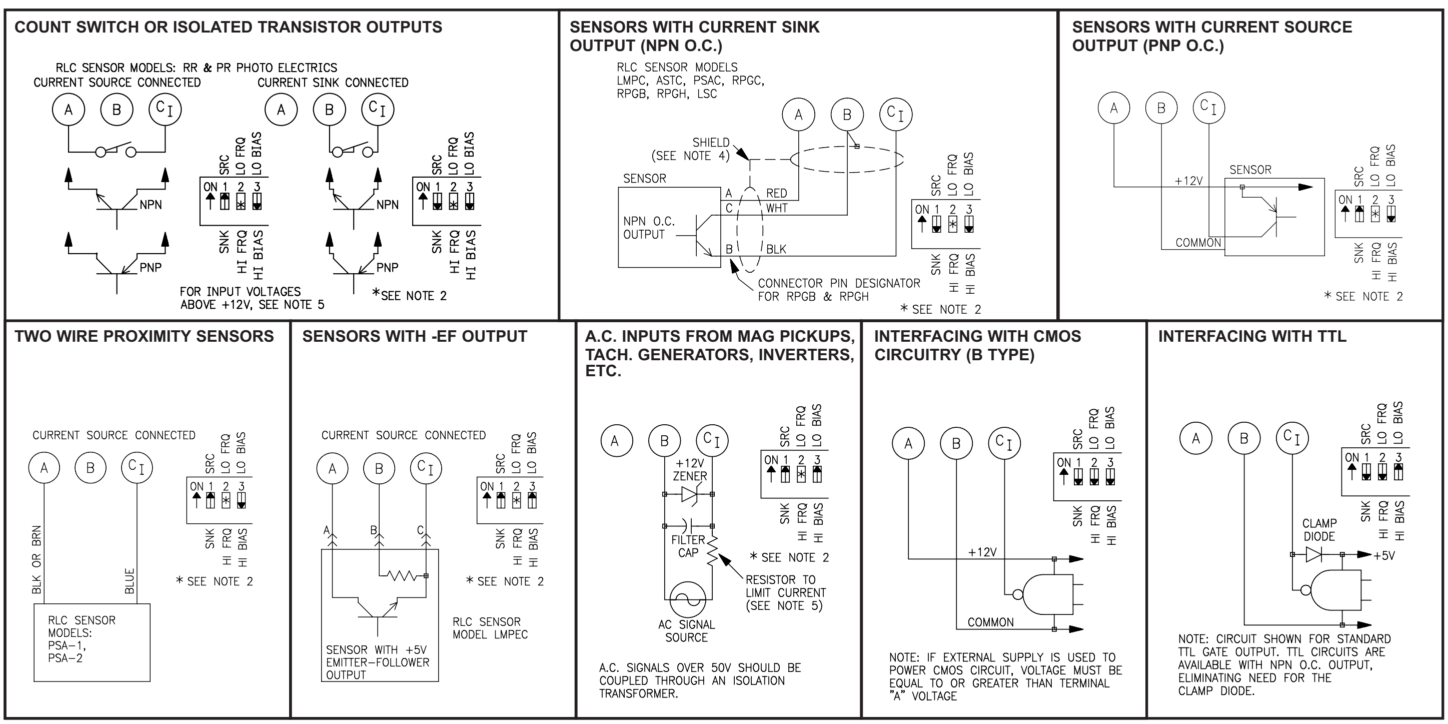
OFF (HI FRQ): Removes damping cap, allows operation to 50 KHz. Minimum count pulse ON/OFF times-10 µsec.

S3 - ON (LO BIAS): Sets input trigger levels to the low range to accept logic pulses with 0 to +5 V swings. *(*V_{IL} = 1.5 V, V_{IH} = 3.75 V, *See Note 3)*

OFF (HI BIAS): Sets input trigger levels at mid-range to accept outputs from 2-wire proximity sensors, resistive photo-cells and logic pulses with full 0 to +12 V swings. *(*V_{IL} = 5.5 V, V_{IH} = 7.5 V, *See Note 3)*



CONNECTIONS & CONFIGURATION SWITCH SET-UPS FOR VARIOUS SENSOR OUTPUTS



NOTES:

1. SUPPLY VOLTAGE & CURRENT

+12 VDC Power for the RMX and Sensor is supplied by the counter. Current drain for the RMX alone is 20 mA. Check counter specifications for available output current.

2. HI/LO FRQ SELECTION

The HI/LO FRQ Selection switch MUST be set on LO FRQ when switch contacts are used to generate count input signals. Since the LO FRQ mode also provides very high immunity against electrical noise pickup, it is recommended that this mode also be used whenever possible with electronic sensor outputs, as added insurance. The LO FRQ mode can be used with any type of sensor output provided count pulse widths never decrease below 5 milliseconds, and the count rate does not exceed 100 cps.

3. V_{IL} and V_{IH} levels given are nominal values ±10% when counter voltage on terminal A is +12 VDC. These nominal values will vary in proportion to the variations in Terminal A voltage caused by line voltage and load changes.

4. When shielded cable is used, shield should be connected to Terminal B at the RMX and left unconnected at sensor end.

5. The Count Input *(Terminal C)*, can accept source pulses from other circuits up to +28 V in amplitude. For voltages above +28 V a limiting resistor and zener diode should be used to limit the voltage at Terminal C. Negative input voltages to Count Input *(Terminal C)*, will damage the input circuit. If the possibility exists that the input voltage can swing negative, an external shunt or series diode should be used to block the negative swing.