THE LEGEND SERIES

COUNT
321674

F1 PRS ∧ ENT
F2/RST ←ESC ∨ SEL→

MODEL LGD INSTRUCTION MANUAL

INTRODUCTION

The Legend Series LGD is another unit in our multi-purpose series of industrial control products that are field-programmable for solving various applications. This series of products is built around the concept that the end user has the capability to program different personalities and functions into the unit in order to adapt to different indication and control requirements.

The Legend unit LGD, which you have purchased, has the same high quality workmanship and advanced technological capabilities that have made Red Lion Controls the leader in today's industrial market.

Red Lion Controls has a complete line of industrial indication and control equipment, and we look forward to servicing you now and in the future.

**CAUTION: Risk of Danger.
Read complete instructions prior to
installation and operation of the unit.**

CAUTION: Risk of electric shock.

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GENERAL DESCRIPTION

The Legend unit (LGD) is a two input, microprocessor-based device that offers the features and performance of a dual level preset Counter and time interval Rate indicator. The internal count precision is maintained to 9 digits.

The RS485 serial communication port provides for computer and printer interface that extends the capabilities of the unit. It can be used for data retrieval and for programming various data values.

Optional Legend Programming Software (SFLGP) for IBM® compatible PCs is available to program all of the Legend configuration parameters, such as User Inputs, Count modes, etc. The software allows unit configurations to be created, uploaded, downloaded, and saved to a file for rapid programming of the Legend unit.

Application flexibility is provided through the two-line by eight-character alphanumeric display. The display features English language menus for easy viewing and simplified programming. The four scroll-through indication displays can be programmed to show various parameters and to automatically scroll, if desired. A program disable DIP switch used with an external User Input can be utilized to protect the settings and guarantee that no unwanted changes occur during operation.

The five Programmable User Inputs can be set for a variety of functions. Three user inputs are located on the upper rear terminal block and the other two inputs are front panel function keys.

When power is turned off, the unit automatically saves the settings and data in its no-power memory. When power is restored, the LGD restores the parameters it had at power down. The EPROM's life expectancy is at least 100,000 power cycles.
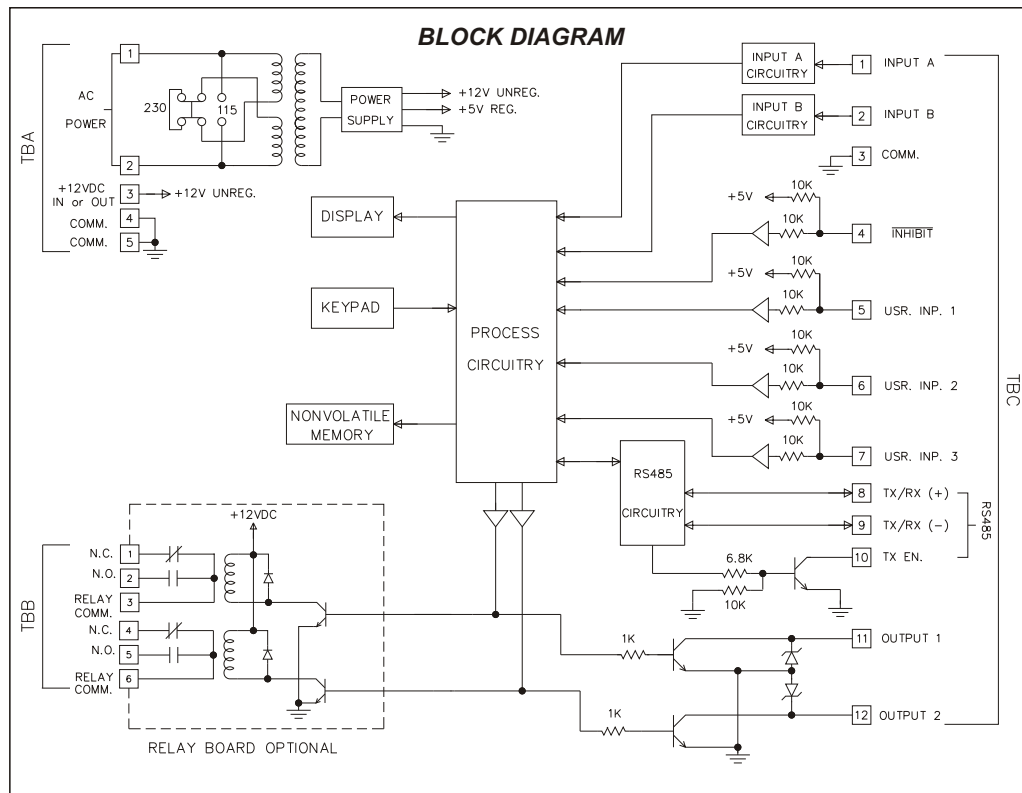
The LGD offers a choice of seven programmable counting modes for use in applications requiring Bi-directional, Anti-coincidence, and Quadrature counting. A separate Inhibit terminal can be used for any of the count modes.

BLOCK DIAGRAM

Input A accepts a signal for the Count and Rate display. Input B accepts a signal for the Count display or direction control. In the Anti-coincidence mode, both inputs are monitored simultaneously, so that no counts are lost, and the final count can be chosen as the sum or difference of the two inputs.

Rate and Count displays have separate scaling and decimal point placement, for the readouts in different units.

The Counter Load feature enables the operator to modify the count value under circumstances that occur when flawed material has been counted and it is necessary to adjust the count value accordingly.

The rate operates in the time interval method (1/tau) to calculate the rate value. This method insures high resolution at all input rates. Averaging can be accomplished by programming the Minimum and Maximum Update Time for the desired response. Extensive scaling capabilities allow practically any reading at very slow input rates.

Each of the two open collector outputs can be assigned to either the Counter or Rate indicator. The programmable outputs can be set for a variety of functions. The optional plug-in relay board operates in parallel with the open collector outputs and makes it easy to field upgrade the Legend unit to provide for two, 5 amp, 240 VAC relay outputs.

The construction of the Legend LGD unit is a lightweight, high impact plastic case with a clear viewing window. The sealed front panel with the silicone rubber keypad meets NEMA 4X/IP65 specifications for wash-down and/or dusty environments, when properly installed. Plug-in style terminal blocks simplify installation and wiring change-outs.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so, can be potentially harmful to persons or equipment in the event of a fault to the unit.

BASIC OPERATION

The Legend has a counter that keeps track of the input pulse Count. The unit takes the actual number of pulses counted (internal count value) and multiplies them by the Count Scale Factor and Count Scale Multiplier. This results in the desired reading value for the count display. The unit can count on both edges of the pulse if desired. Input A accepts the signal for the count and Input B is used for quadrature or anti-coincidence counting, or to control up or down counting. There is a separate Inhibit terminal that can be used with any of the count modes.

The Counter has three Reset Action modes associated with the display; Reset to Zero *(up-count modes)*, Reset to Preset *(down-count modes)*, or Reset to the Counter Load value. A Reset can be a Manual reset, using a programmable user input, or it can be one of the seven programmable Automatic Reset modes. Both the reset action and automatic reset modes are programmed in the Program Counter Module.

The Counter will display the scaled number of pulses that have been entered. When the count equals either preset 1 or 2, the appropriate output will activate. The count can be programmed to automatically reset if desired. The internal precision of the Counter is maintained to 9 digits.

The signal at Input A is also used for the Rate indicator portion. The Rate Indicator uses a time interval method (1/tau) to calculate the rate value. The unit counts on the negative edge of the input pulses. After the programmed minimum update time elapses and the next negative edge occurs, the unit saves the number of edges that occurred during the elapsed time. The number of edges is multiplied by the Rate Scale Factor, Rate Scale Multiplier, and the Rate Conversion Factor to calculate the rate value. Averaging can be accomplished by programming the Rate Minimum Update Time for the desired response. Extensive scaling capabilities allow practically any desired reading at very slow count rates.

The following is a Block Diagram overview of the basic operation.
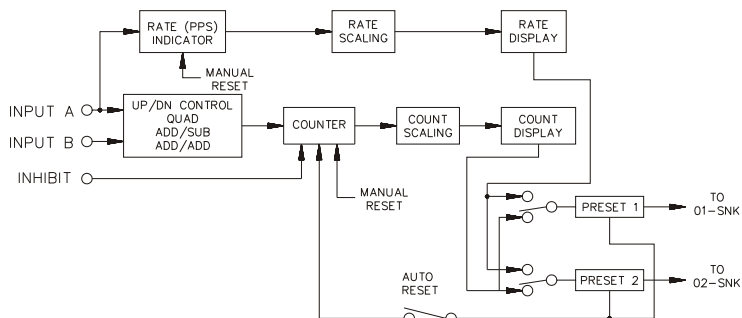
OVERFLOW INDICATION

The Legend will flash the word "OVERFLOW" in the appropriate display when an overflow condition occurs. An overflow occurs if the capacity of the display *(6-digits)* is exceeded or if the internal count capacity *(9-digits)* is exceeded. The use of an extremely small Scale Multiplier and a Scale Factor Value can cause the internal count capacity to overflow before the displayed value will overflow.

For example, if a Scale Factor of 0.0001 and a Scale Multiplier of 0.001 is used, for every 10,000,000 count edges received, the display will increment by 1. Before the display reaches 215, the internal counter will overflow. When the capacity of the display is exceeded, the count value will be maintained and will be valid. But if the internal count capacity is exceeded, then this value will no longer be valid. It should be noted that the use of a Scale Factor larger than "1" could cause the displayed count value to overflow before 999,999 counts are accumulated. Also the use of a Rate Scale Factor, Scale Multiplier, and Rate Conversion Factor larger than "1" can cause the rate display to be in an overflow condition.

The Counter should not be allowed to operate in an overflow condition. As soon as, or before the counter overflows, the information should be recorded and the counter reset.

INHIBIT

When the Inhibit terminal is low, connected to common, all input pulses will be ignored by the counter. The rate input, however, is unaffected by the Inhibit terminal and will continue to indicate the rate of the signal at input A. When the Inhibit terminal is high, the signal for the counter will be sensed and counted.

PEAK & VALLEY

The Peak and Valley registers will record the lowest *(Valley)* and the highest *(Peak)* readings of the rate input signal. These values are viewed in the indication display loop and are updated automatically. A User Input can be programmed to reset the values to the current rate value individually or by sending the proper command via the serial communication port. The Peak and Valley values are <u>NOT</u> retained when power to the unit is removed.

NORMAL OPERATING MODE

In the normal operating mode, the up, down, left, and right arrow keys are used to scroll through the main display loop. In the main display loop, the four indication displays, scale factor, and program mode module are viewed, as shown. In the indication display loop, the up and down arrow keys are used to scroll to each display. The indication displays are referenced as 1 (RATE), 2 (PEAK), 3 (VALLEY), and 4 (COUNT), and are the factory default settings. The indication displays can be programmed to show other parameters and automatically scroll if desired (Refer to the Program Displays Module). When exiting the indication display loop, using the left or right arrow keys, the last display that was viewed will be the first display to be viewed when re-entering the indication display loop. Also, the last indication display that was viewed at power down, will be the one viewed on power up.

The Presets and Counter Load values are accessed from any of the indication displays or from the programming loop. The Count and Rate scale factors are accessed from the Scale Factors display or when in the programming loop from the Program Scaling module. In the Program Mode display, the operator enters the programming loop to access all parameters to configure the unit.

Shown below is the Main Display Loop.
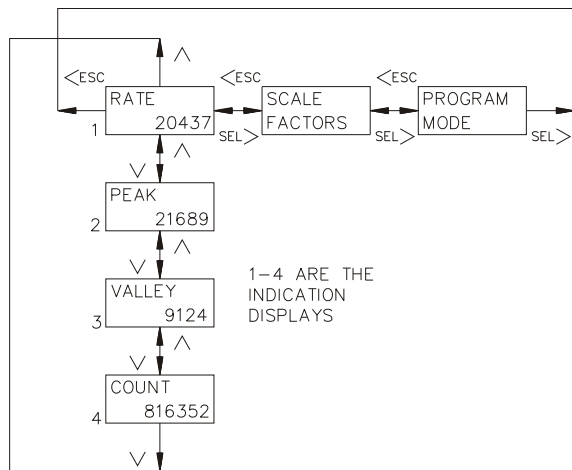
The front panel has a clear viewing window to view the two line by eight character LCD display, with yellow/green or red backlighting. The front panel meets NEMA 4X/IP65 requirements when properly installed. The keypad has a key array of two rows by four columns and some keys have a dual function. The following is a description of each key:

KEYPAD FUNCTIONS

F1 - Function key F1 is a User Programmable Input. When the key is pressed, the unit performs the appropriate function as programmed in the *"Program User Module"*.

F2 RST - Function key F2/RST is a User Programmable Input. When the key is pressed, the unit performs the appropriate function, as programmed in the *"Program User Module"*. The *"RST"* printing on this key is used as a quick reference for the operator, as long as the function key is programmed for a reset function.

PRS - The PRS key accesses the Preset and Counter Load Module provided these values are not programmed for 'loc'k. If all values are 'loc'ked, pressing the PRS key does nothing. Preset values that are accessible (changeable), can be changed immediately. Within the preset menu, pressing this key saves the value and advances the display to the next available preset. Pressing the PRS key at the end of the module exits the module and returns the user to the main display loop.

<ESC - The Left arrow/escape key scrolls to the left in the main display loop. When programming a numerical value, it selects the digit to the left. In a sub-menu, it will exit to the next higher level menu in the loop. It is also used to exit the programming loop. When exiting the programming loop, the Legend will store all the parameters into nonvolatile memory and return to the last viewed indication display.

KEYPAD FUNCTIONS (Cont'd)

∧ - The Up arrow key scrolls through the indication displays. In the programming loop, this key can be used to scroll through the main menus. When programming a numerical value, it increments (decrements, i.e., goes more positive, for negative values) at the selected digit position. If the key is pushed and held, the value will scroll (count up) automatically. After 5 counts, the unit enters fast scroll mode. If the key remains pushed, a digit shift occurs every one hundred counts until the maximum value or zero (for negative presets) is reached. When the digit shift occurs, the previously scrolling digit goes to zero. When zero is reached (for negative values), the display holds at zero. To go positive, the key must be released and pushed again.

∨ - The Down arrow key scrolls through the indication displays. In the programming loop, it scrolls through the main menus and sub menus. When programming a numerical value, it decrements (increments or goes more negative, for negative values) at the selected digit position. If the key is pushed and held, the value will auto scroll (count down automatically). After 5 counts, the unit enters fast scroll mode. If the key remains pushed, a digit shift occurs every one hundred counts until zero is reached. When the digit shift occurs, the previously scrolling digit goes to zero. When zero is reached, the display holds at zero. To go negative, the key must be released and pushed again.

ENT - The Enter key enters the programming loop, when "Program Mode" is displayed from the main display loop. When "Scale Factors" is displayed, pressing Enter allows access to the scale factors. This key is also used to save changes to data values. If the data value is a preset or counter load value, the value is entered and the preset menu is exited. For all other numeric data values (i.e., Output time, Rate update times, etc.), the value is entered and the value edit mode is exited. The value is still viewed in the display, but with no digits flashing.

SEL> - The Select/Right arrow key scrolls right in the main display loop. When programming a numerical value, it selects the digit to the right. In a sub-menu loop, it is used to go to the next lower level and eventually into an edit menu.

FRONT PANEL ACCESSIBLE FUNCTIONS WITH PROGRAM DISABLE

The Legend has several ways to limit the programming of parameters from the front panel keypad. There is an Operator Access module, in the programming loop, that is used with the Program Disable (PGM DIS) DIP switch and an external programmable User Input. Only one external User Input can be selected for program disable. The following list describes the possible program disabling functions.

PGM.DIS. DIP Switch	Programmed User Input	Description
OFF	Inactive	All programming enabled.
OFF	Active	Operator Accessible Functions Enabled, Program Loop Disabled.
ON	Inactive	Operator Accessible Functions Enabled, Program Loop Disabled.
ON	Active	Operator Accessible Functions Disabled, Program Loop Disabled.

Note: If the User Input, set for PGM. DIS., is to be changed to another function, make sure the User Input is not low (active). If it is low and the mode is changed, the Program Disable modes will operate as if a PGM. DIS User Input were active.

PROGRAMMING GENERAL DESCRIPTION

Programming the LEGEND unit is done through the front panel keypad, which allows the user to enter into Main Menus, Sub-Menus, and Edit Menus. The English language prompts, the flashing parameters values, and the front panel keypad aids the operator during programming.

Although the unit has been programmed at the factory, the parameters will generally have to be changed to suit the desired application. From the main display loop, the Main Menus are entered by pressing the enter (ENT) key when Program Mode is displayed. This allows the user to then enter a Sub-Menu from a main menu where parameter values can be viewed. From the Sub-Menu the operator can advance into an Edit Menu. An Edit Menu is where a parameter value is changed and entered. There are two types of Edit Menus:

1. A Choice Edit Menu allows the operator to scroll through options by pressing the down arrow key until the desired option is viewed. The option is selected by pressing the ENT (enter) key, which returns the operator to the previous sub-menu. The operator can exit the Edit Menu WITHOUT making a selection by pressing the <ESC key, which will then return the operator to the previous sub-menu.

2. In a Numerical Value Edit Menu, the operator uses the left or right arrow key to select a digit. The up and down arrow keys change the digit's value. The PRS key toggles the left most digit between a minus (-) and a zero for plus (+), for that numeric value. When the appropriate numerical value is selected, it is entered by pressing the ENT (enter) key, which returns the operator to the previous sub-menu.

All parameter values that are changed in the Programming Loop are saved when exiting the loop. The operator can exit the programming loop from any of the main menus by pressing the <ESC key. When the <ESC key is pressed, the display will blank momentarily, while the parameter values are saved in nonvolatile memory. The unit will return to the indication display that was last viewed. Shown is the Main Display Loop and the Main Programming Menus of the Dual Preset Legend *(LGD)* unit.

All of the flow charts that follow, which have slanted characters, will be flashing in the units display and will have programmable options.

MAIN DISPLAY LOOP

MAIN PROGRAMMING MENUS
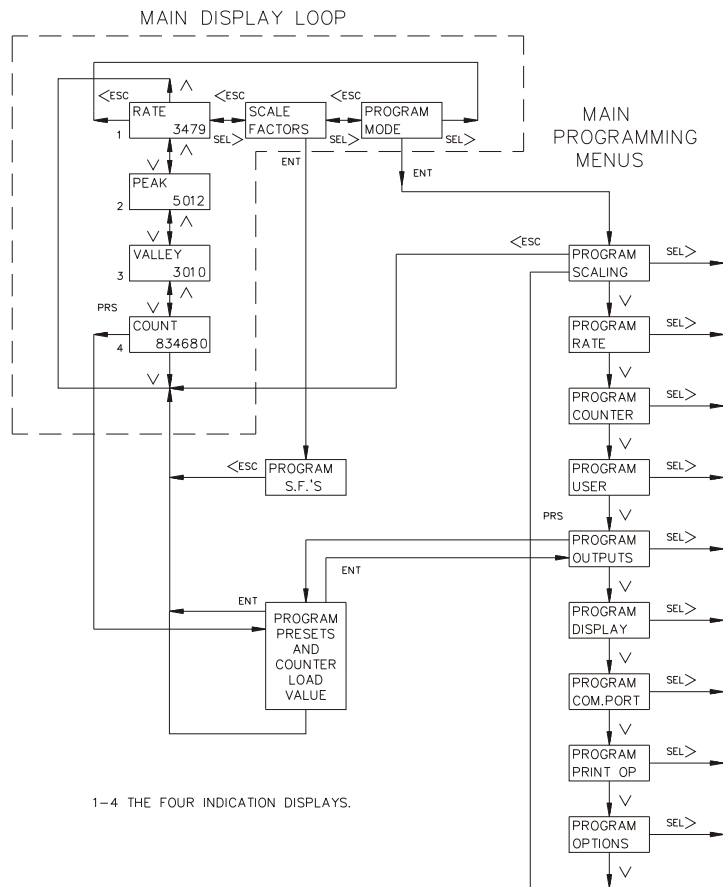
1-4 THE FOUR INDICATION DISPLAYS.

PROGRAM PRESETS & COUNTER LOAD MODULE

The Preset and Counter Load values are accessed from any of the indication displays, or from any of the main menus in the programming loop, by pressing the PRS key. The top line shows the Preset number and the display that it is assigned to *(C = Count, R = Rate)*. The following flowchart shows only the Preset and Counter Load portion:

The Count Scale Factor will have a direct effect on the preset value being entered if the output *(preset)* is assigned to the count display. For a Scale Factor Value greater than "1", the preset value should be a whole number multiple of the Scale Factor value. If it is not, the Legend will automatically adjust the preset value up or down to force it to be evenly divisible by the Scale Factor.

COUNTER LOAD VALUE

The Counter Load value *(CL)* allows the user to change the count value. The count display will reset to the counter load value if the reset mode is set to counter load *(In the Program Counter Module)*. The counter load value can be programmed from -99999 to 999999.

PRESETS VALUES

Preset values P1 and P2 activate solid state outputs 01-SNK & 02-SNK respectively, when the assigned display value equals the preset value. The output *(preset)* may be assigned to the count or rate display and the output action *(Timed, Latched, or Boundary)* is programmed in the Program Outputs Module. The preset values may range from -99,999 to 999,999.

Note: The optional relay board operates in parallel with the solid state outputs, 01 SNK & 02 SNK.

PROGRAM SCALE FACTORS MODULE

The Scale Factors are accessed from the Scale Factors Module in the main display loop or from the Scaling Module in the programming loop.

Since the Scale Factors may need to be changed periodically, this module allows the operator to change a scale factor value WITHOUT entering the programming loop. The following flowchart shows only the Scale Factor portion:

PROGRAMMABLE OPTIONS:

0.0001 TO 5.9999

0.0001 TO 5.9999

* − LEFT & RIGHT ARROW KEYS TO
SELECT DIGIT, UP & DOWN KEYS
TO CHANGE THE DIGITS VALUE.

1−4 INDICATION DISPLAYS
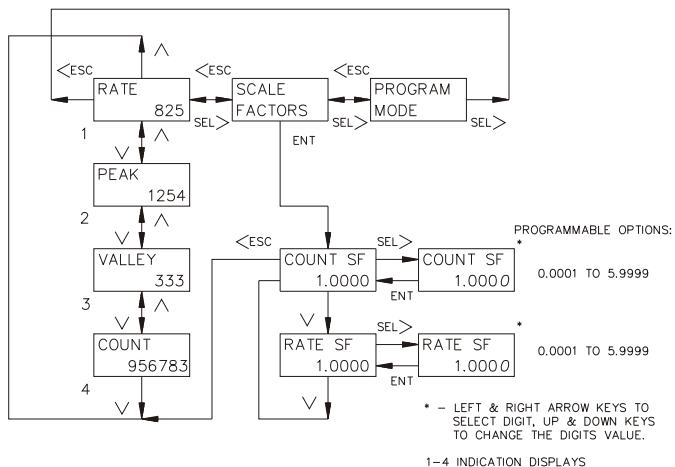
COUNT SCALE FACTOR

The number of pulses counted *(internal count value)* is multiplied by the count scale factor value and the Scale Multiplier to obtain the desired count display value. A Count Scale Factor Value of 1.0000 and a Scale Multiplier of "1" will result in the display of the actual number of input pulses that were counted. The Count Scale Factor value is used for converting the number of pulses counted to the required units of measure for the display. This includes conversion from different units of measure *(i.e feet to meters, etc.)*.

The Count Scale Factor Value can range from 0.0001 to 5.9999. It is important to note that the precision of a counter application cannot be improved by using a Scale Factor greater than "1". To accomplish greater precision, more pulse information must be generated per measuring unit. For details, refer to Scaling for Count Indication in the Appendix.

RATE SCALE FACTOR

The internal rate value *(pulses per second)* is multiplied by the Rate Scale Factor, Rate Scale Multiplier, and Rate Conversion Factor values to obtain the desired rate display value. The Rate Scale Factor value is used for converting the internal rate *(in pulses per second)* to the required units of measure for the display. This includes conversion from different units of measure *(i.e feet to meters, etc.)*.

The Rate Scale Factor Values range from 0.0001 to 5.9999. Due to the way the rate is calculated, high resolution and accuracy are achieved at all input rates, slow or fast. For details, refer to Scaling for Rate Indication in the Appendix.

PROGRAMMING MENUS

The programming menus are accessed when "Program Mode" is displayed in the main display loop. All parameter values can be accessed from the Main Programming Menus. Accessibility to the programming menus will depend on the Program Disable Function setting *(Refer to Front Panel Accessible Functions with Program Disable section)*.

In the programming menus, pressing the down arrow key will scroll through all the main menu options. From the main menu, a sub-menu is accessed by pressing the SEL> key. In a sub-menu, the operator can view the parameter values that are currently selected. To change a parameter value, the edit menu is accessed by pressing the SEL> key *(Refer to Programming General Description section)*.

The Preset and Counter Load module can be accessed from any main programming menu by pressing the PRS key. When exiting the preset and counter load module, the operator will return to the last main menu that was being viewed. When all parameter changes have been made, the operator can exit the programming loop, from any main menu, by pressing the <ESC key. Exiting will save all parameter values and return the operator to the last indication display that was viewed. Shown are all of the main programming menus.

MAIN DISPLAY LOOP

MAIN PROGRAMMING MENUS
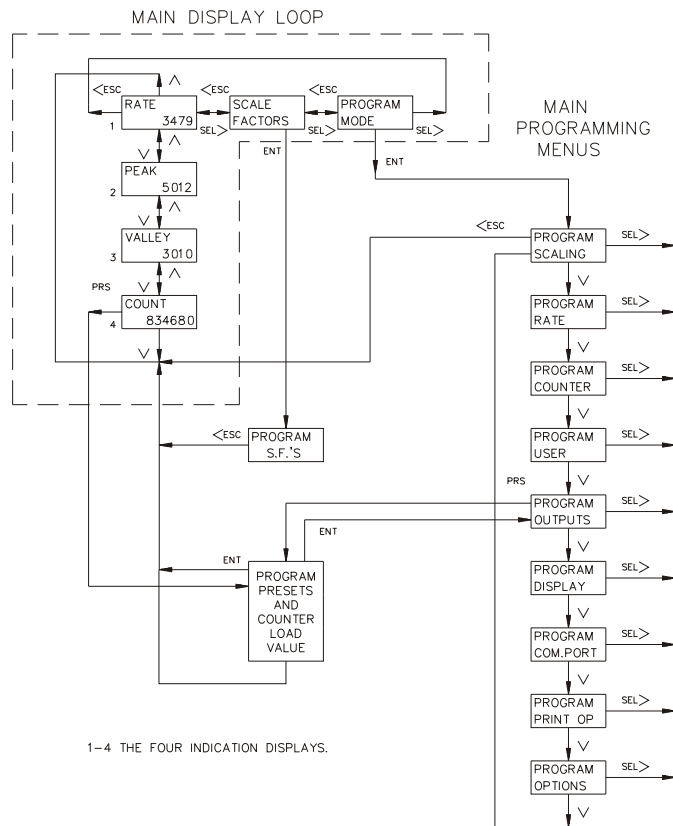
1-4 THE FOUR INDICATION DISPLAYS.

PROGRAMMING SCALING MODULE

In the scaling module, the Count and Rate scale factors, scale multipliers, rate conversion factor, and decimal points are accessed. The following flowchart shows only the Scaling portion:

MAIN MENU

```
PROGRAM
MODE
  | ENT
PROGRAM          SUB              EDIT
SCALING   SEL>   MENU      SEL>   MENU        PROGRAMMABLE OPTIONS:
  |                                                **
  |              COUNT SF   SEL>   COUNT SF     *   0.0001 TO 5.9999
PROGRAM   <ESC   1.0000           1.000O
RATE                        | ENT
                  V                            **
                RATE SF    SEL>   RATE SF      *   0.0001 TO 5.9999
                1.0000            1.000O
                            | ENT
                  V                                X1
                CNT. SCM   SEL>   CNT. SCM     *   X0.1
                X1               X 1               X0.01
                            | ENT                  X0.001
                  V                                0
                CNT. DP    SEL>   CNT. DP      *   0.0
                0                O                 0.00
                            | ENT                  0.000
                                                   0.0000
                                                   0.00000
                  V                                X1
                RATE SCM   SEL>   RATE SCM     *   X0.1
                X1               X 1               X0.01
                            | ENT                  X1000
                                                   X100
                                                   X10
                  V                                
                RATE PER   SEL>   RATE PER     *   SECOND
                SECOND           SECOND            MINUTE
                            | ENT                  HOUR
                  V                                0
                RATE DP    SEL>   RATE DP      *   0.0
                0                O                 0.00
                            | ENT                  0.000
                                                   0.0000
                  V                                0.00000
```

* – DOWN ARROW KEY TO TOGGLE THROUGH OPTIONS.

** – LEFT & RIGHT ARROW KEYS TO SELECT DIGIT, UP & DOWN KEYS TO CHANGE THE DIGITS VALUE.

COUNT SCALE FACTOR (COUNT SF)

The number of pulses counted *(internal count value)* is multiplied by the count scale factor value and the count scale multiplier to obtain the desired count display value. A count Scale Factor Value of 1.0000 will result in the display of the actual number of input pulses that were counted. The count Scale Factor value is used for converting the number of pulses per unit of measure to the required units of measure for the display. This includes conversion from different units of measure *(i.e feet to meters, etc.)*.

The Count Scale Factor Value can range from 0.0001 to 5.9999. It is important to note that the precision of a counter application cannot be improved by using a Scale Factor greater than "1". To accomplish greater precision, more pulse information must be generated per measuring unit. For details, refer to Scaling for Count Indication in the Appendix.

RATE SCALE FACTOR (RATE SF)

The internal rate value *(pulses per second)* is multiplied by the Rate Scale Factor, Rate Scale Multiplier, and Rate Conversion Factor values to obtain the desired rate display value. The Rate Scale Factor value is used for converting the internal rate *(in pulses per second)* to the required units of measure for the display. This includes conversion from different units of measure *(i.e feet to meters, etc.)*.

The Rate Scale Factor Value can range from 0.0001 to 5.9999. Due to the way the rate is calculated, high resolution and accuracy are achieved at all input rates, slow or fast. For details, refer to Scaling for Rate Indication in the Appendix.

Note: Since the Count and Rate Scale Factors may need to be changed periodically, they can also be accessed from the Scale Factors module in the main display loop.

COUNT SCALE MULTIPLIER (CNT. SCM)

There are four Count Scale Multipliers available; X 1, X 0.1, X 0.01, or X 0.001 that change the count display value accordingly. The number of pulses counted *(internal count value)* is multiplied by the scale multiplier and the scale factor values to obtain the desired Count display.

Note: Use of a small scale multiplier with a small scale factor could cause the internal count value to be exceeded, before the 6-digit display value is exceeded.

PROGRAMMING SCALING MODULE (Cont'd)

RATE SCALE MULTIPLIER (RATE SCM)

The Rate Scale Multiplier is used with the rate scale factor and rate conversion factor to scale the rate display value for the proper units of measure. The scale multipliers available are; X 1, X 0.1, X 0.01, X 1000, X 100, or X 10.

RATE CONVERSION FACTOR (RATE PER)

The Rate Conversion Factor is used to display the rate value in the proper time units of measure, per second (X1), per minute (X60), or per hour (X3600) for the desired time units for the Rate display.

DECIMAL POINT (DP)

There are six Decimal Point locations available for the Rate and Count displays. The decimal point is programmed individually for the Rate and Count displays. The decimal point location programmed for the Rate display will also be the same for the Peak and Valley displays.

PROGRAMMING RATE MODULE

In the Rate module the Minimum and Maximum Update Times are programmed. The update times can range from 0.1 to 99.9 seconds. The following flowchart shows only the Rate portion:
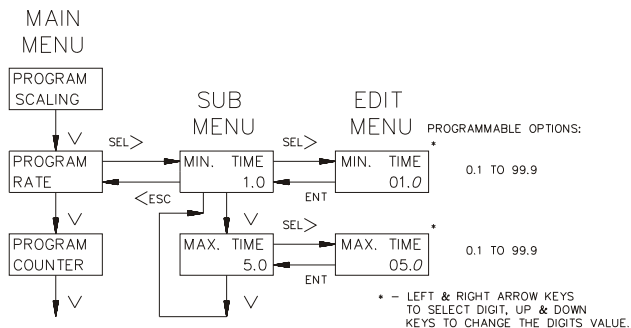
The Rate value calculation uses the method in which the time measured between the first and last pulse is the measurement period. When the minimum update time has expired, the unit will end the measurement period on the next negative going edge. The unit will count the number of pulses that occurred during the measurement period and multiply them by the rate scale factor, scale multiplier, and rate conversion factor. The result is divided by the actual measurement period, to obtain the Rate display value. The unit will update the rate display at the end of the measurement period. If the unit does not receive a negative edge within the maximum update time from the start of the measurement period, the unit will end the time period and the rate display will go to zero. At very slow count rates the measurement period will be the actual period of one count cycle, as long as the input rate frequency is not longer than the maximum update time. The rate indicator will only use the falling edge of the Input A signal.

*Note: The minimum update time must be equal or less than 65536 divided by the maximum operating frequency (in Hz) or the internal rate counter will overflow. For example, if the maximum operating frequency is 10,000 Hz, the minimum update time must be less than 6.5 sec. (65,535 ÷ 10,000 = 6.5).*

BASIC TIMING DIAGRAMS FOR RATE OPERATION

ONE COUNT CYCLE MEASUREMENT

AVERAGE CYCLE MEASUREMENT
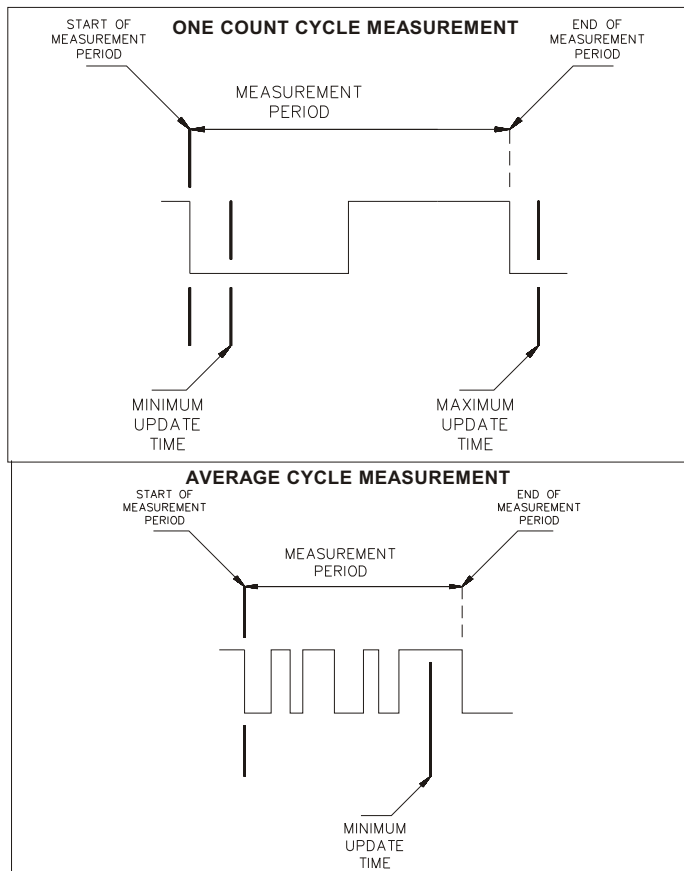
PROGRAM COUNTER MODULE

In the Counter Module, the count mode, reset action, and automatic reset capability are selected. The following flowchart shows only the Counter portion:
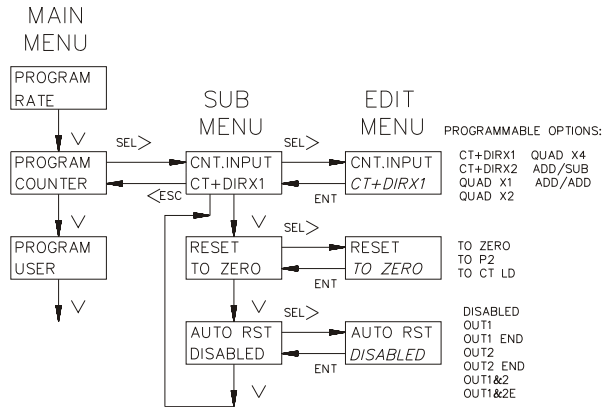
COUNT MODES

There are seven available count modes, which can be used with the separate external Inhibit terminal. Input A signal is used for count and the rate input. Input B is used in combination with Input A for Count Control Direction, Quadrature counting, Anti-coincidence Add/Subtract or Anti-coincidence Add/Add counting applications.

CT+DIRX1 (X1 COUNTING WITH DIRECTION)

The unit will count one count on every negative edge of the input signal at Input A. The direction of the count is determined by the logic state of Input B. A high level at Input B will cause the unit to count in a positive direction. A low level will cause the unit to count in a negative direction. The rate display is NOT affected by the logic state of Input B.

CT+DIRX2 (X2 COUNTING WITH DIRECTION)

The unit will count one count on every negative edge of the input signal and one count on every positive edge of the input signal at Input A. In this mode, the input signal is effectively doubled. The direction of the count is

determined by the logic state of Input B. A high level at Input B will cause the unit to count in a positive direction. A low level will cause the unit to count in a negative direction. The rate display is NOT affected by the state of Input B.

QUAD X1 (QUADRATURE X1)

Quadrature counting modes are primarily used in positioning and anti-jitter applications. The reason this mode works is due to the manner in which the two incoming pulses are positioned relative to each other. The pulse signal on Input B is shifted 90° away from the pulse signal at Input A. These two signals are processed by the Legend as follows:

Input A serves as the count and rate input, while Input B serves as the quadrature input. For quadrature with single edge counting, the counter will count in a positive direction when Input A is a negative going edge and Input B is at a low level. The counter will count in a negative direction when Input A is a positive going edge and Input B is at a low level. All transitions on Input A are ignored when Input B is at a high level. These logic rules provide the basis for anti-jitter operation which will prevent false counts from occurring due to back-lash, vibration, chatter, etc.

QUAD X2 (QUADRATURE X2)

When two edge counting is used, the quadrature mode works the same as with single edge counting when Input B is low. But when Input B is a high level, counts at Input A are no longer ignored. Instead, the logic rules for Input A are complemented, allowing both edges of Input A to be counted. This doubles the effective resolution of the encoded input.

QUAD X4 (QUADRATURE X4)

This mode takes the quadrature mode, with two edge counting, one step further. In quadrature times 4, both Input A and Input B serve as the count or quadrature input, depending on their state. In one instance, Input A will serve as the count input and Input B will serve as the quadrature input. In another instance, Input A will be the quadrature input and Input B will be the count input. This enables each edge, positive and negative going, of both inputs, 1 and 2, to be counted. This results in a resolution four times greater than in the basic quadrature X1 mode. As in the other modes, Input A is also used for the rate input.

ADD/SUB (TWO INPUT ANTI-COINCIDENCE ADD/SUBTRACT)

This mode effectively separates count pulses that may simultaneously appear at the two inputs. The Legend unit processes the count pulses into a string of time-separated pulses, so the internal counter will not lose any count pulses. Input A serves as the add input *(count increments)* and Input B serves as the subtract input *(count decrements)*.

ADD/ADD (TWO INPUT ANTI-COINCIDENCE ADD/ADD)

This mode effectively sums count pulses that may simultaneously appear at the two inputs. The Legend unit processes the count pulses into a string of time-separated pulses so the internal counter will not lose any count pulses. Input A serves as an add input *(count increments)* and Input B serves as an additional add input *(count increments)*.

RESET ACTION

The count display can be reset to Zero, Preset 2, or to the Counter Load value. The method of reset for the display can be automatic or by a user input. The type of reset from a user input can be a Maintained or Momentary reset (Refer to Program User Module for details). Automatic reset is covered in the next section.

Note: Response time for a manual reset is 10 msec maximum.

RESET TO ZERO

When reset, the Counter Display value will return to Zero.

RESET TO PRESET 2

When reset, the Counter Display value will return to the Preset 2 value. Output 2 triggers when the count reaches zero.

RESET TO COUNTER LOAD

When reset, the Counter Display value will return to the Counter Load value.

AUTOMATIC RESET

The Automatic reset mode can be enabled or disabled. The Counter display will automatically reset to the programmed reset action when one of the automatic reset modes is selected. A manual reset by a user input will cause the count to reset regardless of the automatic reset mode. The following choices are available:

OUT 1 (Reset at Beginning Of Output 1):

In this mode, the counter will reset when the count equals the preset 1 value. Output 1 can be timed or latched.

OUT 1 END (Reset at End Of Timed Output 1):

In this mode, the counter will reset after output 1 has timed out.

OUT 2 (Reset at Beginning Of Output 2):

In this mode, the counter will reset when the count equals the preset 2 value. Output 2 can be timed or latched.

OUT 2 END (Reset at End Of Timed Output 2):

In this mode, the counter will reset after output 2 has timed out.

OUT 1 & 2 (Reset at Beginning Of Output 1 or Output 2):

In this mode, the counter will reset when the count equals either preset 1 or preset 2 value. Outputs 1 and 2 can be Timed or Latched.

OUT 1 & 2E (Reset at End Of Timed Output 1 or Output 2):

In this mode, the counter will reset after output 1 or output 2 has timed out.

NOTES

1. For Auto Reset modes, when operating between approximately ½ to maximum count rate, all other presets should not occur within 1 to 6 counts following the count value at which Auto Reset occurs. In Reset to Zero modes, with positive preset values, this would apply to preset values between 0 to 6 counts less than the Preset 2 value *(when positive)*.

2. For Auto Reset at Out2 or Out1 & 2 modes, Output 1 will not activate if Preset 1 is set to the same value as Preset 2 or Zero *(for Reset to Preset or Counter Load mode)*.

PROGRAM USER MODULE

There are five User Inputs, three external User Inputs and two front panel Function keys, which have a variety of programmable capabilities. A rear terminal User Input is active when tied to common. A front panel function key is active when pressed. The priority of order for the rear terminal user inputs is USR INP3, USR INP2, and USR INP1 with USR INP3 the highest priority. The F2 front panel button has the highest priority between the F1 and F2 user input buttons.

The options for each User input are the same, except the two Function keys *(F1 & F2/RST)*, which DO NOT have the Program Disable *(PGM.DIS.)* option. The operator can select only one option for each User Input.

Note: The user input must NOT be active when selecting an option.

In this module, the operator may have to enter a second sub-menu for some options before entering the edit menu. The following flowchart shows only the User portion:
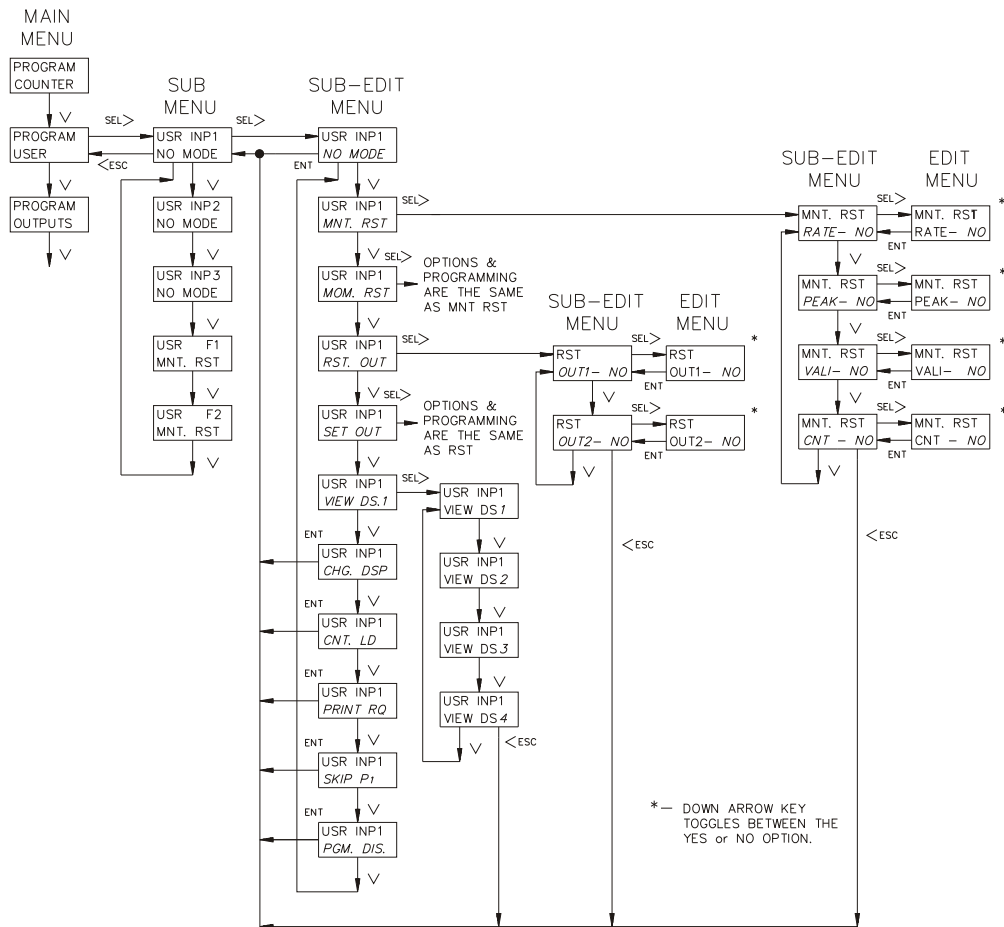
NO MODE

If a User Input terminal or a Function key is activated it will be ignored.

MAINTAINED RESET (MNT RST)

Maintained reset has four selectable options, in which any or all can be selected in the edit menu by selecting YES or NO using the UP and DOWN arrow keys. When using the maintained reset with a small preset value, the Inhibit input should be used with maintained reset, if the signal is present at the input when the reset is activated.

RATE: Resets the measurement period. The rate display value will be the last reading obtained before the reset. The next reading will occur after the release of the reset and the expiration of the measurement period. The Rate display will not reset to zero.

PEAK: Resets the peak value to the current rate value.

VALLEY: Resets the valley value to the current rate value.

COUNT: Resets the count value to the programmed reset action.

With Maintained reset, the value is held reset as long as the User Input or Function key is active. The unit will start updating the appropriate display when no longer in reset. Maintained reset is level sensitive and overrides an automatic reset mode.

MOMENTARY RESET (MOM RST)

Momentary reset has the same four selectable options as Maintained Reset. With Momentary reset, the value resets when the user input or function key is activated. The value will start updating (counting) after the reset action has occurred, even if the user input or function key is still active. Momentary reset is negative edge sensitive and overrides an automatic reset mode.

RESET OUTPUT (RST OUT)

The operator can select to have Output 1 and/or Output 2 reset. If the output is active, it will reset to its inactive state when the user input or function key is activated. This is a momentary reset.

Note: The inactive state of an output can be ON or OFF depending on what the Phase is programmed for in the Program Outputs Module.

SET OUTPUT (SET OUT)

The operator can select to have Output 1 and/or Output 2 set. If the output is inactive, it will go (set) to its active state when the user input or function key is activated. If an output is programmed with a time delay and this user input is activated, the output will **NOT** latch, but will time out after the time delay value expires. This is a momentary reset.

Note: The active state of an output can be ON or OFF depending on what the Phase is programmed for in the Program Outputs Module.

VIEW/FREEZE DISPLAY (VIEW DS1)

When a User Input is activated, an indication display will be viewed and the numeric value for that display will be held. If the operator is in the main display loop, the unit will advance to the indication display to be viewed. If more than one user input is used for this option, the input with the highest priority will be the only one that will hold (freeze) the display. Also, it will be the only input, when activated, that will advance to the indication display from the main display loop. Any other user input programmed, will only advance in the indication display loop. DS1 selects display 1, DS2 display 2, DS3 display 3, and DS4 display 4. The values that are viewed/frozen on the display are determined by what is selected in the Program Displays Module.

*Note: If an external and a front panel user input are both selected for this option, the display will be viewed but the numeric value will **NOT** freeze when either user input is activated.*

CHANGE DISPLAY (CHG DSP)

In the indication display loop, when a user input is activated, the indication display will toggle to the next indication display. The change display is a momentary action.

COUNTER LOAD (CNT LD)

When a user input is activated, the count value is reset to the counter load value regardless of the reset action mode. The counter load is a maintained action.

PRINT REQUEST (PRINT RQ)

When a user input is activated, the unit transmits all the information selected in the Print Options Module via the RS485 serial port. The print request is a maintained action.

PROGRAM USER MODULE (Cont'd)
SKIP PRESET 1 (SKIP P1)

Output 1 will NOT activate and an automatic reset will NOT occur when the count value equals preset 1 if the user input is active. This mode is typically used with the Automatic Reset at output 1 or output 2 mode, or the reset after timed output 1 or 2 mode. The skip preset 1 is maintained.

PROGRAM DISABLE (PGM. DIS.)

Only one external User Input can be used for this option. This option used with the Program Disable DIP switch can limit operator access to programmable parameters (Refer to Operator Accessible Functions With Program Disable section). The program disable is maintained.

PROGRAM OUTPUTS MODULE

Presets 1 and 2 activate solid state Outputs 1 and 2 respectively. The outputs can be assigned to either the Count or Rate display and the preset values will automatically be assigned to the appropriate display. The relays operate in parallel with the solid state outputs on the optional relay board. A manual reset will override a timed output. If boundary or latched is selected for the output mode, the time value will not appear as an option.

Program Output 2 has the same programmable options as Output 1, except the "OUT1 END" Sub-menu will be "OUT2 END" and the options are: DISABLED, @OUT1, @OUT1END. The following flowchart shows only the Outputs portion:

PHASE

The positive (+) phase of an output indicates that when the display value equals the preset value, the output will turn on. When the output is reset it will be turned off.

A minus (-) phase mode refers to the complementing of the logic state of the output. When the display value equals the preset value, the output will turn off. The reset condition of the output is the on state. When an output is changed to the other phase it will not take effect until a manual reset or power down is performed.

Note: The state of the relay, if used, will be the same as the solid state output.
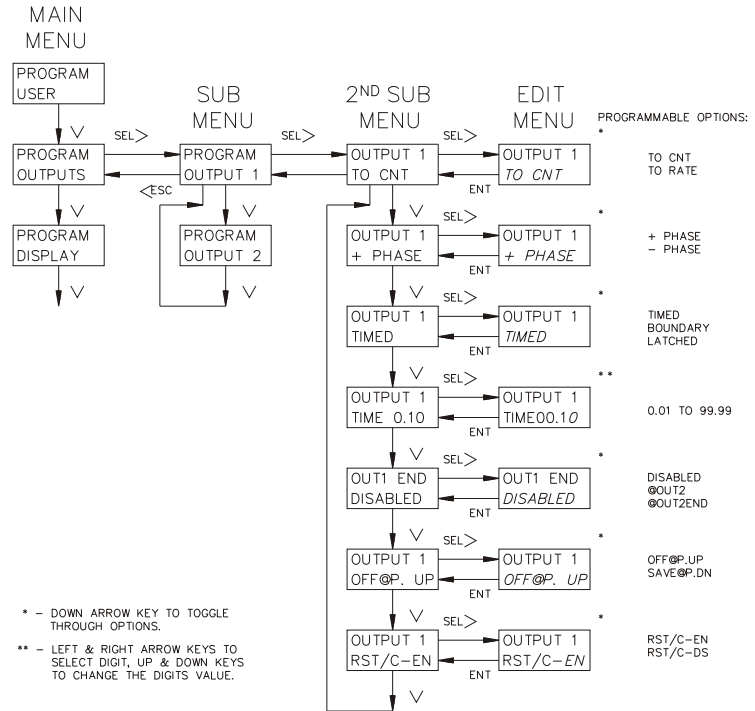
TIMED, LATCHED, OR BOUNDARY

Timed Mode can be programmed from 0.01 to 99.99 seconds. When the display value equals the preset value, the output will be active for the time selected. After the time value expires, the output will return to its inactive state. An output may appear to be latched if the time delay is longer than the time required for the counter to reach the preset value. When an output is assigned to the rate display, the output will appear to be latched, if the output time delay is greater than the Minimum Update Time. The output will deactivate when the rate drops below the preset value and the output time expires.

An output selected for Latch will activate when the display value equals the preset value. The output will stay active until it is manually reset by a User Input selected for that function. When the unit is reset, the output will return to its inactive state.

An output selected for the Boundary mode will be active when the display value is greater than or equal to the positive preset value. If the display value is less than the positive preset value, the output will be inactive. For negative preset values, the output will be active when the count value is less *(more negative)* than the negative preset value. The output will be inactive when the display value is greater *(more positive)* or equal to the negative preset value. If an output is programmed for boundary, the Output End (Reset) Modes will not be applicable and therefore will not appear in the display.

OUTPUT END (RESET) MODES

The Output End modes operate with a timed or latched output mode. If either output is selected as boundary and/or rate, the Output End modes will **NOT** be available.

OUTPUT 1
> @ **OUT 2 (Output 1 End at Output 2 Start):**
>> Output 1 will reset, return to its inactive state, when output 2 becomes active.
> @ **OUT 2 END (Output 1 End at Timed Output 2 End):**
>> Output 1 will reset, return to its inactive state, when output 2's time delay expires.

OUTPUT 2
> @ **OUT 1 (Output 2 End at Output 1 Start):**
>> Output 2 will reset, return to its inactive state, when output 1 becomes active.
> @ **OUT 1 END (Output 2 End at Timed Output 1 End):**
>> Output 2 will reset, return to its inactive state, when output 1's time delay expires.

OUTPUT POWER UP STATE (OFF @ P.UP OR SAVE @ P.DN)

Each output can be programmed individually to have the state of the output OFF at power up (OFF@P.UP) or saved at power down (SAVE@P.DN). The save at power down option will restore the state of the output to what it was at power down when power is restored. The save at power down option DOES NOT restore a timed output to the active state if the output was active at power down. The OFF at power up option refers to the active state of the output, which is determined by the Output Phase.

RESET OUTPUT WITH COUNT (RST/C-EN OR DS)

The Reset with Count Enabled will reset the output when a manual reset of the Count or Rate display is performed by a user input. If Reset with Count is Disabled, the output will **NOT** reset when a manual reset is performed on the Count value.

PROGRAM DISPLAY MODULE

Each of the indication displays are programmed individually. Each line of each indication display can be programmed to show mnemonics (MNE), a numeric value (VAL), output status, a preset value, or the counter load value. If a display shows the mnemonic and numeric value of the same parameter, each on a separate line of the same display the full mnemonic will be displayed as follows:

RATE
PEAK
VALLEY
COUNT

If an indication display is to show two different numeric values, one for each line, then there will be a single or dual character mnemonic to the left of the numeric value. This will also be the same if one line is programmed for output status, preset value, or counter load value and the other a numeric value.

DISPLAYS 1 - 4

Each line of each display has the same programmable options. MNE is the abbreviation for Mnemonics and VAL is for value.

The following is a list of the single or dual character mnemonics that will be displayed:

R   –   Indicates the Rate Value.
Rp   –   Indicates the Rate Peak Value.
Rv   –   Indicates the Rate Valley Value.
C   –   Indicates the Counter Value.
O-■ ■   –   Indicates output status:
                The block (■) to the left will change to the digit 1 when output 1 is active.
                The block (■) to the right will change to the digit 2 when output 2 is active.
P1   –   Indicates Preset 1 Value.
P2   –   Indicates Preset 2 Value.
CL   –   Indicates Counter Load Value.

SCROLL SPEED (SCRO.SPD)

The indication displays can be set to scroll automatically at a 2.5 or 5 second scroll rate. The displays can be selected not to scroll, in which case the up and down arrow keys are used to scroll through the displays.

The following flowchart shows only the Display portion:
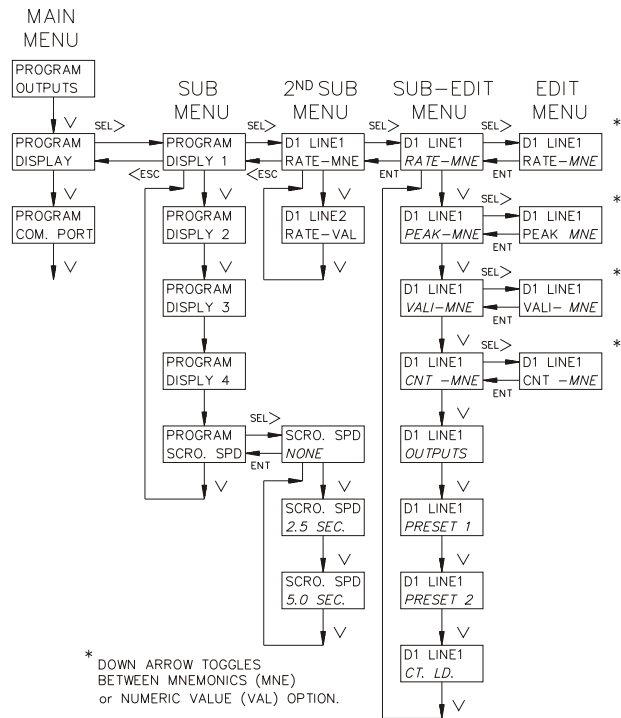
PROGRAM COMMUNICATION PORT MODULE

When communicating to a Legend unit via the serial port, the data formats of both units must be identical. The Baud Rate and Parity Bit are selected for the data format in this module along with the Unit address and Serial transmit delay. Serial communication is covered in detail in the RS485 SERIAL COMMUNICATIONS SECTION. The following flowchart shows only the Communication portion:
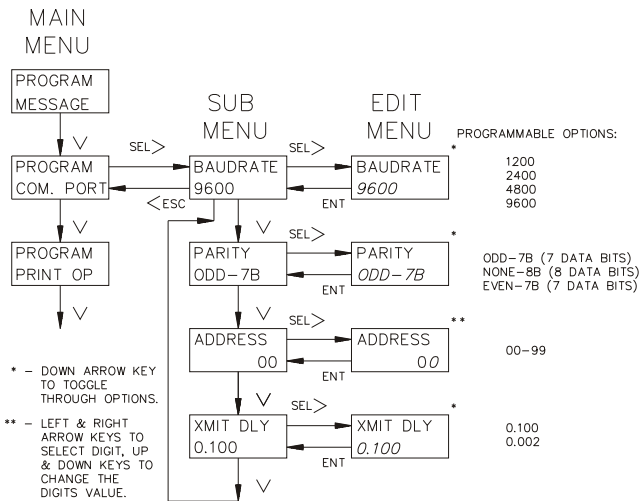
BAUD RATE

The Baud Rates available are: 1200, 2400, 4800, and 9600 Baud.

PARITY

The Parity can be ODD, EVEN, or No parity.

UNIT ADDRESS

Allows multiple units on a single pair of wires with each unit capable of having a different address. If only one unit is on the line an address of zero can be used, eliminating the need for an address command. The address numbers range from 00 to 99.

SERIAL TRANSMIT DELAY

The Serial Transmit Delay is the amount of time the Legend unit will wait to transmit data to a peripheral unit. The time will begin after the Legend receives a command to transmit data or when a print request is received. The delay can be set for 0.002 or 0.100 second.

PROGRAM PRINT OPTIONS MODULE

A print operation occurs when a user input, programmed for the print request function, is activated or when a "P" command is sent via the serial communications port. The unit will transmit the values selected as *"YES"* in this module.

When transmitting data, the unit can be programmed to suppress the address number, mnemonics, and some spaces by selecting NO for the MNE (mnemonics). A selection of NO results in a faster transmission and may be useful when interfacing with a computer. However when interfacing with a printer, sending mnemonics is usually desirable. An example of sending and NOT sending mnemonics are shown below:

<div align="center">

6 CNT   123.8<CR><LF>

123.8<CR><LF>

</div>

If a display is in an overflow condition, an asterisk will precede the digits that are printed (ex. positive overflow * 2178, negative overflow *- 2178).

Serial transmissions are covered in detail in the serial communications section.

The following flowchart shows only the Print portion:
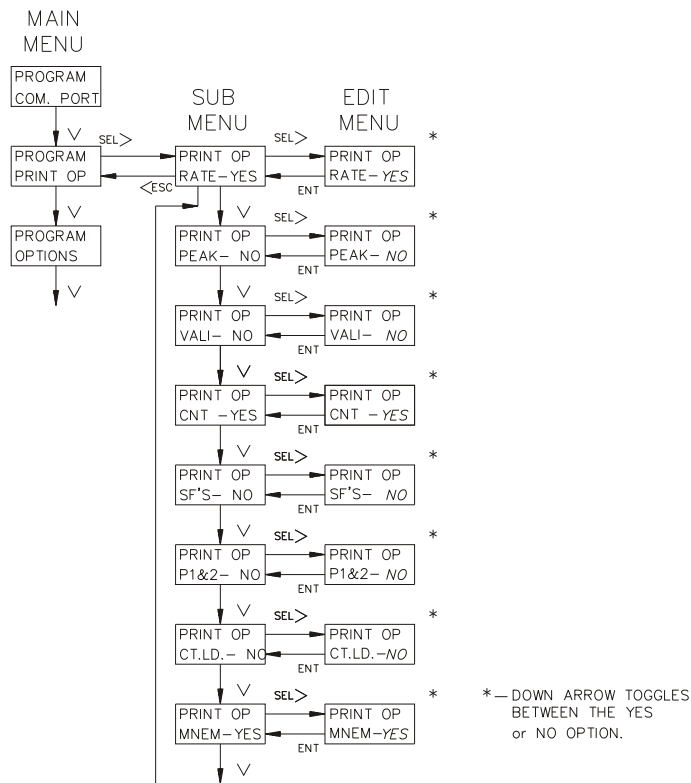
PROGRAM OPTIONS MODULE

The Program Options Module is used to enable or disable the Operator Accessible functions, Preset Tracking selections, or load the Factory settings.

The following flowchart shows only the Options portion:

OPERATOR ACCESS

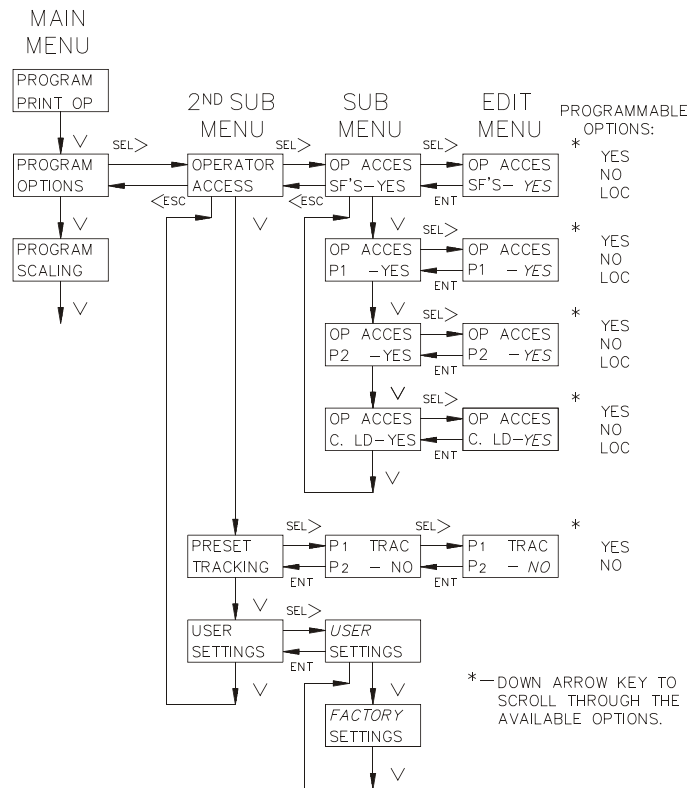The Operator Access menu is used with the Program Disable DIP switch and/or an external User Input selected for program disable. Values can be set for YES, NO, or LOC. When a value is selected for NO, the operator can view the value, but CANNOT change it from the front panel keypad (See Front Panel Accessible Functions With Program Disable for details). Values selected for LOC do not appear in the displays outside of the programming loop. The following values can be disabled from front panel access programming:

Preset 1	Counter Load value
Preset 2	Scale Factors

PRESET TRACKING

If Preset 1 Tracking Preset 2 is enabled, and the Preset 2 value is changed, the Preset 1 value will also change by the same offset. The amount of offset between Preset 1 and Preset 2 is changed by changing the Preset 1 value first. For example, if Preset 2 is 100 and it is desired that Preset 1 occurs 20 counts before Preset 2, the Preset 1 value would be set to 80. If Preset 2 is then changed to 200, Preset 1 will automatically change to 180, maintaining the same 20 count offset.

USER SETTINGS

This module should only be entered if the operator wants to reset ALL parameters to the factory settings. When the word *"FACTORY"* is flashing in the display and the ENT key is pressed, all parameters will be set to the factory settings when exiting the programming loop. The operator can exit the factory settings option WITHOUT resetting all parameters by pressing the <ESC key. The following are the settings when shipped from the factory, along with a chart for user settings:

CAUTION: If factory settings are selected, all programming by the user will be reset.

LGD FACTORY SETTINGS

PRESETS:

P1	500
P2	1000
Counter Load	-100

COUNT:

Scale Factor	1.0000
SCM	X1
Decimal Point	0
Input	CT+DIRX1
Reset to	ZERO
Auto Reset	DISABLED

RATE:

Scale Factor	1.0000
SCM	X1
Decimal Point	0
Rate Per	SECOND
Min. Time	1.0
Max. Time	5.0

USER INPUTS:

User Input 1	NO MODE	
User Input 2	NO MODE	
User Input 3	NO MODE	
User Key F1	Maintain Reset	
	RATE	NO
	PEAK	YES
	VALLEY	YES
	COUNT	NO
User Key F2	Maintain Reset	
	RATE	NO
	PEAK	NO
	VALLEY	NO
	COUNT	YES

OUTPUTS:

Output 1:	
Assigned	TO COUNT
Phase	+ PHASE
Type	TIMED
Time Delay	0.1
OUT1 END	DISABLED
Status	OFF@P.UP
Reset w/Cnt	ENABLED
Output 2:	
Assigned	TO COUNT
Phase	+ PHASE
Type	TIMED
Time Delay	0.1
OUT2 END	DISABLED
Status	OFF@P.UP
Reset w/Cnt	ENABLED

DISPLAYS:

Display 1:	
Line 1	RATE-MNE
Line 2	RATE-VAL
Display 2:	
Line 1	PEAK-MNE
Line 2	PEAK-VAL
Display 3:	
Line 1	VALI-MNE
Line 2	VALI-VAL
Display 4:	
Line 1	CNT- MNE
Line 2	CNT- VAL
Scroll Speed	NONE

COMMUNICATIONS:

Baud rate	1200
Parity	ODD
Address	00
Xmit Delay	0.100

PRINT OPTIONS:

Rate	YES
Peak	NO
Valley	NO
Count	YES
Scale Factors	NO
P1 & P2	NO
Counter Load	NO
Mnemonics	YES

OPTIONS:

Operator Access:	
Scale Factors	YES
P1	YES
P2	YES
Counter Load	YES
Preset Tracking:	
P1 trac P2	NO

LGD USER SETTINGS CHART

PRESETS:
    P1   _____
    P2   _____
    Counter Load   _____

COUNT:
    Scale Factor   _____
    SCM   _____
    Decimal Point _____
    Input   _____
    Reset to   _____
    Auto Reset   _____

RATE:
    Scale Factor   _____
    SCM   _____
    Decimal Point _____
    Rate Per   _____
    Min. Time   _____
    Max. Time   _____

USER INPUTS:
    User Input   _____
                  _____
                  _____
                  _____

    User Input 2   _____
                  _____
                  _____
                  _____

    User Input 3   _____
                  _____
                  _____
                  _____

    User Key F1   _____
                  _____
                  _____
                  _____

    User Key F2   _____
                  _____
                  _____
                  _____

LGD USER SETTINGS CHART (Cont'd)

OUTPUTS:
    Assigned   _____
    Output 1:   _____
      Phase   _____
      Type   _____
      Time Delay   _____
      OUT1 END   _____
      Status   _____
      Reset w/Cnt   _____
    Output 2:   _____
      Assigned   _____
      Phase   _____
      Type   _____
      Time Delay   _____
      OUT2 END   _____
      Status   _____
      Reset w/Cnt   _____

DISPLAYS:
    Display 1:
      Line 1   _____
      Line 2   _____
    Display 2:
      Line 1   _____
      Line 2   _____
    Display 3:
      Line 1   _____
      Line 2   _____
    Display 4:
      Line 1   _____
      Line 2   _____
    Scroll Speed   _____

COMMUNICATIONS:
    Baud rate   _____
    Parity   _____
    Address   _____
    Xmit Delay   _____

PRINT OPTIONS:
    Rate   _____
    Peak   _____
    Valley   _____
    Count   _____
    Scale Factors   _____
    P1 & P2   _____
    Counter Load   _____
    Mnemonics   _____

OPTIONS:
    Operator Access:
      Scale Factors   _____
      P1   _____
      P2   _____
      Counter Load   _____
    Preset Tracking:
      P1 trac P2   _____

RS485 SERIAL COMMUNICATIONS

RS485 communications allows for transmitting and receiving of data over a single pair of wires. This feature can be used for monitoring various values, resetting output(s), and changing values, all from a remote location. Typical devices that are connected to a Legend unit are a printer, a terminal, a programmable controller, or a host computer.

The RS485 differential (balanced) design has good noise immunity and allows for communication distances of up to 4000 feet. Up to 32 units to be connected on a pair of wires. The unit's address can be programmed from 00 to 99. An Optional RLC Serial Converter Module (RS422 to 20 mA current loop) can be installed to expand the unit's flexibility.

PROGRAMMING SOFTWARE

Software for IBM® compatible PCs is available to program all of the Legend configuration parameters such as User Inputs, count modes, etc. The software allows unit configurations to be created, uploaded, downloaded, and saved to a file for rapid programming of the Legend. Before using the programming software, the Legend unit should be powered up and the version number recorded. This information is needed to take full advantage of the programming software capabilities.

Note: While using the Legend Programming Software, the Legend unit should NOT be controlling a process. If the unit is connected while uploading or downloading the configuration files, unit operation will be interrupted and counts will be missed.

MINIMUM REQUIREMENTS:
IBM® compatible 286 or better.
Minimum of 450 K FREE conventional memory.
MSDOS 3.3 or later.
RS232 or RS485 serial port with ID of COM1 or COM2.
Video TEXT mode of 80 columns x 25 rows.
Mouse supported.

INSTALLING SOFTWARE

A backup copy should be made of the program disk. The program may be run using the floppy drive, or it may be installed to a Hard drive. To install on the hard drive, copy all files from the program disk to the desire directory on the hard drive.

Refer to the "SERIAL CONNECTIONS" section of the manual for connecting the Legend unit to a computer.

USING SOFTWARE

To start the Legend Programming Software (SFLGP) switch to the disk/directory that contains the Software. Type SFLGP and press ENTER. The software will display an opening screen that displays the current version of the Legend Programming Software. Press ENTER to proceed to the main editing screen. The screen is divided into four areas. The top of the screen contains a pull-down menu that allows actions such as uploading and downloading of a file. The bottom of the screen displays an alternate method of accessing the pull-down menu selections by using the F1-F8 keys in combination with the ALT key. The middle section displays the programming parameters of the current file and model of Legend. Below the pull-down menu is the file status information that indicates the current file name, model and available message/mnemonic memory available. Multiple pages are used to display all of the programming parameters. To change the page displayed press PGUP/PGDN or use the mouse to click on the arrows located at the upper and lower right of the screen.

Uploading/Downloading of files from the Legend requires that the Baud Rate and Unit Address of both the Legend and the SFLGP be identical. Prior to performing either an upload or a download, a menu of the current PC communications settings will be displayed. These settings may be modified before proceeding with the intended action. Once the action is started, the Legend will display "TX'ING PROGRAM" if uploading or "RX'ING PROGRAM" if downloading. Uploading is file transfer from the LEGEND to the PC and Downloading is file transfer from the PC to the Legend.

COMMUNICATION FORMAT

The half-duplex communication operation sends data by switching voltage levels on the common pair of wires. Data is received by monitoring the levels and interpreting the codes that were transmitted. After the Legend receives a Transmit Command or Print Request, it will wait the Serial Transmit Delay time before it will begin transmitting data. The serial transmit delay can be programmed for 0.002 or 0.100 second. In order for data to be interpreted correctly, there must be identical formats and baud rates between the communicating devices. The formats available for the Legend unit are 1 start bit, 7 data bits, No parity (Parity Bit = 0) or 1 parity bit (odd or even) and 1 stop bit. The baud rates are programmable and the choices are; 1200, 2400, 4800, or 9600 baud.

10 BIT DATA FORMAT

1 START BIT — 7 DATA BITS — PARITY BIT ODD — 1 STOP BIT

T0 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10
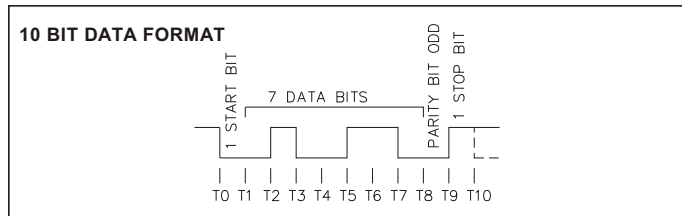
Before serial communication can take place, the unit must be programmed to the same baud rate and parity as the connected equipment. In addition, the loop address number and print options should be known. When used with a terminal or host computer and only one unit is employed, an address of zero (00) may by used to eliminate the requirement for the address specifier when sending a command. If more than one unit is on the line, assignment of unique non-zero addresses is required.

SENDING COMMANDS AND DATA

When sending commands to the Legend unit, a command string must be constructed. The command string may consist of command codes, value identifiers, and numerical data. Below is a list of commands and value identifiers that are used when communicating with the LGD unit.

COMMAND	DESCRIPTION
N (4EH)	Address command; Followed by a one or two digit address number 1-99.
P (50H)	Transmit print options command; Transmits the options selected in the Program Options Module section.
R (52H)	Reset value command; Followed by one Value Identifier (E, I, J, O, 1, or 2).
T (54H)	Transmit value command; Followed by one Value Identifier (A-O).
V (56H)	Change value command; Followed by one Value Identifier (A-E, or O), then the proper numerical data.

VALUE IDENTIFIERS	MNEMONIC
A (41H) PRESET 1	P1
B (42H) PRESET 2	P2
C (43H) SCALE FACTOR COUNT	SFC
D (44H) SCALE FACTOR RATE	SFR
E (45H) COUNT	CNT
H (48H) RATE	RT
I (49H) PEAK	PEK
J (4AH) VALLEY	VAL
O (4EH) COUNTER LOAD	CLD
1 (31H) OUTPUT 1	N/A
2 (32H) OUTPUT 2	N/A

*Note: Command identifiers other than those listed should **NOT** be transmitted. Otherwise, undefined or unpredictable operation could result.*

The command string is constructed by using a command, a value identifier, and a data value if required. The Data value need not contain the decimal point since it is fixed within the Legend unit, when programmed at the front panel. The Legend will accept the decimal point, however, it does not interpret them in any way. Leading zeros can be eliminated, but all trailing zeros must be present.

EXAMPLE: If a Scale Factor of 1.0000 is to be sent, the data value can be transmitted as 1.0000 or 10000. If a "1" is transmitted, the Scale Factor will be changed to 0.0001.

The Address command is used to allow a command to be directed to a specific unit on the Serial Communications Line. When the unit address is zero, transmission of the Address command is not required. This is done for applications that do not require more than one Legend. For applications that require several units, each Legend on the line must be given a non-zero address. If they are given the same address, a command such as the Transmit Value Command, will cause all the units to respond simultaneously, resulting in a communication collision. All Legends in a multiple unit application should be given an address other than zero. If a unit has an address of zero, it will attempt to process any transmissions from the other Legends as commands. These transmissions fill up the receive buffer of the unit with an address of zero, which may produce unpredictable results.

In a multiple unit configuration an asterisk must be sent to clear the input buffer of all units on the line after a transmit value or print request command is sent to a specific unit on the line.

The Legend will require a maximum of 50 msec to process the asterisk (*).

The command string is constructed in a specific logical sequence. The Legend will not accept command strings that do not follow this sequence. Only one operation can be performed per command string. Below is the procedure to be used when constructing a command string.

1. The first two or three characters of the command string must consist of the Address Command (N) and the address number of the unit (1-99). If the Legend address is zero, the address command and number need NOT be sent.
2. The next character in the command string is the actual command that the Legend is to perform (P, R, T, or V).
3. A Value Identifier is next if it pertains to the command. The command P (print) does not require a Value Identifier.
4. The numerical data will be next in the command string if the "Change Value" command is used.
5. All command strings must be terminated with an asterisk * (2AH). This character indicates to the Legend that the command string is complete and begins processing the command.

Below are some typical examples of properly constructed command strings.

(EX. 1) Change Preset 1 Value to 123.4 on the Legend with an address of 2.

COMMAND STRING: N2VA1234*

(EX. 2) Transmit the Count Value of the Legend unit with an address of 3.

COMMAND STRING: N3TE*

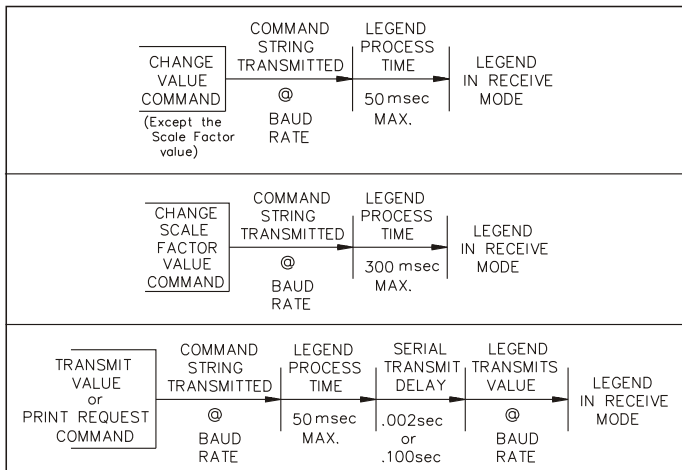**(EX. 3)** Reset Output 1 of the Legend unit with an address of 0.

COMMAND STRING: R1*

If illegal commands or characters are sent to the Legend, the unit will respond by transmitting an error character "E" (45H) in which case the string must be re-transmitted.

When writing application programs in Basic, the transmission of spaces or carriage return and line feed should be inhibited by using the semicolon delimiter with the "PRINT" statement. The Legend will not accept a carriage return or line feed as valid characters.
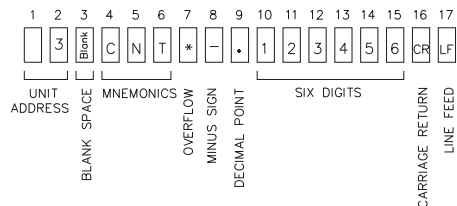
SENDING COMMANDS AND DATA (Cont'd)

It is recommended that a "Transmit Value" command follow a "Change Value" Command. If this is done, the reception of the data can provide a timing reference for sending another command and will insure that the change has occurred. When a "Change Value or Reset Value" command is sent to the Legend, there is time required for the unit to process the command string. The diagrams show the timing considerations that need to be made.

```
                COMMAND      LEGEND
                 STRING      PROCESS
  CHANGE       TRANSMITTED    TIME      LEGEND
  VALUE      ────────────────────────→  IN RECEIVE
  COMMAND         @         50 msec      MODE
(Except the     BAUD        MAX.
 Scale Factor   RATE
 value)
```

```
                COMMAND      LEGEND
  CHANGE         STRING      PROCESS
  SCALE        TRANSMITTED    TIME      LEGEND
  FACTOR     ────────────────────────→  IN RECEIVE
  VALUE           @         300 msec     MODE
  COMMAND        BAUD        MAX.
                 RATE
```

```
              COMMAND    LEGEND    SERIAL    LEGEND
  TRANSMIT     STRING     PROCESS  TRANSMIT  TRANSMITS
  VALUE      TRANSMITTED   TIME     DELAY     VALUE     LEGEND
  or       ──────────────────────────────────────────→ IN RECEIVE
  PRINT REQUEST   @       50 msec  .002sec     @         MODE
  COMMAND        BAUD      MAX.      or       BAUD
                 RATE              .100sec    RATE
```

RECEIVING DATA

Data is transmitted from the Legend when a "T" Transmit Value or a "P" Transmit Print Options command is sent to the Legend via the serial port or when a User Input, programmed for the Print Request function, is activated. The Legend will wait until the serial transmit delay (0.100 or 0.002 sec) time expires and then begin transmissions. The Legend can be programmed to transmit Mnemonics. The format for a typical transmission string with mnemonics is shown below:

```
 1  2   3    4  5 6  7  8 9  10 11 12 13 14 15 16 17
┌──┬──┬─────┬──┬─┬─┬──┬─┬─┬──┬──┬──┬──┬──┬──┬──┬──┐
│  │3 │Blank│C │N│T│* │─│•│1 │2 │3 │4 │5 │6 │CR│LF│
└──┴──┴─────┴──┴─┴─┴──┴─┴─┴──┴──┴──┴──┴──┴──┴──┴──┘
  UNIT   BLANK SPACE  MNEMONICS  OVERFLOW  DECIMAL POINT  SIX DIGITS  CARRIAGE RETURN  LINE FEED
 ADDRESS                         MINUS SIGN
```

The first two digits transmitted are the unit address followed by one blank space. If the unit address is 0, the first locations will be left blank. The next three characters are the mnemonics followed by one or more blank spaces. The numerical data value is transmitted next. Negative values are indicated by a "-" sign. If the numeric value is in an Overflow condition an asterisk (*) will precede the most significant digit of the value. The decimal point position will "float" within the data field depending on the actual value it represents. The numeric data is right justified without leading zeros.

When a "T" command or print request is issued, the above character string is sent for each line of a block transmission. An extra < SP> < CR> < LF> is transmitted following the last line of transmission from a print request to provide separation between print outs.

If Mnemonics are NOT transmitted, just numeric data is sent with no built-in time delay. If the Legend transmits Mnemonics, there is a 400 msec built-in time delay after each transmission string. When interfacing to a printer, sending Mnemonics are usually desirable. Examples of transmissions are shown below:

3 CNT -6732.5< CR> < LF> (400 msec delay)   Mnemonics Sent
    -6732.5< CR> < LF>   NO Mnemonics Sent

The various Print Options are used with a printer or a Computer Terminal. They provide a choice of which Legend data values are to be printed, when either the User Input, programmed for the print request function is activated, or a "P" *(Transmit Print Options)* command is sent to the Legend via the serial port. The Print Options are programmed in the *"Program Print Options"* module, the available options are:

    A. Print Rate Value.
    B. Print Peak Value.
    C. Print Valley Value.
    D. Print Count Value.
    E. Print Scale Factors (Count & Rate) Values.
    F. Print Presets 1 & 2 Values.
    G. Print Counter Load Value.
    H. Print Mnemonics for all Values.

A print out from a Legend unit with an address of 1 and all print options selected is shown below:

1	RT	54
1	PEK	100
1	VAL	0
1	CNT	4000
1	SFC	1.0000
1	SFR	1.0000
1	P1	500
1	P2	1000
1	CLD	-100

When using this program, the Serial Transmit Delay should be set to 0.100 seconds.

SERIAL CONNECTIONS

When wiring, remove the 12-position terminal block, which is the top board at the rear of the unit. Refer to the numbers listed on the top label with the terminal description for installing each wire in its proper location.

The two data (transceiver) wires connect to the TX/RX (+) and TX/RX (-) terminals. It is recommended that shielded (screened) cable be used for serial communications. This unit meets the EMC specifications using Alpha #2404 cable or equivalent. There are higher grades of shielded cable, such as, four conductor twisted pair, that offer an even higher degree of noise immunity.

In some applications a signal ground may be required to establish a ground reference. The signal ground is required if the equipment does not have internal bias resistors connected to the RS485 transceiver lines. The signal ground is connected from only one legend to the RS485 equipment. If necessary the shield can be used as the signal ground.

When all connections are made, replace the terminal block into its proper location.

TERMINAL DESCRIPTIONS
**COMM. -** Common required for some applications.
TX/RX (+) & TX/RX (-) - The Legend transmits and receives on these two terminals which are connected to the external device.
TX EN. - Used primarily to connect Legends in a 20 mA communication loop with other units.

CONNECTING TO A HOST TERMINAL

Six Legend units are used to monitor and control parts packaging machines in a plant. Legend units are located at each machine in the production area of the building. A communication line is run to an Industrial computer located in the production office. The drawing shows the line connection. Each Legend is programmed for a different address and are all programmed for the same baud rate and parity as the computer (ex 9600 baud, parity even). An application program is written to send and receive data from the units using the proper commands.
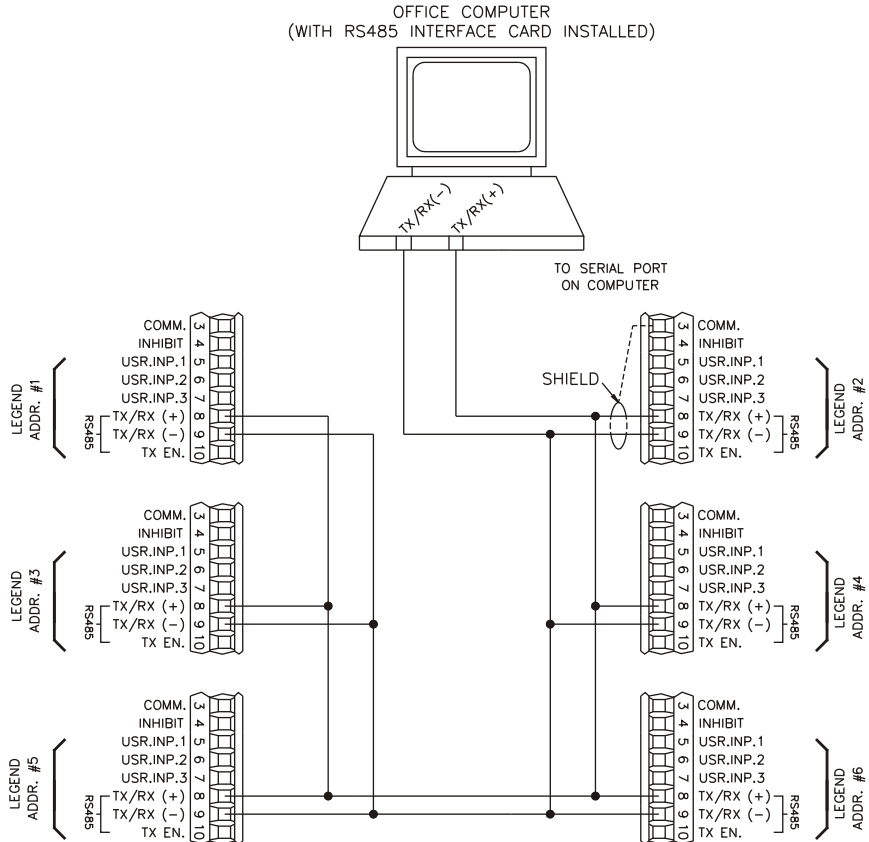
TROUBLESHOOTING SERIAL COMMUNICATIONS

If problems are encountered when interfacing the Legend*(s)* and host device or printer, the following check list can be used to help find a solution.

1. Check all wiring. Refer to the previous application examples and use them as a guide to check your serial communication wiring. Proper polarity of all Legend(s) and other peripherals must be observed.

2. If the Legend is connected to a *"host computer"*, device or printer, check to make sure that the computer or device is configured with the same communication format as the Legend. The communication format the Legend will accept is; 1 start bit, 7 data bits, no parity or 1 parity bit (odd or even), and 1 stop bit.

3. Check the baud rate and parity in the Program Communication Module and make sure all devices on the line are set to the same baud rate and parity.

4. Check the Legend's unit address. If the Address command is not used when transmitting a command to the Legend, the Legend's address must be set to 0. See *"Sending Commands & Data"* section for command structure.

5. If two-way communications are to be established between the Legend and a computer, have the computer receive transmissions from the Legend first. Activating a User Input, programmed for the print request function, will initiate transmissions from the Legend.

6. When sending commands to the Legend, an asterisk * *(2Ah)* must terminate the command. NO CARRIAGE RETURNS (0Dh) OR LINE FEED (0Ah) CHARACTERS SHOULD BE SENT TO THE LEGEND. If they are sent, the Legend will respond by transmitting an "E".

7. In multiple unit configurations, make sure each unit has a different address other than zero. If a transmit value or Print Request command is issued, an asterisk (*) must be sent before sending another transmission.

8. If all the above has been done, try reversing the polarity of the transceiver wires between the Legend*(s)* and the RS485 interface card. Some cards have the polarity reversed.

9. A twisted pair with a signal ground may be needed in some applications to establish a ground reference. The signal ground is required if the equipment does not have internal bias resistors connected to the RS485 transceiver lines. The signal ground is connected from only one legend to the RS485 equipment.

INSTALLATION & CONNECTIONS

INSTALLATION ENVIRONMENT

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.
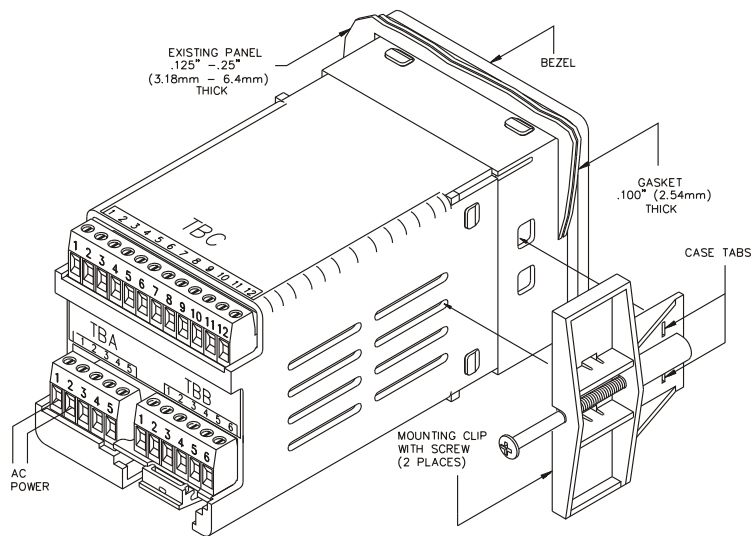
Before installing the Legend into the panel, the user should first become familiar with the unit. Also, it may be desirable to program the unit and set the appropriate DIP switches for the application. When programming is complete, all parameters will be saved in nonvolatile memory. The Program Disable DIP switch used with an external User Input, programmed for the program disable function, provides various levels of security to prevent accidental or unauthorized programming changes.

The unit meets NEMA 4X/IP65 requirements for indoor use when properly installed. The Legend unit is intended to be mounted into an enclosed panel with a gasket to provide a water-tight seal. Two mounting clips and screws are provided for easy installation. Consideration should be given to the thickness of the panel. A panel that is too thin may distort and not provide a water-tight seal, therefore, the recommended minimum panel thickness is 1/8" (3.2 mm). The recommended clearance behind the panel for mounting clip installation is 3.0" (6.45 cm)H x 4.0 (10.16 cm)W.

After the panel cut-out is completed and deburred, carefully apply the gasket to the panel. DO NOT APPLY THE ADHESIVE SIDE OF THE GASKET TO THE BEZEL. Insert the unit into the panel as depicted in the drawing. Thread the screws into the clips until the pointed end just protrudes through the other side. Install each mounting clip by inserting the case tabs of the clip into the holes, located on either side of the bezel. Then snap the rear end of the clip into the case and slide the clip towards the rear of the unit, locking it in place. Tighten the screws evenly to apply uniform compression, thus providing a water-tight seal.

Caution: Only minimum pressure is required to seal panel. Do NOT overtighten screws.

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EMC INSTALLATION GUIDELINES

Although Red Lion Controls Products are designed with a high degree of immunity to Electromagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into a unit may be different for various installations. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed are some EMI guidelines for a successful installation in an industrial environment.

1. A unit should be mounted in a metal enclosure, which is properly connected to protective earth.
2. Use shielded cables for all Signal and Control inputs. The shield connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield to earth ground (protective earth) at one end where the unit is mounted.
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is over 1 MHz.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors, feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run through metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter. Also, Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
4. Long cable runs are more susceptible to EMI pickup than short cable runs.
5. In extremely high EMI environments, the use of external EMI suppression devices such as Ferrite Suppression Cores for signal and control cables is effective. The following EMI suppression devices (or equivalent) are recommended:
   Fair-Rite part number 0443167251 (RLC part number FCOR0000)
   Line Filters for input power cables:
      Schaffner # FN2010-1/07 (Red Lion Controls # LFIL0000)
6. To protect relay contacts that control inductive loads and to minimize radiated and conducted noise (EMI), some type of contact protection network is normally installed across the load, the contacts or both. The most effective location is across the load.
   a. Using a snubber, which is a resistor-capacitor (RC) network or metal oxide varistor (MOV) across an AC inductive load is very effective at reducing EMI and increasing relay contact life.
   b. If a DC inductive load (such as a DC relay coil) is controlled by a transistor switch, care must be taken not to exceed the breakdown voltage of the transistor when the load is switched. One of the most effective ways is to place a diode across the inductive load. Most RLC products with solid state outputs have internal zener diode protection. However external diode protection at the load is always a good design practice to limit EMI. Although the use of a snubber or varistor could be used.
   RLC part numbers: Snubber: SNUB0000
                     Varistor: ILS11500 or ILS23000
7. Care should be taken when connecting input and output devices to the instrument. When a separate input and output common is provided, they should not be mixed. Therefore a sensor common should NOT be connected to an output common. This would cause EMI on the sensitive input common, which could affect the instrument's operation.

Visit RLC's web site for more information on EMI guidelines, Safety and CE issues as they relate to Red Lion Controls products.

WIRING CONNECTIONS

The bottom board has a removable terminal block on the left where the power connections are made. The optional plug-in relay board also has a removable terminal block and is located at the bottom right of the unit. The top board has a removable terminal block where the signal inputs, user inputs, solid state outputs, and serial communications connections are made. When wiring the unit, remove the terminal block and use the numbers on the top label to identify the position number with the proper function. All conductors should meet voltage and current ratings for each terminal. Also cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the unit (AC or DC) be protected by a fuse or circuit breaker. Strip the wire, leaving approximately 1/4" bare wire exposed (stranded wires should be tinned with solder). Insert the wire into the terminal and tighten down the screw until the wire is clamped in tightly. Each terminal can accept up to two 18-gage wires. After the terminal block is wired, install it in the proper location at the rear of the unit. Wire each terminal block in this manner.

A.C. POWER WIRING

The AC power is connected to the bottom left terminals 1 & 2 marked AC PWR. The voltage selector switch, located at the side of the unit, is used to select the proper voltage. The switch is a slide movement type and can be set by using a small screwdriver. If the switch is toward the front of the unit, it is set for 115 VAC input. If the switch is towards the rear of the unit, it is set for 230 VAC input. The switch will be in the 230 VAC position when shipped from the factory.

Note: Before applying power to the unit make sure the A.C. power switch is set for the proper voltage setting.

To reduce the chance of noise spikes entering the AC line and affecting the unit, the AC power should be relatively "clean" and within the specified ±10% variation limit. Connecting power from heavily loaded circuits or circuits that also power loads that cycle on and off, *(contactors, relays, motors, etc.)* should be avoided.

DC POWER WIRING

The DC power is connected to the bottom left terminals 3 & 4 marked +12 VDC and common. The DC power source must be capable of supplying the unit's rated current *(250 mA)* and be within the specified ±20% variation limit. It is not necessary to provide battery backup to retain programmable information. The Legend has nonvolatile memory and information is stored on power down (Refer to block diagram).

SERIAL COMMUNICATIONS

Refer to the RS485 Serial Communications section of the manual, for wiring and operational procedures.

USER INPUT WIRING

Programmable external user inputs are digital inputs that are active when connected to TBC #3 Common. The use of shielded cable is recommended. Follow the EMC Installation Guidelines for shield connection.

OUTPUT WIRING
RELAY CONNECTIONS

To prolong contact life and suppress electrical noise interference due to the switching of inductive loads, it is good installation practice to install a snubber across the contactor. Follow the manufacturer's instructions for installation.

Note: Snubber leakage current can cause some electro-mechanical devices to be held ON.

SIGNAL WIRING
INPUTS A & B

Input A and Input B have the same input circuitry. Input A and Input B each have separate DIP switches for setting the type of signal input. A Magnetic Pickup or Logic Input signal can be sent to either input. When a MAGNETIC PICKUP is used the Sink/Source DIP switch for the appropriate input, must be in the "SRC" position or the unit will not count. The HI/LO FRQ DIP switch will effect the maximum input frequency at that input.

The Input schematic shows the details of Input A and Input B circuitry and share the same common. Each input has three DIP switches associated with its input. The functions of these switches are as follows:

SIGNAL WIRING (Cont'd)

INPUTS A & B (Cont'd)

INPUT A

SW1 - MAG: Sets input for a Magnetic Pickup signal.
  Sensitivity: 200 mV peak; hysteresis: 100 mV.

Note: SW2 and SW5 must be in the "SRC" position for a Magnetic Pickup signal.

  LOGIC: Sets input for a Logic signal.
   Input trigger levels: V_{IL}=1.5 Vmax; V_{IH}=3.75 Vmax.

SW2 - SNK: Provides a 7.8 K internal pull-up resistor for sensors with current sinking outputs.
  SRC: Provides a 3.9 K internal pull-down resistor for sensors with current sourcing outputs.

SW3 - HI FRQ: Removes damping capacitor and allows operation up to the max. frequency.
  LO FRQ: Connects damping capacitor for switch contact debounce. Limits count speed to 50 cps max. Min. count pulse ON or OFF time - 10 msec.

Note: The HI/LO FRQ selection switch must be set on "LO FRQ" when switch contacts are used to generate count input signals. 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. The "LO FRQ" mode can be used with any type of sensor output, provided count pulse widths never decrease below 10 msec, and the count rate frequency does not exceed 50 cps.

INPUT B

SW4 - Same as SW1
SW5 - Same as SW2
SW6 - Same as SW3

Note: A Magnetic Pickup type sensor should not be used unless a large enough signal is provided at all speeds of operation.
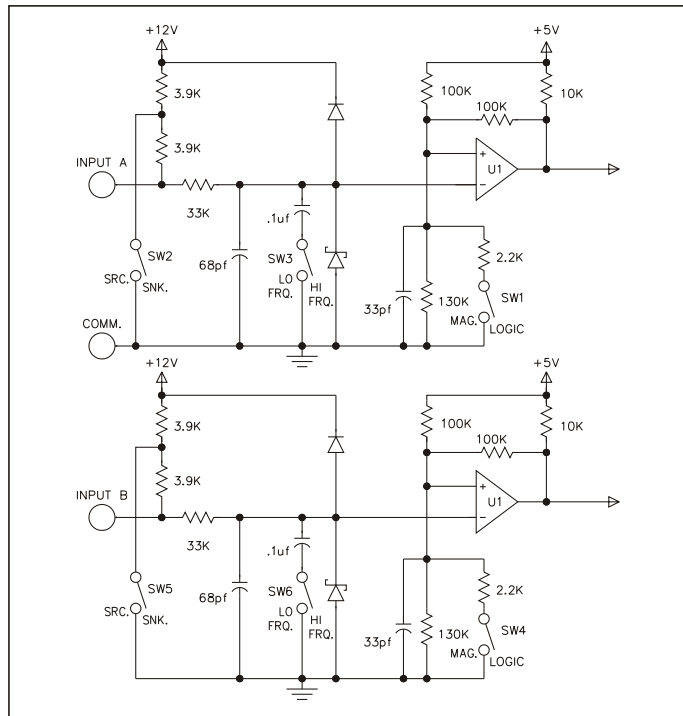
INSTALLATION & REMOVAL OF OPTIONAL RELAY BOARD

To install the relay board, locate the relay opening at the lower right-hand corner, on the back of the Legend. Using a small screwdriver, inserted into the slot of the relay latch, bend the tab down while sliding the board into the two slots in the housing. The relay board will seat into the unit, allowing the tab to return to its original position. To remove the relay board, pull down on the tab just enough to allow the relay board to slide out. Grasp the terminal block and pull to remove the board.
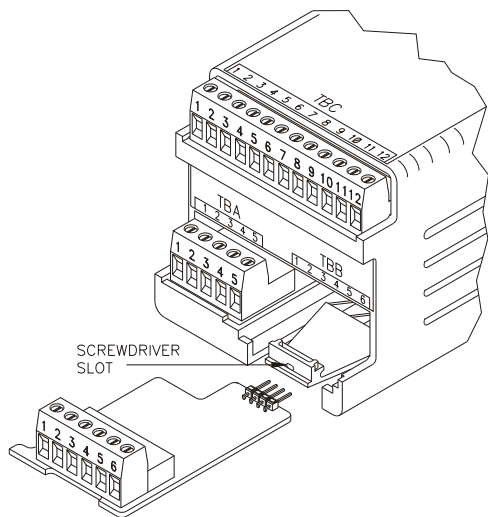
DIP SWITCH SET-UP

The DIP switches are accessible through the side of the Legend. The DIP switch positions and their functions are shown below:
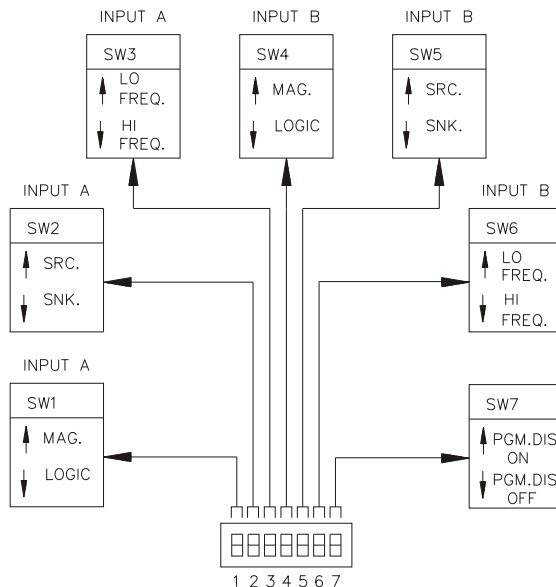
VARIOUS SENSOR OUTPUT CONNECTIONS [See Note 1]

COUNT SWITCH OR ISOLATED TRANSISTOR OUTPUTS

CURRENT SOURCE CONNECTED
(COUNT ON OPENING)

CURRENT SINK CONNECTED
(COUNT ON CLOSING)

SEE NOTE 4 FOR INPUT VOLTAGES GREATER THAN +12V.
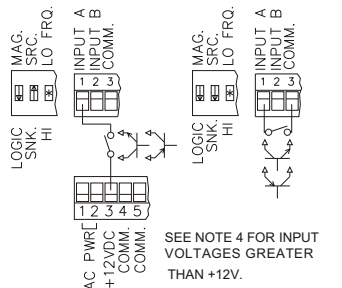
RLC SENSOR MODELS: PR & RR PHOTO-ELECTRICS

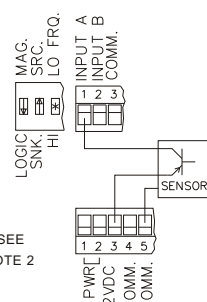### SENSORS WITH -EF OUTPUT-CURRENT SRC CONN.
(COUNT ON FALLING EDGE)

SENSOR WITH +5V EMITTER FOLLOWER OUTPUT
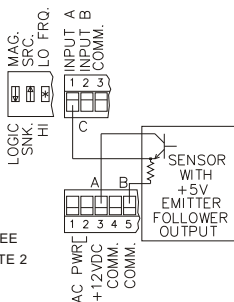
* SEE NOTE 2

RLC SENSOR MODELS: LMP-EC

SENSORS WITH CURRENT SINK OPEN COLLECTOR (NPN O.C.)
(COUNT ON TURN-ON)

NPN O.C.

SHIELD SEE NOTE 3
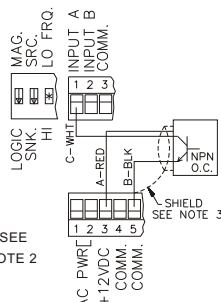
* SEE NOTE 2

RLC SENSOR MODELS: ASTC, LMPC, LSC, PSAC, RPGB, RPGC, RPGH

SENSORS WITH CURRENT SOURCE OUTPUT (PNP O.C.)
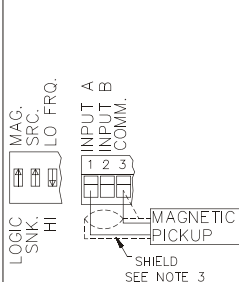(COUNT ON TURN-OFF)

SENSOR

* SEE NOTE 2

2-WIRE PROXIMITY SENSORS

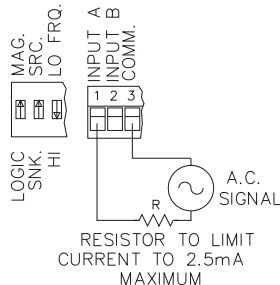CURRENT SOURCE CONNECTED
(COUNT ON CURRENT FALL)
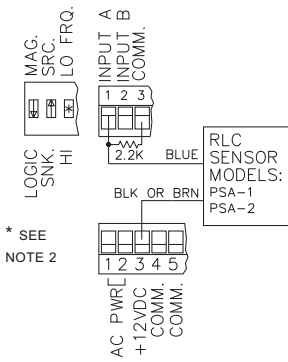
RLC SENSOR MODELS: PSA-1 PSA-2

2.2K   BLUE

BLK OR BRN

* SEE NOTE 2

MAGNETIC PICKUPS

MAGNETIC PICKUP
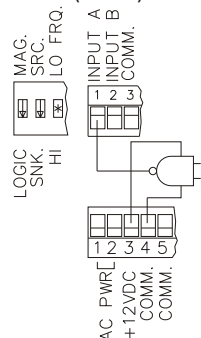
SHIELD SEE NOTE 3

A.C. INPUTS FROM INVERTERS, TACH. GENERATORS, ETC.

A.C. SIGNAL
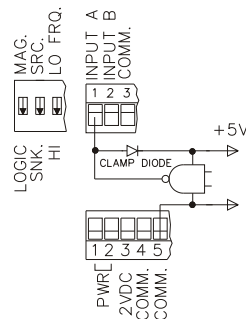
RESISTOR TO LIMIT CURRENT TO 2.5mA MAXIMUM

A.C. SIGNALS OVER 50VAC PEAK SHOULD BE ISOLATED BY A STEP DOWN TRANSFORMER.

INTERFACING WITH CMOS CIRCUITRY (B TYPE)

NOTE: IF EXTERNAL SUPPLY IS USED TO POWER CMOS CIRCUIT VOLTAGE MUST BE ≥ DC OUT VOLTAGE.

INTERFACING WITH TTL

+5V

CLAMP DIODE

NOTE: CIRCUIT SHOWN FOR STD. TTL OUTPUT. TTL CIRCUITS ARE AVAILABLE W/OPEN COLLECTOR OUTPUTS ELIMINATING NEED FOR DIODE CLAMP.

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NOTES:

1. SENSOR VOLTAGE AND CURRENT

The +12 VDC (in/out) terminal can supply voltage to a sensor within a ±25% variation, due to line and internal load variations. All RLC sensors will accommodate this variation.

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. 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. The "LO FRQ" mode can be used with any type of sensor output, provided count pulse widths never decrease below 10 msec, and the count rate frequency does not exceed 50 cps.

3. When shielded cable is used, the shield should be connected to "COMM." at the unit and left disconnected at the sensor end.

4. Inputs A and B 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 the input.

SPECIFICATIONS

1. **DISPLAY:** 2x8, 0.3" (7 mm) high characters, negative image transmissive LCD, with yellow/green or red LED backlighting.
2. **POWER:**
   AC Operation: 115/230 VAC ±10%, 50/60 Hz, 10 VA, switch selectable.
   DC Operation: +12 VDC ±20% @ 250 mA.
3. **MEMORY:** Non-volatile memory retains all programming information. Count and Preset values are written to non-volatile memory when power is interrupted. All other programming parameters are written to memory when programming mode is exited. If power is removed while in the programming menu's, the parameters are restored to previously saved settings.
   Data Retention: 10 yrs. minimum.
4. **SENSOR POWER:** +12 VDC ±25% @ 100 mA.
5. **INPUTS A and B:** DIP Switch selectable to accept count pulses from a variety of sources including switch contacts, outputs from CMOS or TTL circuits, and all standard RLC sensors.
   LOGIC: Input trigger levels $V_{IL} = 1.5$ V_{MAX}; $V_{IH} = 3.75$ V_{MIN}.
   Current sinking: Internal 7.8 KΩ pulled up internally to +12 VDC , $I_{MAX} = 1.9$ mA.
   Current sourcing: Internal 3.9 KΩ pull-down, 7.3 mA @ 28 VDC_{MAX}.
   Debounce: Damping capacitor provided for switch contact bounce. Limits count speed to 50 Hz and input pulse widths to 10 msec minimum.

MAGNETIC PICKUP:
   Sensitivity: 200 mV peak.
   Hysteresis: 100 mV.
   Input impedance: 3.9 KΩ @ 60 Hz.
   Maximum input voltage: 50 Vp
   Note: For magnetic pickup input, the sink/source DIP switch must be in the SRC position.
6. **RATE ACCURACY:** +0.01%.
7. **RATE MINIMUM INPUT FREQUENCY:** 0.01 Hz.
8. **MAXIMUM COUNT RATE IN KHz:**

| MODEL	CNT + DIR		QUAD			ADD/ADD	ADD/SUB
	X1	X2	X1	X2	X4	X1*	X1*
LGD (Dual Preset)	20	10	8.5	7	5	20	10

Notes:

1. Maximum count rates given are for Process counter set for Auto reset with the auto cycle preset set to an equivalent of 100 count pulses or greater. With auto cycle presets less than 100 count pulses, with Count SF = 0.5000 and Count Scale Multiplier = X1, would be 50.

2. Maximum count rate given for X2 & X4 count modes are given for 50% duty cycle signals and Quad signals with 90º phase shift.

* - Inputs' A & B count rates summed.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 3.0" (76.2)H x 4.0" (101.6)W.
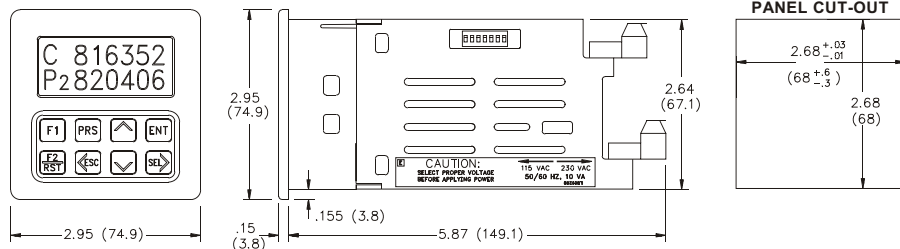
9. **CONTROL INPUTS:**
  Programmable user inputs (3): Internal 10 K   pull-up to +5 VDC, $V_{IL} = 1.0 V_{MAX}$; $V_{IH} = 4.0 V_{MIN}$, response time = 10 msec max.
  Inhibit: Internal 10 K   pull-up to +5 VDC, $V_{IL} = 1.0 V_{MAX}$; $V_{IH} = 4.0 V_{MIN}$.
10. **SERIAL COMMUNICATIONS:**
  Type: RS485 Multi-point Balanced Interface.
    (Can connect up to 32 units on a line.)
  Baud Rate: Programmable from 1200 to 9600.
  Maximum Addresses: Programmable from 00 to 99.
    (Actual number on a line is limited by hardware specifications.)
  Transmit Delay: Programmable for 0.002 or 0.100 second.
  Data Format:
    10 Bit Frame; 1 start bit, 7 data bits, 1 parity bit, and 1 stop bit.
    Parity is programmable for either ODD, EVEN, or No Parity.
11. **OUTPUT(S):**
  Solid-State: Current sinking NPN open collector transistor.
  $V_{CE} = 1 V_{SAT}$ @ 100 mA maximum. $V_{OH} = 30$ VDC maximum.
  (Internal Zener Diode Protection).
  Relay(s): Mounted on field-replaceable P.C. board. Form C contacts rated at 5 amps @ 120 VAC/240 VAC or 28 VDC *(resistive load)*, 1/8 H.P. @ 120 VAC *(inductive load)*. The operate time is 5 msec nominal and the release time is 3 msec nominal.
  Life Expectancy: 100,000 cycles at maximum load rating. *(Decreasing load and/or increasing cycle time, increases life expectancy.)*
  Programmable Timed Output(s): Programmable time ranges from 0.01 to 99.99 seconds, ±0.05% - 11 msec. max.
  Count Boundary Output Response Time: 10 msec
12. **ENVIRONMENTAL CONDITIONS:**
  Operating Temperature: 0 to 50°C
  Storage Temperature: -40 to 70°C
  Operating and Storage Humidity: 85% max. (non-condensing) from 0°C to 50°C.
  Vibration to IEC 68-2-6: Operational 5 to 150 Hz, 2 g.
  Shock to IEC 68-2-27: Operational 20 g (10 g relay).
  Altitude: Up to 2000 meters.

13. **CONSTRUCTION:** High impact plastic case with clear viewing window. The front panel meets NEMA 4X/IP65 requirements for indoor use when properly installed. Installation Category II, Pollution Degree 2. Panel gasket and mounting clips included.
14. **WEIGHT:** 1.5 lbs. (0.68 Kg)

TROUBLESHOOTING GUIDE

For further technical assistance, contact technical support at the appropriate company numbers listed.

PROBLEMS	POSSIBLE CAUSE	REMEDIES
NO DISPLAY	1. Power off 2. Improperly wired 3. Voltage selector switch in the wrong position. 4. Power in a Brown out condition. 5. If powered by +12 VDC source, not enough current to drive Legend unit.	1. Verify power. 2. Check wiring. 3. Check switch position. 4. Verify voltage reading. 5. Verify Source current rating.
CHECKSUM ERROR 1 OR 2 ON DISPLAY	1. Data error detected by processor.	1. Press "ENT" key. a. Check all programming parameters. 2. Check signal lines for possible noise sources.
UNIT DOES NOT COUNT	1. No input signal. 2. Type of input signal incorrectly selected. 3. Count inhibited. 4. Scale factor and/or multiplier value too small.	1. Check sensor connections. a. Verify power to sensor. 2. Check DIP switch setting on side of unit. 3. Disable count inhibit. 4. Check scale factor value and scale multiplier values.
UNIT WILL NOT ACCEPT THE DESIRED PRESET	1. When a count scale factor greater than 1 is used, the preset value must be evenly divisible by the scale factor.	1. Unit automatically adjusts preset to be evenly divisible by the scale factor.
UNIT COUNTS INCORRECTLY	1. Input signal type incorrectly selected. 2. Inputs improperly connected. 3. Electrical noise interference. 4. Incorrect counting mode. 5. Scale factor incorrect.	1. Check DIP switches. Set HI/LO FRQ. switch to LO for a count speed of less than 50 Hz. 2. Check sensor input connections. 3. Check power source for noise. a. Check signal wire routing. 4. Verify programming in "Program Cntr Module". 5. Verify scale factor value.

TROUBLESHOOTING GUIDE (Cont'd)

PROBLEMS	POSSIBLE CAUSE	REMEDIES
COUNT, PEAK, OR VALLEY VALUES WILL NOT RESET WHEN A MANUAL RESET IS PERFORMED	1. User input NOT properly programmed.	1. Verify programming in "Program User Module".
CANNOT ENTER INTO PROGRAMMING MENUS	1. Front panel disabled.	1. Check "Front Panel Accessible Functions With Program Disable" section in manual.
PRESETS, COUNTER LOAD, OR SCALE FACTORS CAN BE VIEWED BUT NOT CHANGED	1. Front panel disabled.	1. Verify programming in "Program Options Module" sub-menu Operator Access. 2. Check "Front Panel Accessible Functions With Program Disable" section of manual.
UNIT COUNTS WHILE RESET IS ACTIVATED	1. User input Reset mode set for Momentary reset.	1. Program User input to a Maintained reset.
OUTPUT WILL NOT RESET	1. Output assigned to wrong display (Count or Rate). 2. Reset with count disabled (Program Outputs Module). 3. User input NOT properly programmed.	1. Verify programming in "Program Outputs Module". 2. Verify programming in "Program Outputs Module". 3. Verify programming in "Program User Module".
NO RATE INDICATION	1. No signal at input A. 2. Type of input signal selected incorrectly. 3. Rate Scale factor and/or Rate Scale Multiplier too small.	1. Check sensor connections. a. Verify power to sensor. 2. Check DIP switch setting on side of unit. 3. Check scale factor value and scale multiplier values.

TROUBLESHOOTING GUIDE (Cont'd)

PROBLEMS	POSSIBLE CAUSE	REMEDIES
INCORRECT RATE READING	1. Input signal type incorrectly selected.	1. Check DIP switches. Set HI/LO FRQ. switch to LO for a count speed of less than 50 Hz.
	2. Inputs improperly connected.	2. Check sensor input connections.
	3. Electrical noise interference.	3. Check power source for noise. a. Check signal wire routing.
	4. Scale factor incorrect.	4. Verify scale factor value.
	5. Rate input signal too high of a frequency.	5. Verify input signal.
RATE DISPLAY FLASHING OVERFLOW	1. Rate Scale Factor, Multiplier and/or Conversion Factor values too large.	1. Check values.

APPENDIX "A" - SCALING FOR COUNT INDICATION

The Legend is factory set to provide 1 count on the display for each pulse that is input to the unit. In many applications, there will not be a one to one correspondence between input pulses and display units. In these applications it will be necessary for the Legend to scale or multiply the input pulses by a scaling factor to achieve the proper display units desired (feet, meters, gallons, etc.). There are three different parameters used in scaling the input pulses to the desired reading. They are: the "Count Scale Factor", the "Counter Scale Multiplier", and the "Number of Count Edges". The number of count edges is determined in the Program Counter Module. For example, the number of edges for the "CNT+DIRX1" mode is one and the "QUAD X4" mode is four. All three are factored together to provide the Total Scaling that is necessary. The Count Scale Factor and Scale Multiplier are programmed in the Program Scaling section.

The first step in scaling the counter requires that the "Number of Pulses" per "Display Unit(s)" needs to be obtained. This may require a small amount of deductive reasoning.

Example: A 48-tooth gear is mounted to a 2 ft circumference feed roll in a paper processing plant. It is desired to totalize the total footage of paper processed. In this example, the display units will be in feet. A sensor sensing the gear teeth will provide 48 pulses for each revolution of the feed roll. Each revolution will equate to a linear distance of 2 feet. The number of "Display Units" desired will be 2. The "Number of Pulses" per "Display Units" will be 48. When the number of "Display Units" and the "Number of Pulses" have been obtained, the Total Scaling Factor can be calculated.

The "Total Scaling Factor", denoted as "K_T", is simply the total amount of scaling required. It is obtained by dividing the "Display Units" by the "Number of Pulses" as shown in Formula #1 below.

FORMULA #1: K_T = Display Units ÷ Number of Pulses

WHERE:

K_T = Total Scaling Factor.

Display Units = The number of desired units (revolutions, feet, 10ths of feet, meters, etc.) that would be acquired after the "Number of Pulses" has occurred.

Number of Pulses = The Number of pulses required to achieve the number of "Display Units".

For the preceding example, the Total Scaling Factor, "K_T", is calculated by plugging in 2 and 48 in the formula:

$$K_T = 2 ÷ 48 = 0.041667$$

As previously stated, the Total Scaling Factor, "K_T", is the combination of the Scale Factor, Scale Multiplier, and Number of Count edges. In many applications the Total Scale Factor, "K_T", can be programmed directly into the Count Scale Factor, "SF", in which case the Scale Multiplier and Number of Count Edges can be left at the factory settings of X1.

In some applications, more display resolution may be required. When the Total Scaling Factor (K_T) is greater than 1.0000 and using only one edge per count pulse, there may not be enough display resolution.

Example: With a Total Scaling Factor of 2.000, when an input pulse is generated, the display will increment by 2. If the display units are in feet, when 3 feet have gone by, the display will still only read 2. It will not increment again until 4 feet have been accumulated. With this amount of display resolution it would be impossible to set the Preset and have the output respond at odd feet intervals (1, 3, 5, etc.). To increase resolution, the Number of Count edges must be increased. This can be achieved by selecting the CT+DIRX2 mode (Count plus direction times 2) in the Program Count Module or by selecting the QUAD X4 mode, if quadrature counting is being used. If enough resolution still has not been attained, more input pulses will need to be generated per display unit.

The amount of resolution required will vary depending on the particular application. In cut-to-length applications, a high amount of resolution is often necessary. However, in totalizing applications, display resolution may not be important. It should be noted that whenever the number of count edges is increased to 2 or 4, the maximum count frequency will decrease. (See Specifications for maximum count frequency).

Note: When using 2 or 4 edge counting for length sensor, on/off duty cycle must be 50% to maintain max. accuracy (mag. pickup will not work).

Once the Number of Count Edges (NCE) to be used has been determined, the Remaining Scaling factor required, "K_R", can be calculated. This is the Total Scaling Factor, "K_T", divided by the Number of Count edges used as shown in Formula #2:

FORMULA #2: $K_R = K_T \div NCE$

WHERE:

K_R = Remaining Scaling Factor.
K_T = Total Scaling Factor.
NCE = Number of Count Edges.

In our original example, the Total Scaling Factor, "K_T" was determined to be 0.041667. Since this value is less than one, sufficient pulse information is being generated, i.e., there is enough resolution for the units selected. The Number of Count edges can be left at the factory set value of X1. The Total Scaling Factor, "K_T", therefore equals the Remaining Scaling Factor, "K_R".

$K_R = 0.041667 \div 1 = 0.041667$

If the remaining scaling is between 0.6000 and 5.9999, it can be programmed directly into the Scale Factor value and the X1 factory setting for the Count Scale Multiplier "SCM", can be used.

COUNT SCALE MULTIPLIER

The general rule for choosing an SCM value is, when the Remaining Scaling Factor, "K_R", is less than 0.6000, an SCM value of 0.1 or 0.01 can be used to get a Scale Factor value between 0.6 and 5.9999 or to the point where the maximum number of significant digits is obtained.

FORMULA #3: $SF = K_R \div SCM$

WHERE:

SF = Count Scale Factor.
K_R = Remaining Scaling Factor.
SCM = Count Scale Multiplier.

Following our continuing example, it is easy to see that the Remaining Scaling Factor, "K_R" (0.041667), cannot fit into the Scale Factor Value without losing significant digits. Using the Formula above and a Scale Multiplier value of 0.01 will allow us to get the maximum number of significant digits possible for the Count Scale Factor value:

$SF = K_R \div SCM = 0.041667 \div 0.01 = 4.1667$

COUNTER SCALING EXAMPLE:

EXAMPLE #1:

A flow sensor provides 62 pulses per gallon. Calculate the scaling required to provide a display reading in gallons. The number of "Display Units" displayed after 62 pulses have been counted should be 1.

STEP 1 - Calculate the Total Scaling Factor, "K_T", using Formula #1.

FORMULA #1:
K_T = Display Units ÷ Number of Pulses = $1 \div 62 = 0.016129$

STEP 2 - In this application 62 pulses per gallon provides more than enough resolution, so the "Number of Count Edges" (Selected in the Program Counter Module) is set to a value of X1. With an "NCE" value of 1, the remaining scaling factor required is still 0.016129.

FORMULA #2:
$K_R = K_T \div NCE = 0.016129 \div 1 = 0.016129$

STEP 3 - To provide maximum scaling accuracy, a "Scale Multiplier" value is chosen that will give the maximum amount of significant digits in the Scale Factor. A value of 0.01 will result in a Scale Factor Value of 1.6129.

FORMULA #3:
$SF = K_R \div SCM = 0.016129 \div 0.01 = 1.6129$

COUNTER SCALING EXAMPLE:

EXAMPLE #2:

A quadrature Rotary Pulse Generator that provides 100 pulses per revolution is coupled to a feed roll that is 2.5 feet in circumference. It is desired to read in feet with display resolution to the nearest hundredth of feet (0.01).

In this application, the requirement is for the display to read in hundredths of a foot. A 2.5 ft. distance will equate to 250 "Display Units" (hundredths). The "Number of Pulses" for 2.5 ft. is 100, as stated.

From the information obtained, the Total Scaling Factor, "K_T", can be calculated, using Formula #1.

$$K_T = \text{Display Units} \div \text{Number of Pulses} = 250 \div 100 = 2.5$$

With a Total Scaling Factor, "K_T", of 2.5, it can easily be seen that for every pulse that is input, the display will increment by 2.5 display units (hundredths). The application requires resolution to the nearest hundredth of a foot. To get higher resolution, Quadrature x4 Input Response Mode is selected. This will provide four times the resolution. Using Formula #2, and 4 for the "Number of Count Edges", the Remaining Scaling, "K_R", is calculated.

$$K_R = K_T \div \text{Number of Count Edges} = 2.5 \div 4 = 0.625$$

At this point, it can be seen that the Remaining Scaling Factor value of 0.625 will fit into the Scale Factor value range without losing any significant digits or scaling it any further. Because of this, the Scale Multiplier (SCM) factory set value of X1 is used, and 0.6250 is programmed directly in for the Scale Factor, "SF".

$$SF = K_R \div SCM = 0.6250 \div 1 = 0.6250$$

APPENDIX "B" - SCALING FOR RATE INDICATION

The Legend offers a simplified method for scaling the rate portion of the indicator. The method does not require time unit conversions. The desired time format (Rate Per Second, Rate Per Minute, Rate Per Hour) is simply selected as part of the programming procedure.

Due to the way the rate is calculated (See "General Description" section), high resolution and accuracy can be realized at all input rates, slow or fast.

Note: It is not necessary to increase the pulse information to obtain higher resolution.

The Rate Minimum Update Time can be programmed from 0.1 up to 99.9 seconds to provide averaging in applications where the input pulse spacing is not stable. The Update time selected, however, will not affect the scaling in any manner.

Scaling the Rate channel involves programming the Legend so that input pulses to the unit will be scaled to the desired display units (revolutions, feet, meters, etc.) and in the desired time format (Rate Per Second, Rate per Minute, Rate Per Hour).

If the rate indicator is to display the rate at which the counter is counting. The rate indicator can be programmed with the same scaling parameters as the counter. The only other requirement is that the desired "Rate Conversion Factor" be selected to provide the rate display in the desired time format, Rate per Second (X1), Rate per Minute (X60), or Rate per Hour (X3600). This will automatically scale the rate by X1 (1 pulse per second), X60 (60 pulses per minute), or X3600 (3600 pulses per hour).

Note: The rate uses only the negative edge of the pulse at Input A. The counter uses both edges of the input pulse for X2 or X4 count mode. The rate can show the same reading as the count, but take into account the counter mode selected.

If the rate application is to display a specific Display Unit, then to scale the rate, it is only necessary to know the number of pulses per display unit desired or units (feet, revolutions, etc.).

Example: A 48-tooth gear, which is coupled to a shaft, is being sensed and it is desired to indicate the shaft speed in revolutions, the display units will be in revolutions. It is obvious that 48 pulses will occur in one revolution.

To convert the pulse units to revolutions, it is necessary for the Legend to multiply the number of pulses by a scaling factor to convert the pulse units to revolution units. The Legend has a Rate Scale Factor and a Rate Scale Multiplier to scale pulse units to the desired display units. They are programmed in the Program Scaling section. Both are used to attain the Total Scaling Factor, "K_T" To calculate the Total Scaling Factor, "K_T", for the application, the following formula is used.

FORMULA #1: K_T = Display units ÷ Number of pulses

WHERE:

K_T = Total Scaling Factor.

Display Units = The number of desired units (revolutions, feet, 10ths of feet, meters, etc.) that would be acquired after the "Number of Pulses" has occurred.

Number Of Pulses = The Number of pulses required to achieve the number of "Display Units".

Using the example previously discussed, the desired display unit would be 1 revolution and the number of pulses per display unit would be 48. Therefore, the Total Scale Factor would be 0.020833.

K_T = 1 rev ÷ 48 pulses per rev = 0.020833

In many applications the Total Scale Factor, "K_T", can be programmed directly into the Rate Scale Factor, "SF", in which case the Scale Multiplier "SCM" can be left at the factory setting of X1. However, in some applications, such as the one above, it may be desired to obtain more significant digits in the Scale Factor, "SF".

These situations occur when the "K_T" factor does not calculate to an even number that will fit into the four decimal places available to the Scale Factor. The following formula can be used to calculate the Scale Factor when an SCM value other than X1 is needed.

FORMULA #2: SF = K_T ÷ SCM

WHERE:

SF = Rate Scale Factor.

K_T = Total Scaling Factor.

SCM = Rate Scale Multiplier.

In this formula, the Total Scaling Factor, previously calculated, is divided by the Scale Multiplier Value, "SCM", to obtain the Scale Factor, "SF".

RATE SCALE MULTIPLIER

The general rule for choosing an SCM value is, when the Total Scale Factor, "K_T", is less than 0.6000, an SCM value of 0.1 or 0.01 can be used to get a Scale Factor value between 0.6 and 5.9999, or to the point where the maximum number of significant digits is obtained. If the Total Scaling Factor, "K_T", is greater than 5.9999, then an SCM value of 10, 100, or 1000 can be used to obtain a Scale Factor Value between 0.6 and 5.9999.

In our initial example, the Total Scaling Factor, "KT" was determined to be 0.020833. It is easy to see that this number cannot be programmed into the Scale Factor, "SF", without losing significant digits. Using formula #2 and the general rules stated above, a Scale Multiplier Value of 0.01 is chosen and the Scale Factor is calculated as shown below. This will provide maximum amount of conversion accuracy possible.

$$SF = K_T \div SCM = 0.020833 \div 0.01 = 2.0833$$

In situations where the Total Scale Factor is already in range of the Scale Factor (0.0001 to 5.9999) and when there are no significant digits that are lost, the Total Scaling Factor, "K_T", can be programmed directly into the Scale Factor Value and a Scale Multiplier value of X1 (the factory set value) can be used.

Example: If the desired display units are in feet and there are 100 pulses per foot, the Total Scaling Factor,"K_T", would be 0.01.

$$K_T = \text{Display units} \div \text{number of pulses} = 1 \div 100 = 0.01$$

Since the Total Scaling Factor, "K_T", is exactly 0.01, it can be programmed into the Scale Factor Value, "SF", and the Scale Multiplier Value, "SCM", can be left at its factory setting of X1.

After the Scale Factor and Scale Multiplier values are selected, all that is necessary to complete the scaling is to choose the Rate Conversion Factor. The Rate Conversion Factor (RCF) can be selected to provide indication in Rate per Second (X1), Rate Per Minute (X60), or Rate per Hour (X3600).

There may be situations where there are many more pulses per display unit than needed. In these situations the minimum SCM value (0.01) may not provide enough significant digits in the Scale Factor. To achieve more significant digits, the Rate Conversion Factor should be set to Rate per Second and the following formula be used.

$$SF = K_T \text{ x RCF} \div SCM$$

WHERE:

RCF = 60 for display reading in Rate Per Minute or 3600 for display reading in Rate Per Hour

RATE SCALING EXAMPLE:

EXAMPLE #1:

A 60-tooth gear is mounted to a roll that has a circumference of 2 feet. It is desired to have a rate readout with a resolution in 10ths of feet per minute. Calculate the Scale Factor and Scale Multiplier values necessary to provide the desired readout.

In this example one revolution of the web will provide 60 pulses for 2 feet of linear travel. Since the desired display units are to be in tenths of feet, it is necessary to convert 2 feet to tenths ($2 \div 0.1 = 20$), giving us 20 tenths (display units). The Total Scaling Factor, "K_T", is calculated by simply plugging in the two numbers into Formula #1.

$$K_T = \text{Display Units} \div \text{Number of Pulses} = 20 \div 60 = 0.333333$$

To get the maximum number of significant digits in the Scale Factor we use formula #2 and a Scale Multiplier value of 0.1 as shown below.

$$SF = K_T \div SCM = 0.333333 \div 0.1 = 3.3333$$

To obtain rate indication in Feet Per Minute, the Rate Conversion Factor is programmed for the Rate per Minute mode. A decimal point is programmed to 0.0, which allows the unit to display in 10ths of feet.

RATE SCALING EXAMPLE (Cont'd):

EXAMPLE #2:

The shaft of a positive displacement pump has a 14 tooth sprocket that is being sensed by a magnetic pickup. It is known that the unit pumps 810 liters of water per minute, when the shaft is turning 400 RPM. It is desired to have a display readout in liters per minute.

With the Legend, it is not necessary to deal with time unit conversions. From the information given, we know that when the shaft has turned 400 revolutions, 810 liters of water will have been pumped. The first step we need to take is to calculate the number of pulses that occur when 810 liters have been pumped.

Number of Pulses = # of Rev x Pulses per Rev = 400 Rev x 14 PPR = 5600 pulses.

We now have all the information necessary to scale the rate. The Total Scaling Factor, "K_T", is calculated using Formula #1 as shown below.

K_T = Display Units ÷ Number of Pulses = 810 ÷ 5600 = 0.144643

It is noticed that there are more significant digits in the Total Scale Factor, "K_T", than there are available for the Scale Factor, "SF". To acquire the maximum amount of significant digits for the Scale Factor, Formula #2 is used and a Scale Multiplier value of 0.1 is selected.

$$SF = K_T ÷ SCM = 0.144643 ÷ 0.1 = 1.4464$$

The Scale Factor, "SF", equals 1.4464 (1.44643 rounded to 4 decimal places). This provides the maximum amount of conversion accuracy possible.

The final step is to select a Rate Conversion Factor. The Rate Conversion Factor is chosen to be Rate Per Minute as was required.

DUAL PRESET COUNTING APPLICATION

A typical industrial application for a Legend unit requires both a slow down output and a final stop output. The Legend can be easily programmed to solve this requirement. For instance, a textile web process requires a dual output as the web progresses to the proper length. A typical length of material for this application is a 10,000 foot length. In this case, it would be best to set the unit up for Manual Reset with Preset tracking. Preset 2 is set at 10000 and Preset 1 set for 9500. The counter causes the process to slow down until 10,000 (preset 2) is reached at which point Output 2 would activate and latch for final stop. The advantage of using Preset tracking is that when changing the total length it is only necessary to change Preset 2 (length). Preset 1 (slow down) will maintain the same differential (500), assuming the same amount of slow down is required. In the program counter module, the continue mode is programmed for count with direction x1 (CT=DIRx1) with input B disconnected so the unit will count in a positive direction. The reset action mode is set for reset to preset 2 and the automatic reset mode is disabled. In the program options module the preset tracking is enabled. User input function key F1 is set to reset the count display and user input 1 is programmed to set output 2 in case of an emergency stop. Outputs one and two are assigned to the count display for latch mode, and the reset with count is enabled.

The accompanying drawing shows an PSAC sensing a 60 tooth gear which is attached to a 2.5 ft. Circumference drum. Since the unit of measure is a foot, the first step is to find the number of pulses per foot that will be used.
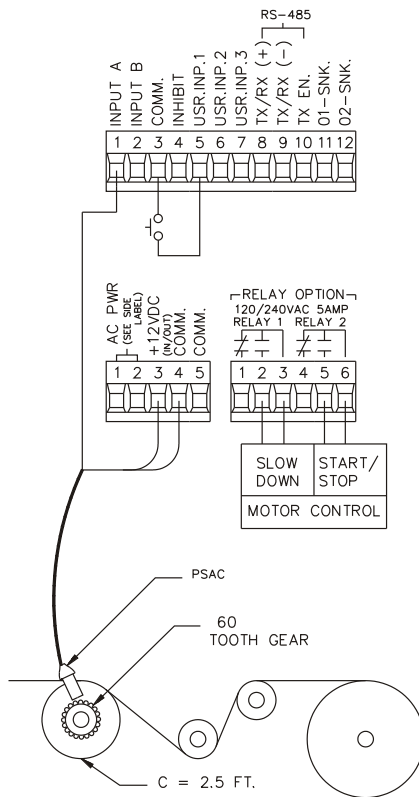
The following formula is used.

$$Pulses/ft. = \frac{60\ pulses/rev.}{2.5\ ft./rev.} = 24\ pulses/ft.$$

Since the desired readout is in feet, and there are 24 pulses per foot, it is necessary to scale the count. To determine the multiplier that is needed, the formula below is used.

$$K_T = \frac{Desired\ Display\ Units}{Number\ of\ Pulses} = 1 \div 24 = 0.041667$$

The remaining scale factor (K_R) required is determined by dividing the total scaling factor (K_T) by the number of count edges. (NCE).

$$K_R = K_T \div NCE = 0.0416667 \div 1 = 0.0416667$$

The general rule for choosing a count scale multiplier (SCM) is used to get the maximum amount of decimal point accuracy. A Count Scale Multiplier of 0.01 is used, which would give a scale factor *(rounded off)* of 4.1667.

$$SF = K_R \div SCM = 0.0416667 \div 0.01 = 4.1667$$

If we used the count multiplier as the scale factor, and used a scale multiplier of 1, the scale factor would round off to 0.0417, in which case 2 decimal places of accuracy would be lost.

TYPICAL COUNTER/RATE APPLICATION
COAL FEED RATE & USAGE INDICATION

An industrial plant has an in-house coal fired boiler that provides heating and powers an electric generator used for secondary power. An auger feeds the coal into the boiler furnace. The actual pressure of the boiler is controlled by the feed rate of the auger. An indication is required when the feed rate falls below or exceeds the desired RPM levels. The plant manager also wants an indication of the amount of coal that is used. The desired auger revolution rate is between 25 and 35 RPM. A shaft rotation speed of 30 RPM is equal to a feed rate of 1.8 tons of coal per hour. Rate and usage indication is to be in 10ths of tons per hour.

An PSAC can be used to sense a bolt head located on the auger shaft. The count with direction x1 (CT = DIRx1) is programmed in the program counter module with input B left open to the unit counts in a positive direction. The reset action mode is set to reset to zero and the automatic reset is disabled. First the scaling required for the counter is calculated.

The number of pulses must be calculated:

Number of pulses = # of rev x pulses per rev =
  1 x 30 = 30 pulses/min (PPM)
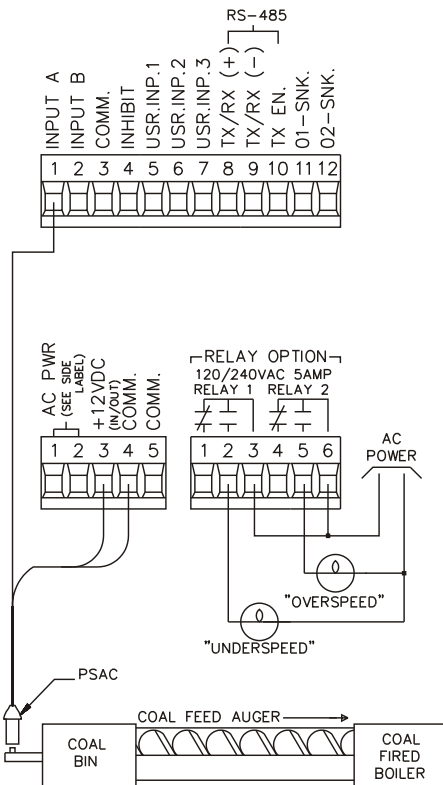Per hour = x time = 30 x 60 = 1800 PPH

The total scaling factor is calculated by the following formula:

$$K_T = \text{Desired display units} \div \text{number of pulses} = 18 \div 1800 = 0.01$$

The Count Scale Factor (SF) is calculated using the following formula and the scale multiplier is chosen using the general rule (reference scaling for count indication):

$$SF = K_T \div SCM = 0.01 \div 0.1 = 0.1$$

The decimal point location for the count display is programmed for 0.0.

At 30 RPM the pulse rate per minute is the same since a single bolthead is being sensed once each revolution. Since it takes one hour at 30 RPM to use 1.8 tons of coal, the number of pulses accumulated in that hour will be 1800 (30 PPM x 60 min/hr = 1800). The Scale Factor needed is 0.01 (SF = desired reading/# of pulses = 18/1800 = 0.01). The rate display is to indicate RPMs with a resolution in tenths, The total scaling factor is calculated by the following formula:

$$K_T = \text{Desired display units} \div \text{number of pulses} = 300 \text{ RPM} \div 30 = 10$$

The Rate Scale Factor (SF) is calculated using the following formula and the scale mutiplier is chosen using the general rule *(reference scaling for count indication)*:

$$SF = K_T \div SCM = 10 \div 10 = 1$$

It is then only necessary to program the Rate Conversion Factor for Rate per Minute. Since the application requires two presets for the upper and lower limits, the outputs are programmed to the Rate display. Both outputs are programmed for boundary operation and output 1 is programmed for "-" phase. The relay outputs are connected to overspeed and underspeed indicator lights.

APPENDIX "D" - ORDERING INFORMATION

MODEL NO.	DESCRIPTION	OPTION W/RELAY BOARD	PART NUMBERS 115/230VAC & +12VDC
LGD	Dual Preset Legend w/Yel-Grn Backlighting	NO	LGD00001
		YES	LGD00000
	Dual Preset Legend w/Red Backlighting	NO	LGD00101
		YES	LGD00100
—	Dual Relay Board	—	RLYLG002

APPENDIX "E" - FLOWCHART FOLD-OUT (Insert)

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained and relies on no other warranties or affirmations.

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