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## SCOPE OF THIS MANUAL

This manual is intended to help you get the F5140 K-factor scaler and the F5141 Programming Software up and running quickly.

### IMPORTANT

*Read this manual carefully before attempting any installation or operation. Keep the manual accessible for future reference.*

## UNPACKING AND INSPECTION

Upon opening the shipping container, visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts, or any other sign of damage that may have occurred during shipment.

**NOTE:** If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the purchaser.

## SAFETY

### Terminology and Symbols



Indicates a hazardous situation, which, if not avoided, *will* result in death or serious personal injury.



Indicates a hazardous situation, which, if not avoided, *could* result in severe personal injury or death.



Indicates a hazardous situation, which, if not avoided, *could* result in minor or moderate personal injury or damage to property.

### Considerations

The installation of the F5140 K-factor scaler and the F5141 Programming Software must comply with all applicable federal, state, and local rules, regulations, and codes.



**IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.**



**DANS LE CAS D'UNE UTILISATION NON PRÉVUE PAR LE FABRICANT, LA PROTECTION FOURNIE PAR L'ÉQUIPEMENT PEUT ÊTRE RÉDUITE.**



**FOR FIELD WIRING CONNECTIONS, WIRE MUST BE RATED AT 158° F (70° C) OR HIGHER.**



**POUR DES CÂBLAGES SUR LE TERRAIN, LES CÂBLES DOIVENT ÊTRE ÉVALUÉS À 70° C (158° F) MINIMUM.**

**IMPORTANT**

*Not following instructions properly may impair safety of equipment and/or personnel.*

**IMPORTANT**

*Must be operated by a class 2 power supply suitable for the location.*

**Electrical Symbols**

<b>Function</b>	<b>Direct Current</b>	<b>Caution</b>
<b>Symbol</b>		

**INTRODUCTION**

The K-factor scaler is a field-adjustable frequency divider, which converts the output signal from a turbine meter or a similar device with a magnetic pickup or pulse output, to an input compatible with a PLC, RTU, CPU data acquisition card or similar totalizer device. The adjustable frequency divider, referred to as a K-factor, allows pulses sent from a turbine meter to accumulate into a unit recognizable by an end device, such as a PLC, for counting and display.

The use of different K-factor values allows the device to display in any number of volumetric measurements such as gallons, cubic meters, liters, barrels and like units. The calibration sheet usually provided with a turbine meter lists a nominal K-factor tested to a specific volumetric flow rate. The K-factor when placed into the K-factor scaler provides an output pulse for each unit of volume that passes through the turbine. Any units of volume are possible by recalculating the K-factor with the appropriate conversion factor.

In addition, if the K-factor is set to one, the K-factor scaler becomes a preamplifier, converting the frequency from a low output level turbine meter to the logic level needed by a PLC or CPU data acquisition card.

## OPERATING PRINCIPLE

Fluid passing through the turbine causes the rotor to spin at a speed proportional to the fluid velocity. As each rotor blade passes through the magnetic field, the blade generates an AC voltage pulse in the pickup coil at the base of the magnetic pickup (see [Figure 1](#)). These pulses produce an output frequency proportional to the volumetric flow through the meter. The output frequency with further processing represents flow rate and/or totalization of fluid passing through the flow meter.

The K-factor scaler input amplifier modifies the signal generated by the turbine. The amplifier sends the modified signal to an onboard microcontroller, which counts pulses up to a predetermined number controlled by the K-factor value. The range of the K-factor is 1...999,999,999. The predetermined value, once reached, triggers a pulse from the output circuitry.

The K-factor is user adjustable through the programming interface. The duration of the output pulse is also selectable. At the end of the output pulse, the internal counters reset to zero and the process starts over.

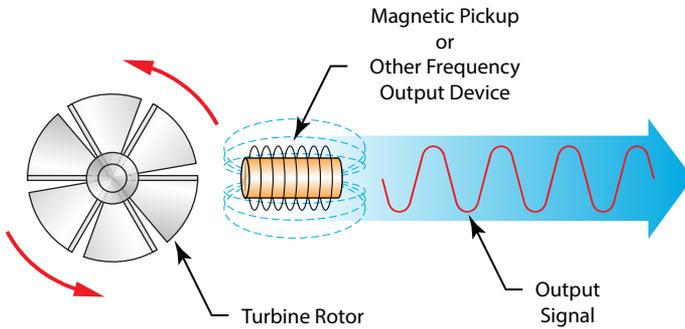


Figure 1: Schematic illustration of electric signal generated by rotor movement

## INSTALLATION

### Electrical Connections

The programmable K-factor scaler was designed to provide a field adjustable frequency divider that converts the low level frequency output from a turbine meter into a scaled square wave output signal. See [Figure 2](#) below for the I/O terminal connections.

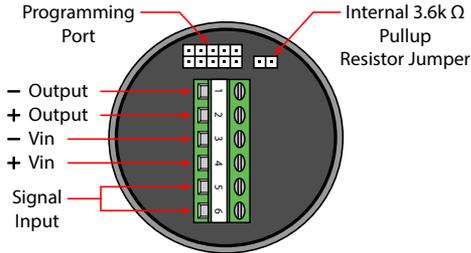


Figure 2: Input/Output terminal connections

### Enclosure Mounting

The enclosure has four mounting holes for easy mounting.

### Power

The K-factor scaler requires 8.5...30V DC to operate and is protected by a diode. See [Figure 2](#) for polarity.

### Turbine Meter

The turbine meter connections are non-polarized. Use shielded twisted-pair wire for this connection to the turbine meter.

### Pulse Output

Either the internal or external pullup resistor must be used for the K-factor scaler to provide an output pulse. This option is controlled by the onboard jumper. With the jumper installed, the internal pullup resistor is connected.

### Internal Pullup Resistor

The internal pullup resistor allows for simple installation. Make sure that the device being connected to by the pulse output can handle voltage levels as high as the supply feeding the K-factor board. And, make sure the output pulse from the K-factor board can supply enough current for the receiving device to be able to read the pulse. The available current that the K-factor board can supply to the receiving device can be calculated with the following equation:

$$\text{Available Current} = \frac{(\text{Input Voltage} - 0.7V)}{(3600\Omega + 47\Omega)}$$

Verify that the receiving device input current requirement is below this value for proper operation. Otherwise, an external pullup resistor less than 3.6K must be used.

## External Pullup Resistor

Using an external pullup resistor offers greater flexibility of controlling the output pulse provided by the K-factor board to the receiving device. Since power sources and receiving devices differ between users, different resistor values are required for different setups.

The external pullup resistor is connected between the receiving device's input and external power source. This power source is the maximum input voltage (of the pulse) to the receiving device. Use the equation below to determine the resistor value.

$$R = \frac{\text{Supply Voltage}}{\text{Current}}$$

Where:

**R** = Resistor value in hms

**Supply Voltage** = External supply voltage connected to the external pullup resistor

**Current** = Input current required by the receiving device in amps

After **R** has been calculated, use the value in the following equation.

$$P = (\text{Supply Voltage}) \left( \frac{\text{Supply Voltage}}{R + 47 \Omega} \right)$$

**P** represents the power capability of the output and should not exceed 0.25 Watts. Exceeding this value could damage the K-factor board. Raising the **R** value decreases the available power output.

## STARTUP

### Connecting to a Computer

The programmable K-factor scaler can be factory or user configured through a USB port of a PC using a Windows® compatible software utility. A programming adapter is required that interfaces the USB port from the PC to the programming port on the board.

To connect the K-factor scaler:

1. Make sure the power is off. Then connect the adapter cable to the K-factor scaler board using the programming port and connect the opposite end to the USB port of a PC. See [Figure 3](#).
2. Turn on the power to the K-factor scaler.

**NOTE:** Power to the K-factor scaler is required in order to perform any programming.

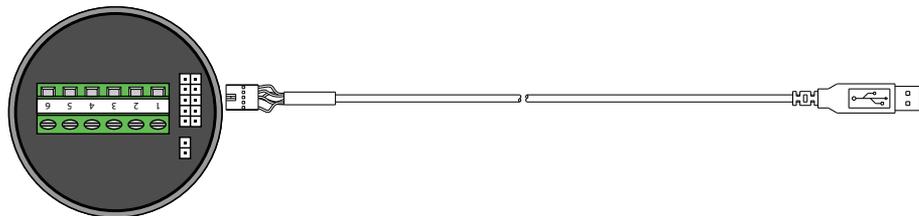


Figure 3: Interface connection

## Using the Programming Software

**NOTE:** The programming software is sold separately.

The programming interface uses two functional divisions as shown in [Figure 3](#). The Program Values column contains the user-selected information for downloading into the K-factor scaler. The Board Values column shows the information that the K-factor scaler currently contains and is not alterable by the user. The Board Values column will only display the contents of the board after performing a Program, Read or Verify function.

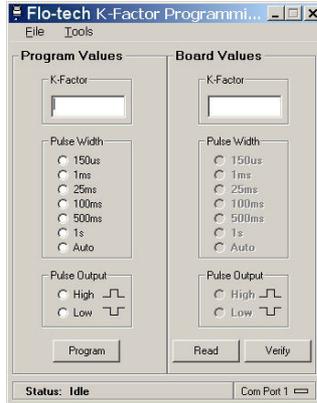


Figure 4: Programming software screen

### Buttons

<b>Program</b>	Programs the K-factor, Pulse Width and Pulse Output to the K-factor board.
<b>Read</b>	Reads the current information from the K-factor board and displays it under the <i>Board Values</i> column of the PC software.
<b>Verify</b>	Compares the <i>Board Values</i> to the <i>Program Values</i> and displays an error if the two do not match.

### Selecting the Com Port

Select the proper Com port within the programming software so the software can communicate with the board. To select the Com port, in the menu bar select Tools and then Com Port. Select the Com port (1...16) that the serial programming cable is connected to on the computer.

If the Com port selected is invalid, the software shows the message ERROR – Invalid Com Port when trying to program the board. If the incorrect Com port is selected, or if there is a problem with the cable, the software shows the message "No Response" after trying to program the board.

## Setting the K-Factor

The K-factor is the ratio of input pulses per each output pulse, for example, if the K-factor is set to 1, then each input pulse would yield one output pulse. The range that the K-factor can be set to is 1...999,999,999. The K-factor is set by entering it in the Program Values column of the software in the K-factor field.

## Setting the Output Pulse Width

The output pulse width is the length of time the pulse remains active before resetting to its original state. The K-factor scaler has a total of seven different pulse widths. The Auto option does not restrain the output pulse to a specific length. Instead, it varies and is dependent on output frequency. The higher the output frequency, the shorter the pulse width output. The lower the frequency output, the longer the pulse width output. This option turns off the Pulse Output selection buttons because they do not apply in this mode.

Some end devices require the pulse to be a certain length or longer for proper detection of each incoming pulse. For these devices, select a pulse width that is long enough for the end device to recognize it.

The pulse width option is set by clicking the required pulse width radio button in the Program Values column of the software.

## Setting the Output Level Normally High or Normally Low

Most end devices are unaffected by this setting, but the K-factor scaler can invert the output pulse level. This option is set by clicking the required pulse output radio button in the Program Values column of the software.

When High is selected, the output level is normally low and the duration of the selected pulse width is high. When Low is selected, the output level is normally high and the duration of the selected pulse width is low.

## Programming the K-Factor Scaler

**NOTE:** All information in the Program Values column must be entered before the software can download the information to the K-factor scaler.

Press Program to download the K-factor, pulse width and pulse output values to the K-factor scaler. At the completion of the programming cycle, the circuit performs automatic verification of the downloaded information. The K-factor scaler retains downloaded values in the memory if it is disconnected from power.

Press Read to load the current information from the K-factor scaler and display it in the Board Values column.

Verify performs the same function as Read, but compares the Board Values to the Program Values and displays an error if the two do not match.

## Setting the Output to Use the Internal or External Pullup Resistor

Either the internal pullup resistor or an external resistor must be used for the K-factor scaler to provide an output pulse. This option is controlled by the onboard jumper and not by the software.

With the jumper installed, the internal 3.6 k $\Omega$  pullup resistor is connected to the input voltage of the board. With the jumper removed, the internal pullup resistor is disconnected and an external pullup resistor and supply voltage are required.

## SPECIFICATIONS

<b>External Power</b>	Input Voltage	8.5...30V DC (diode protected)
	Maximum Current Draw	18 mA (using internal resistor @ 30V DC input)
<b>Environmental</b>	Operating Temperature	-22...158° F (-30...70° C)
	Altitude	2000 m
	Use	Indoor/Outdoor
	Humidity	0...90% non-condensing
<b>Inputs (Magnetic Pickup)</b>	Frequency Range	0...4000 Hz
	Trigger Sensitivity	30 mV p-p...30V p-p
<b>Output Signal</b>	Max Voltage	30V DC
	Max Power	0.25 W
<b>Pulse Output (using internal pullup resistor)</b>	Maximum Current	8 mA
	VH =	Power input voltage - 0.7V DC
	VL =	Less then 0.4V @ maximum input power
	Internal Pullup Resistor	3.6 k $\Omega$ (enabled/disabled by jumper)
<b>Pulse Output (using external pullup resistor)</b>	Maximum Current	100 mA
	VH =	Input voltage to external pullup resistor
	VL =	$[VH / (\text{selected resistor value} + 47 \Omega)] \times 47 \Omega$
	Pulse Length	150 $\mu$ s, 1 ms, 25 ms, 100 ms, 500 ms, 1 s, or auto mode
<b>Enclosure</b>	ABS with mounting flanges	

## **K-FACTORS EXPLAINED**

The K-factor (with regards to flow) is the number of pulses that must be accumulated to equal a particular volume of fluid. Think of each pulse as representing a small fraction of the totalizing unit.

An example might be a K-factor of 1000 (pulses per gallon). This means that if you were counting pulses, when the count total reached 1000, you would have accumulated 1 gallon of liquid. Using the same reasoning, each individual pulse represents an accumulation of 1/1000 of a gallon. This relationship is independent of the time it takes to accumulate the counts.

The frequency aspect of K-factors is a little more confusing because it also involves the flow rate. The same K-factor number, with a time frame added, can be converted into a flow rate. If you accumulated 1000 counts (one gallon) in one minute, then your flow rate would be 1 gpm. The output frequency, in Hz, is found simply by dividing the number of counts (1000) by the number of seconds (60).

$1000 \div 60 = 16.6666$  Hz. If you were looking at the pulse output on a frequency counter, an output frequency of 16.666 Hz would be equal to 1 gpm. If the frequency counter registered 33.333 Hz ( $2 \times 16.666$  Hz), then the flow rate would be 2 gpm.

Finally, if the flow rate is 2 gpm, then the accumulation of 1000 counts would take place in 30 seconds because the flow rate, and hence the speed at which the 1000 counts is accumulated, is twice as great.

### **Calculating K-Factors**

Many styles of flow meters are capable of measuring flow in a wide range of pipe sizes. Because the pipe size and volumetric units the meter will be used on vary, it may not be possible to provide a discrete K-factor. In the event that a discrete K-factor is not supplied, then the velocity range of the meter is usually provided along with a maximum frequency output. An accurate flow rate and the output frequency associated with that flow rate is required for the most basic K-factor calculation.

#### *Example 1*

Known values are:

$$\text{Frequency} = 700 \text{ Hz}$$

$$\text{Flow Rate} = 48 \text{ gpm}$$

$$700 \text{ Hz} \times 60 \text{ sec} = 42,000 \text{ pulses per min}$$

$$\text{K factor} = \frac{42,000 \text{ pulses per min}}{48 \text{ gpm}} = 875 \text{ pulses per gallon}$$

**Example 2**

Known values are:

$$\text{Full Scale Flow Rate} = 85 \text{ gpm}$$

$$\text{Full Scale Output Frequency} = 650 \text{ Hz}$$

$$650 \text{ Hz} \times 60 \text{ sec} = 39,000 \text{ pulses per min}$$

$$\text{K factor} = \frac{39,000 \text{ pulses per min}}{85 \text{ gpm}} = 458.82 \text{ pulses per gallon}$$

The calculation is a little more complex if velocity is used. You first must convert the velocity into a volumetric flow rate to be able to compute a K-factor.

To convert a velocity into a volumetric flow rate, you need to know the velocity and the inside pipe diameter. Also keep in mind that one US gallon of liquid is equal to 231 cubic inches.

**Example 3**

Known values are:

$$\text{Velocity} = 4.3 \text{ ft/sec}$$

$$\text{Inside Diameter of Pipe} = 3.068 \text{ in}$$

**Find the area of the pipe cross section.**

$$\text{Area} = \pi r^2$$

$$\text{Area} = \pi \left( \frac{3.068}{2} \right)^2 = \pi \times 2.35 = 7.39 \text{ in}^2$$

**Find the volume in one foot of travel.**

$$7.39 \text{ in}^2 \times 12 \text{ in. (1 ft)} = \frac{88.71 \text{ in}^3}{\text{ft}}$$

**Determine what portion of a gallon one foot of travel represents.**

$$\frac{88.71 \text{ in}^3}{231 \text{ in}^3} = 0.384 \text{ gallons}$$

So for every foot of fluid travel, 0.384 gallons will pass.

**Determine the flow rate in gpm at 4.3 ft/sec.**

$$0.384 \text{ gallons} \times 4.3 \text{ fps} \times 60 \text{ sec (1 min)} = 99.1 \text{ gpm}$$

Now that you know the volumetric flow rate, all you need is the output frequency to determine the K-factor.

Known values are:

Frequency = 700 Hz (By measurement)

Flow Rate = 99.1 gpm (By calculation)

700 Hz x 60 sec = 42,000 pulses per gallon

$$\text{K factor} = \frac{42,000 \text{ pulses per min}}{99.1 \text{ gpm}} = 423.9 \text{ pulses per gallon}$$

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**Control. Manage. Optimize.**

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