Blancett®
Turbine Flow Meters

Signal Conditioner

B220-885 K-Factor Scaler and B220-900 Programming Software Kit

Badger Meter®

SGN-UM-00282-EN-03 (July 2015)

User Manual

CONTENTS

SCOPE OF THIS MANUAL

This manual is intended to help you get the B220-885 K-factor scaler and the B220-900 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

⚠ DANGER	Indicates a hazardous situation, which, if not avoided, is estimated to be capable of causing death or serious personal injury.
⚠ WARNING	Indicates a hazardous situation, which, if not avoided, could result in severe personal injury or death.
⚠ CAUTION	Indicates a hazardous situation, which, if not avoided, is estimated to be capable of causing minor or moderate personal injury or damage to property.

Considerations

The installation of the B220-885 K-factor scaler and the B220-900 Programming Software must comply with all applicable federal, state, and local rules, regulations, and codes.

⚠ CAUTION

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

⚠ AVERTISSMENT

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

⚠ CAUTION

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

⚠ AVERTISSMENT

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

Function	***Direct Current***	***Caution***
Symbol	⎓	⚠

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.

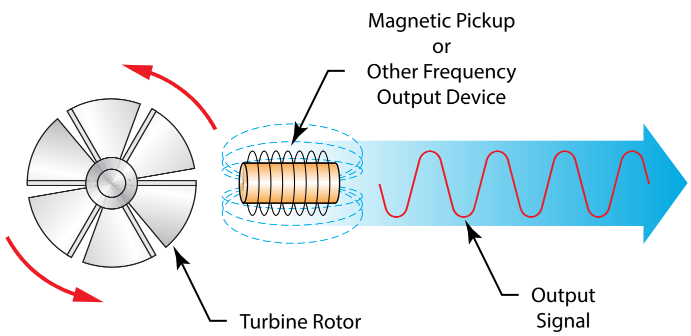

Figure 1: Schematic illustration of electric signal generated by rotor movement

INSTALLATION

The board connections include power input, turbine meter input and the pulse output to a totalizing device. See *Figure 2* for the I/O terminal connections.

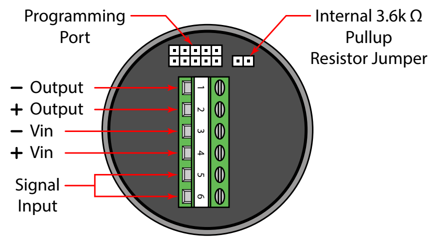

Figure 2: Input/Output terminal connections

Enclosure Mounting (Necessary for CSA Certification)

If the circuit board assembly is supplied without an enclosure, it must be mounted in a certified Killark one-inch NPT model Y-3 conduit elbow outlet box to maintain the CSA "Ordinary Locations" certification.

Electrical Connections

The board connections include power input, turbine meter input and the pulse output to a totalizing device.

Power

The K-factor scaler requires 8.5…30V DC to operate and is diode protected. *Figure 2* shows the supply polarity.

Turbine Meter

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

Pulse Output

Either the internal or an external pullup resistor is required for the K-factor scaler to provide an output pulse. An onboard jumper controls the pullup resistor selection. With the jumper installed, the internal pullup resistor is connected. Without the jumper, an external pullup is required. See *Figure 2* for the I/O terminal connections.

Internal Pullup Resistor

The internal pullup resistor allows for a simple installation. Make sure that the device being connected to the pulse output can accept voltage levels as high as the supply feeding the K-factor scaler. Another important setup consideration when using the internal pullup resistor is to make certain the output pulse from the K-factor scaler can supply enough current for the receiving device to read the pulse. Calculation of the available current that the K-factor scaler can supply to the receiving device uses the following equation.

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

Using the above equation, the maximum current available at an input voltage of 30V is 8 mA. Verify that the receiving device input current requirement is below this value for proper operation. Otherwise, an external pullup resistor less than 3.6 kΩ is required.

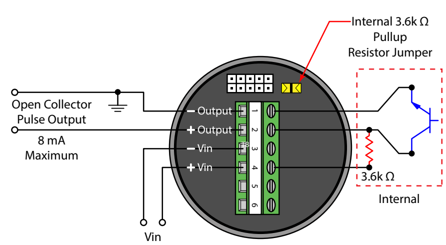

Figure 3: Wiring schematic with internal pullup resistor in circuit

External Pullup Resistor

Using an external pullup resistor offers greater flexibility in controlling the output pulse provided by the K-factor scaler. Power sources and receiving devices differ in individual situations, requiring the use of different pullup resistor values. Connection of the external pullup resistor is between the receiving device's input and external power source (see *Figure 4*). The power source voltage is the maximum input voltage (of the pulse) to the receiving device. Use the following equation to determine the pullup the correct resistor value.

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

R = Resistor value in ohms

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

Current = Input current required by the receiving device in amps

After the resistor value is calculated, make sure in the following equation that power P, the power capabilty of the output, is less than or equal to 0.25 Watts. Exceeding this value can cause damage to the K-factor scaler circuit. Raising the resistor value decreases the available power output and safeguard the circuit.

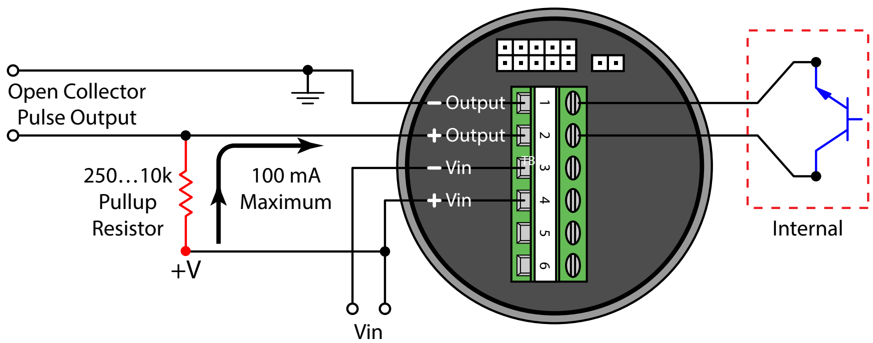

Figure 4: Wiring schematic using an external pullup resistor

To determine the maximum current available using a specific pullup resistor, use the following equation.

$$\text{Current Draw} = \sqrt{\frac{0.25\ \text{Watts}}{\text{External Pullup Resistor}}}$$

STARTUP

Connecting to a Computer

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

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 (see *Figure 2 on page 5)*.
2. Connect the serial-to-TTL converter to the adapter cable. See *Figure 5*.
3. Attach the serial extension cable to the serial-to-TTL converter and connect the opposite end to the PC 9-pin serial port.

NOTE: For computers without a 9-pin serial port, a serial-to-USB converter may be required.

4. Turn on the power to the K-factor scaler.

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

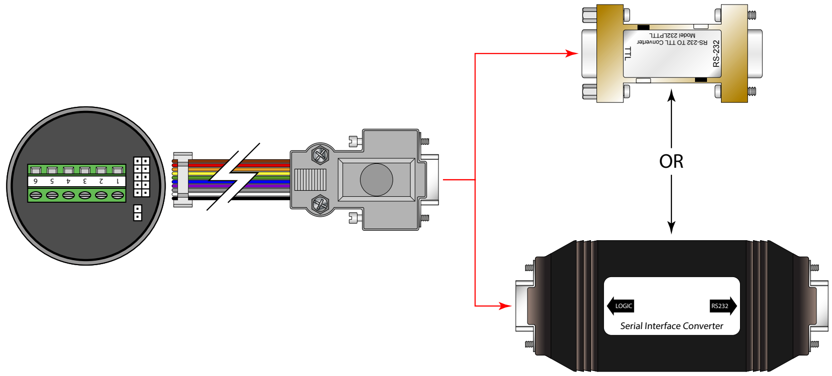

Figure 5: Interface connection

Using the Programming Software

NOTE: The programming software is sold separately.

The programming interface uses two functional divisions as shown in *Figure 6*. 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.

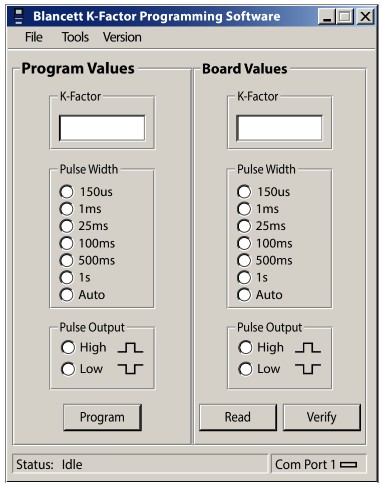

Figure 6: Programming software screen

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.

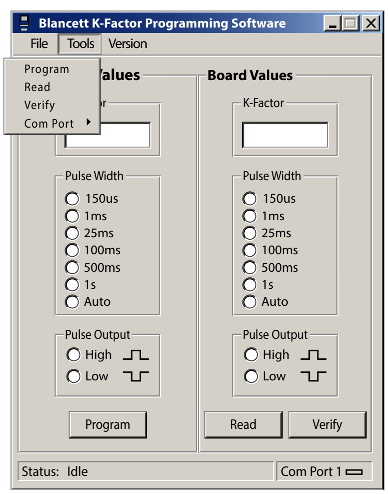

Figure 7: Tools drop down

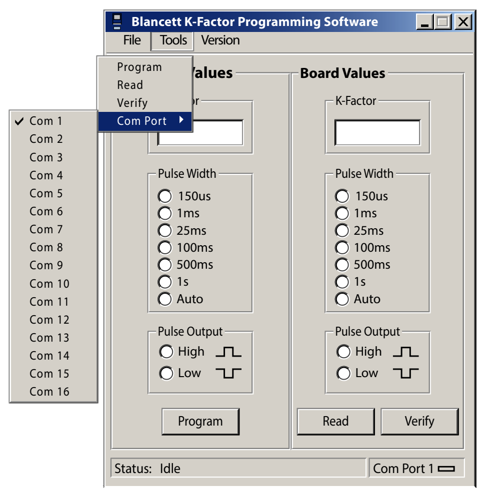

Figure 8: Com port menu drop down

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 kΩ 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

External Power	Input Voltage	8.5…30V DC (diode protected)
	Maximum Current Draw	18 mA (using internal resistor @ 30V DC input)
Environmental	Operating Temperature	–22…158° F (–30…70° C)
	Altitude	2000 m
	Use	Indoor/Outdoor
	Humidity	0…90% non-condensing
Inputs (Magnetic Pickup)	Frequency Range	0…4000 Hz
	Trigger Sensitivity	30 mV p-p…30V p-p
Output Signal	Max Voltage	30V DC
	Max Power	0.25 W
Pulse Output (using internal pullup resistor)	Maximum Current	8 mA
	VH =	Power input voltage – 0.7V DC
	VL =	Less then 0.4V @ maximum input power
	Internal Pullup Resistor	3.6 kΩ (enabled/disabled by jumper)
Pulse Output (using external pullup resistor)	Maximum Current	100 mA
	VH =	Input voltage to external pullup resistor
	VL =	[VH /(selected resistor value + 47 Ω)] × 47 Ω
	Pulse Length	150 µs, 1 ms, 25 ms, 100 ms, 500 ms, 1 s, or auto mode
Enclosure	Killark aluminum capped elbow Y-3. Class I, Div. 1 & 2, Groups C & D; Class II, Div. 1 & 2, Groups E, F and G; Class III	
Agency Listings	CSA	Ordinary Locations
		CAN/CSA C22.2 No. 61010-1-12, UL Std. No. 61010-1 (3rd Edition)
	Pollution Degree 2	
	Overvoltage Category I	

IMPORTANT

For this CSA rating to be valid, the circuit board must be mounted in a certified Killark one-inch model Y-3 conduit outlet box.

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 ÷ 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 × 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 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:

Frequency	=	700 Hz
Flow Rate	=	48 gpm

700 Hz × 60 sec = 42,000 pulses per min

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

Example 2
Known values are:

Full Scale Flow Rate	=	85 gpm
Full Scale Output Frequency	=	650 Hz

650 Hz × 60 sec = 39,000 pulses per min

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

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:

Velocity	=	4.3 ft/sec
Inside Diameter of Pipe	=	3.068 in

Find the area of the pipe cross section.

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

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

Find the volume in one foot of travel.

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

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 gallons × 4.3 fps × 60 sec (1 min) = 99.1 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

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

Control. Manage. Optimize.

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