APPLICATION GUIDE AG334

Externally powered pulse input Rate Totalisers
For models with an 'E' or 'G' suffix

Contents

Externally powered pulse input Rate Totalisers

1. Introduction

This Application Guide is intended to aid the selection of the most suitable pulse input Rate Totaliser from the extensive range of models manufactured by BEKA associates. The guide also contains flow measurement background information and configuration examples.

This guide does not contain detailed system design or step-by-step configuration information which are contained in the instruction manual for each model. Detailed installation and certification information for use in hazardous areas is also contained in the instruction manual for each model which can be viewed on the BEKA website at www.beka.co.uk

Each output pulse from a flowmeter or flow transducer represents a defined volume that has passed through the flowmeter. The total number of pulses therefore represents the total volume and the pulse frequency represents the rate of flow passing through the flowmeter. All BEKA pulse input Rate Totalisers have similar functions and are able to calculate and display the total flow and the rate of flow of most pulse output flowmeters.

The BEKA Rate Totaliser range includes field and panel mounting models for general purpose applications and for use in gas and dust hazardous areas. All models can be supplied with a wide range of factory fitted options including display backlights, alarm outputs and isolated pulse and current outputs for retransmission applications. Some models have two pulse inputs enabling the instrument to calculate and display the sum or difference of the total flow and rate of flow passing through two flowmeters.

All models are configured and calibrated via four push buttons using a common configuration menu. Although easy to configure on-site without the need for test equipment, Rate Totalisers can be supplied configured and ready for installation with a printed slide-in scale card showing customer specified information for no additional charge.

BEKA also manufacture loop powered 4/20mA Rate Totalisers which have similar functions and are described in a separate Application Guide.

Model	BA334E	BA334G	BA384E	BA384G
Some shown with optional backlight				
Enclosure material, size and IP rating	Field GRP 141 x 212mm IP66	Field GRP 122 x 120mm IP66	Field GRP 141 x 212mm IP66	Field GRP 122 x 120mm IP66
Number of M20 cable entries	3	2	3	2
Separate terminal compartment	Yes	No	Yes	No
Display	Primary: 8 digits 18mm high Secondary: 6 digits 12mm high			
Number of inputs	1		2	
Certification International IECEx				
Gas	Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C	Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C	Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C	Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C
Dust	N/A	Ex ia IIIC T80°C Db -40°C ≤ Ta ≤ +60°C	N/A	Ex ia IIIC T80°C Db -40°C ≤ Ta ≤ +60°C
Certification Europe ATEX and UKEX				
Gas	Group II Category 1G Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C	Group II Category 1G Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C	Group II Category 1G Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C	Group II Category 1G Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C
Dust	N/A	Group II Category 2D Ex ia IIIC T80°C Db -40°C ≤ Ta ≤ +60°C	N/A	Group II Category 2D Ex ia IIIC T80°C Db -40°C ≤ Ta ≤ +60°C
Certification USA ETL	Class I Div 1 Gp A, B, C, D T5 Class II Div 1 Gp E, F, G. Class III Div 1 Class I Zone 0 AEx ia IIC T5 Ga -40°C ≤ Ta ≤ 70°C			
Certification Canada cETL	Class I Div 1 Gp A, B, C, D T5 Class II Div 1 Gp E, F, G. Class III Div 1 Ex ia IIC T5 Ga -40°C ≤ Ta ≤ 70°C			
Options - *must be specified when indicator is ordered*				
Backlight	Included	Yes	Included	Yes
Alarms	Included	Yes	Included	Yes
4/20mA output	Included	Yes	Included	Yes
Pulse output	Included	Included	Included	Included
Accessories				
Pipe mounting kit	BA393	BA393G	BA393	BA393G
Panel mounting kit				
Unsealed	N/A	BA394G	N/A	BA394G
Sealed	N/A	BA494G	N/A	BA494G

BA534G	BA584G
	
Field GRP 122 x 120mm IP66	
2	
No	
Primary: 8 digits 18mm high Secondary: 6 digits 12mm high	
1	2
Not Certified General purpose applications only	
Yes Yes Yes Included	Yes Yes Yes Included
BA393G BA394G BA494G	BA393G BA394G BA494G

Table 1 Field mounting rate totalisers

Model	BA337E	BA338E	BA388E	BA337E-SS
Some shown with optional backlight				
Enclosure material & size	Panel Noryl 96 x 48 mm	Panel Noryl 144 x 72 mm		Rugged panel 316 S/S 105 x 60 mm
Protection	Front IP66, rear IP20			
Display	Primary: 8 digits 9mm high Secondary: 6 digits 6mm high	Primary: 8 digits 18mm high Secondary: 6 digits 12mm high		Primary: 8 digits 9mm high Secondary: 6 digits 6mm high
Number of inputs	1		2	1
Certification International IECEx **Gas**	Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C			Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +60°C
Dust	N/A			Ex ia IIIC T80°C Db -40°C ≤ Ta ≤ +60°C *
Certification Europe ATEX and UKEX **Gas**	Group II Category 1G Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +70°C			Group II Category 1G Ex ia IIC T5 Ga -40°C ≤ Ta ≤ +60°C
Dust	N/A			Group II Category 2D Ex ia IIIC T80°C Db -40°C ≤ Ta ≤ +60°C *
Certification USA ETL	Class I Div 1 Gp A, B, C, D T5 Class II Div 1 Gp E, F, G. Class III Div 1 Class I Zone 0 AEx ia IIC T5 Ga -40°C ≤ Ta ≤ 70°C			Zone 20 AEx ia IIIC T80°C Da -40°C ≤ Ta ≤ 60°C *
Certification Canada cETL	Class I Div 1 Gp A, B, C, D T5 Class II Div 1 Gp E, F, G. Class III Div 1 Ex ia IIC T5 Ga -40°C ≤ Ta ≤ 70°C			Ex ia IIIC T80°C Da -40°C ≤ Ta ≤ 60°C *
Options - *must be specified when indicator is ordered*				
Backlight	Yes	Yes	Yes	Yes
Alarms	Yes	Yes	Yes	Yes
4/20mA output	Yes	Yes	Yes	Yes
Pulse output	Yes	Included	Included	Yes
	#			#
Accessories				
Rear sealing kit	BA495	N/A	N/A	BA495

** May be installed in an Ex e, Ex p or Ex t panel enclosure without invalidating enclosure certification.*

BA537E	BA538E	BA588E	BA537E-SS
			
Panel Noryl 96 x 48 mm		Panel Noryl 144 x 72 mm	Rugged panel 316 S/S105 x 60 mm
Front IP66, rear IP20			
Primary: 8 digits 9mm high Secondary: 6 digits 6mm high	Primary: 8 digits 18mm high Secondary: 6 digits 12mm high		Primary: 8 digits 9mm high Secondary: 6 digits 6mm high
1		2	1
Not Certified General purpose applications only			
Yes Yes Yes Yes (#)	Yes Yes Yes Included	Yes Yes Yes Included	Yes Yes Yes Yes (#)
BA495	N/A	N/A	BA495

 # Only one may be fitted

Table 2 Panel mounting rate totalisers

2. Selecting a model

When selecting a model the following requirements should be considered:

Mounting Field or panel

Location Safe area

Gas Hazardous area
- Zone 0, 1 or 2
- Type of protection
- Certification authority

Dust hazardous area
- Zone 21 or 22
- Type of protection
- Certification authority

Number of inputs 1 or 2 flowmeter inputs

Options
- Display backlight
- Dual alarm outputs
- Pulse output
- 4/20mA output

To simplify selection Table 1 summarises the specifications of all the field mounting Rate Totalisers and Table 2 contains similar information for the panel mounting models. Detailed specifications, datasheets, instruction manuals and third party safety and ingress certificates for each model are available from the BEKA website www.beka.co.uk.

2.1 Mounting

The BEKA range of pulse input Rate Totalisers includes models for field and panel mounting.

2.1.1 Field mounting

Field mounting Rate Totalisers with a 'G' model number suffix have a robust glass reinforced polyester (GRP) enclosure with an 8mm thick toughened glass window. The enclosure has IP66 ingress protection which will not be degraded by 7J impacts to the GRP case or 4J impacts to the window at temperatures between -40°C and +70°C. The enclosure's ingress and impact protection has been independently assessed by a third party UKAS accredited test house. The resulting test certificate is shown on the BEKA website.

The enclosure material is carbon loaded to prevent the accumulation of static charges. The thermoset GRP is very strong and will not corrode or degrade when used for Rate Totaliser installations in marine and waste water environments. For installations in hazardous areas, GRP overcomes the restrictions limiting the use of aluminium in potentially explosive atmospheres.

Field mounting instruments with a 'G' model number suffix have two M20 x 1.5 tapped cable entries. To maintain the integrity of the Rate Totaliser enclosure both cable entries should be fitted with impact resistant M20 x 1.5 IP66 glands, conduit entries or blanking plugs.

The instrument's units of measurement and tag information can be marked onto a slide-in scale card clearly visible above and below the display. Although easy to configure on-site, Rate Totalisers can be supplied configured and calibrated with this scale card printed with customer specified units of measurement for no additional charge.

A 316 stainless steel legend plate which can be supplied laser engraved with customer specified information is available as an option.

Field mounting Rate Totalisers are surface mounting, but can be be pipe or panel mounted using one of the BEKA accessory kits.

BA393G 316 stainless steel kit, attaches instrument to any vertical or horizontal pipe with outside diameter between 40 and 73mm.

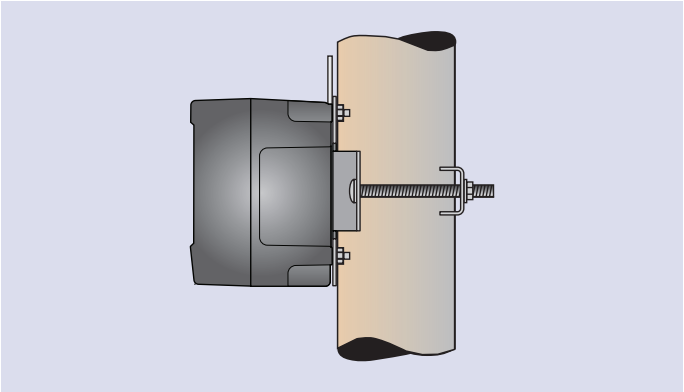


Fig 1 BA393G Pipe mounting kit

BA394G 316 stainless steel panel mounting kit secures field mounting instrument into a panel aperture, but does not seal panel aperture.

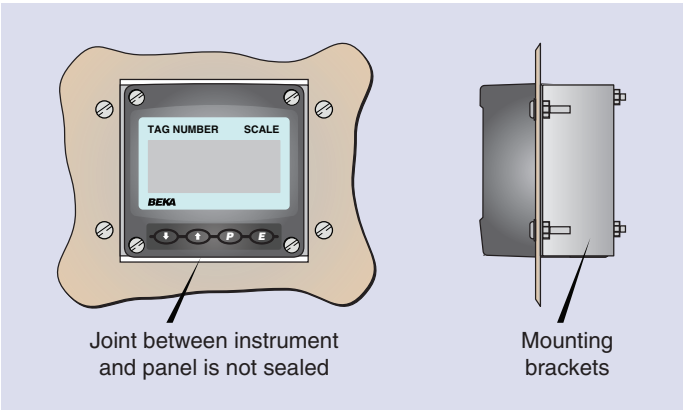


Fig 2 BA394G Panel mounting kit

BA494G GRP panel mounting kit secures field mounting instrument into a panel aperture and provides IP66 seal between front and rear of the panel.

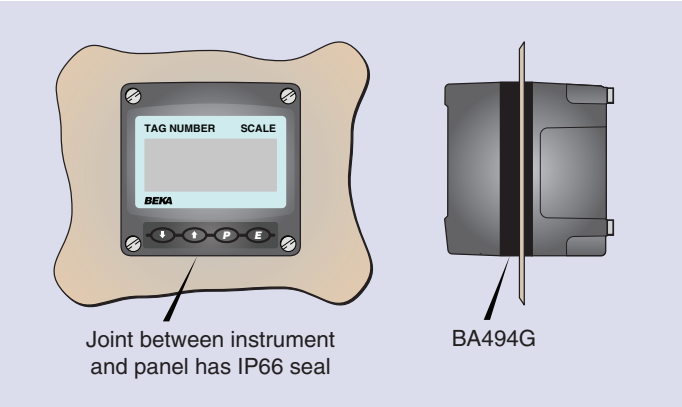


Fig 3 BA494G Sealed panel mounting kit

In addition to the 'G' suffix Intrinsically safe field mounting models, 'E' suffix intrinsically safe Rate Totalisers are also available. The 'E' suffix models have a separate field terminal enclosure and three tapped M20 x 1.5 cable entries. These models have display backlights, dual alarms and isolated pulse and 4/20mA outputs.

2.1.2 Panel mounting

Panel mounting Rate Totalisers are available in 96 x 48mm and 144 x 72mm glass loaded Noryl (modified PPE) DIN enclosures with toughened scratch resistant glass display windows. The enclosure size depends upon the display size and the number of pulse inputs. Both enclosures have IP66 front of panel ingress protection, and when correctly installed provide an IP66 seal between the instrument and the instrument panel.

The ingress protection of the enclosures have been independently assessed at temperatures between -40°C and +70°C by a third party UKAS accredited test house. The resulting test certificate is shown on the BEKA website.

The instrument's units of measurement can be marked onto a slide-in scale card clearly visible at the right hand side of the display. The scale card can be fitted without opening the instrument enclosure or removing the Rate Totaliser from the instrument panel. Although easy to configure on-site, Rate Totalisers can be supplied configured with the scale card printed with customer specified units of measurement for no additional charge.

For panel mounting applications in marine environments, or where the front of the instrument is likely to be impacted, single input rugged models are available in a 316 stainless steel enclosure. These models, which are identified by an '-SS' model number suffix, have identical features as the other models including a slide-in scale card.

The enclosure has IP66 front of panel ingress protection, and when correctly installed provide an IP66 seal between the instrument and the instrument panel. The ingress protection of the enclosure has been independently assessed at temperatures between -40°C and +70°C by a third party UKAS accredited test house. The resulting test certificate is shown on the BEKA website.

Intrinsically safe Rate Totalisers with an '-SS' suffix have been certified for installation in Ex e and Ex p enclosures without invalidating the certification of the panel enclosure in which they are mounted at temperatures between -40°C and +60°C.

The rear of panel ingress protection of all 96 x 48mm and 105 x 60mm rugged stainless steel Rate Totalisers can be increased to IP66 with a BA495 rear cover sealing kit. Manufactured from 316 stainless steel the cover incorporates two M20 entries for cable glands, allowing these Rate Totalisers to be installed in open panels.

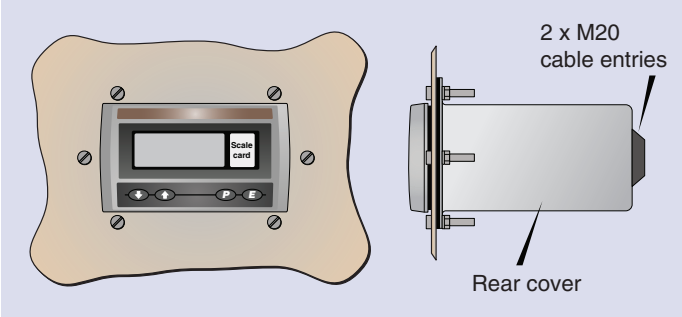


Fig 4 BA495 rear cover

2.2 Location

Having decided how the Rate Totaliser is to be mounted, the location of the installation will help to determine the required model.

2.2.1 General purpose application

If the Rate Totaliser is to be installed in an area which does not have a flammable gas or combustible dust hazard, one of the following general purpose Rate Totalisers should be selected.

Field mounting see Table 1

BA534G	1 input
BA584G	2 input

Panel mounting models are available in two alternative DIN enclosure sizes plus a rugged impact resistant instrument in a 316 stainless steel enclosure.

Panel mounting see Table 2

BA537E	1 input	96 x 48mm
BA538E	1 input	144 x 72mm
BA537E-SS	1 input	Rugged 105 x 60mm
BA588E	2 input	144 x 72mm

2.2.2 Explosive atmosphere applications

To select a Rate Totaliser for a hazardous area installation, the Zone or Division in which it is to be installed and the hazard must be known, together with the required certification authority i.e. IECEx, ATEX, UKEX or ETL.

The range includes intrinsically safe Ex ia models for installation in most gas and dust Zones.

Field mounting see Table 1

BA334E	1 input	1G	Ex ia	*Separate terminal compartment.*
BA334G	1 input	1GD	Ex ia	
BA384E	2 input	1G	Ex ia	*Separate terminal compartment.*
BA384G	2 input	1GD	Ex ia	

Panel mounting see Table 2

BA337E	1 input	96 x 48mm	1G Ex ia
BA338E	1 input	144 x 72mm	1G Ex ia
BA337E-SS	1 input	Rugged 105 x 60mm	1GD Ex ia
BA388E	2 input	144 x 72mm	1G Ex ia

When selecting a Rate Totaliser for installation in a hazardous area, the instrument's hazardous area certificate should be consulted to ensure that the instrument has approval for the required area, hazard and temperature range.

2.3 Two input models

The two input Rate Totalisers are primarily intended for use with two flowmeters. Each Rate Totaliser input is individually configurable and the instrument can display either input, or the sum or difference of the two flow rates and totals.

The two input models enable the total flow and flow rate from two sources to be calculated and displayed. If it is required to add more than two flow sources, multiple Rate Totalisers can be linked using the instrument's synchronous pulse output.

2.4 Operating temperature

All the field and panel mounting Rate Totalisers except models with an 'E-SS' suffix have a specified operating temperature of -40°C to +70°C. Between these temperatures the Rate Totalisers will function normally, however at temperatures below -20°C the display digits will gradually change more slowly and contrast will be reduced. At some temperature below -20° the display will stop functioning, but totalisation will continue normally and the instrument will not be damaged.

Models with an 'E-SS' suffix have a maximum certification temperature of +60°C but performance is the same as the other models at low temperatures.

3. Rate Totaliser function

All BEKA externally powered pulse input Rate Totalisers have similar functions, although the number of inputs and the output options may differ. Fig 5 shows a simplified block diagram of a one input instrument.

All models can accept pulses from a wide variety of flowmeter transducers or outputs. To enable a Rate Totaliser to count pulses from transducers such as a switch contact, open collector transistor or a two wire proximity detector, the transducer has to be powered which is achieved by fitting an external link between two of the Rate Totaliser's field terminals.

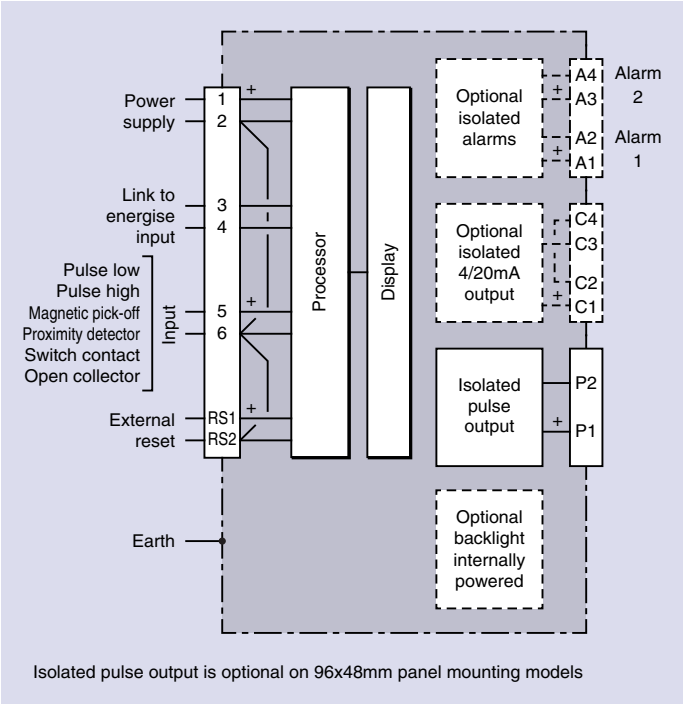


Fig 5 Simplified diagram of single input Rate Totaliser

Rate Totalisers can calculate and display the rate of flow and the total flow from most pulse output flowmeters including non-linear flowmeters such as a turbine meter operating over a wide range of flows. All models include a sixteen segment lineariser which can be configured to minimise non-linearity errors. Rate Totalisers with two inputs have separate configuration functions and a separate lineariser for each input.

All the Rate Totaliser models have separate rate and total displays as shown in Fig 6 with independent calibration allowing the rate of flow and the total flow to be displayed in different units of measurement. e.g. rate of flow could be shown in litres per hour and the total flow could be in cubic metres. The display digit size depends upon the model as shown below.

	Display size	
	6 digits	**8 digits**
Field mounting		
All models	12mm	18mm
Panel mounting		
96 x 48mm	6mm	9mm
144 x 72mm	12mm	18mm
Rugged 105 x 60mm	6mm	9mm

Rate of flow and total flow may be shown on either the 6 or 8 digit displays. If only one variable is required, the lower six digit display may be disabled.

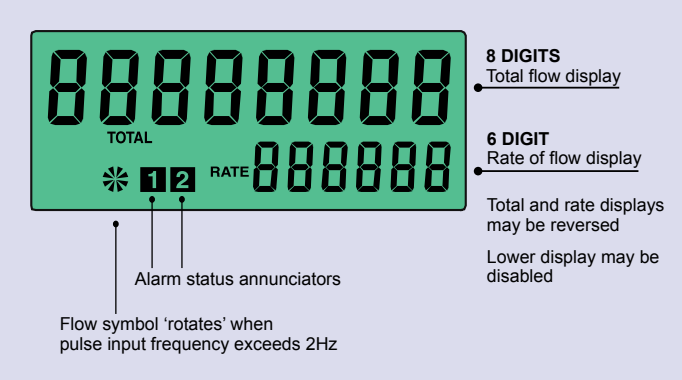


Fig 6 Rate Totaliser display

The total display may be reset to zero by operating two of the Rate Totaliser's push buttons, or remotely by connecting the instruments external reset terminals together for more than one second.

The Rate Totaliser also maintains a protected Grand Total which is not reset when the total display is zeroed. Both the total display and the grand total are retained when the Rate Totaliser is not powered.

4. Rate Totaliser Configuration

All models are configured and calibrated using a common intuitive menu structured in the same way as all BEKA instruments. The menu is accessed via the four instrument push buttons and can be protected by a user defined four digit access code. The calibration structure of all single input Rate Totalisers is shown in Fig 7. This allows a Rate Totaliser to be configured and calibrated on-site without the need for external test equipment.

The configuration menu uses English language names to describe functions and variables such as CodE and dEbounCE. When the function name has more than eight characters a simple abbreviation is used such as di SP- 1 (Display 1) and t-rESEt (Total reset). In this Application Guide these function and variable names are shown in a seven segment font, exactly as they appear on the Rate Totaliser's display.

BEKA rate Totalisers are easy to calibrate as there are only four basic variables to adjust.

Flowmeter K-factor	FACtor
Total scale factor	SCALE t
Rate scale factor	SCALE r
Timebase	t-bASE

The first three variables, FACtor, SCALE t and SCALE r divide the number of input pulses from the flowmeter to convert them to meaningful engineering units, such as gallons or litres. As shown in Fig 7 they are arranged so that the total flow and the rate of flow can be shown in different engineering units. Each variable is adjustable between 0.0001 and 99999 and is described separately in the following sections.

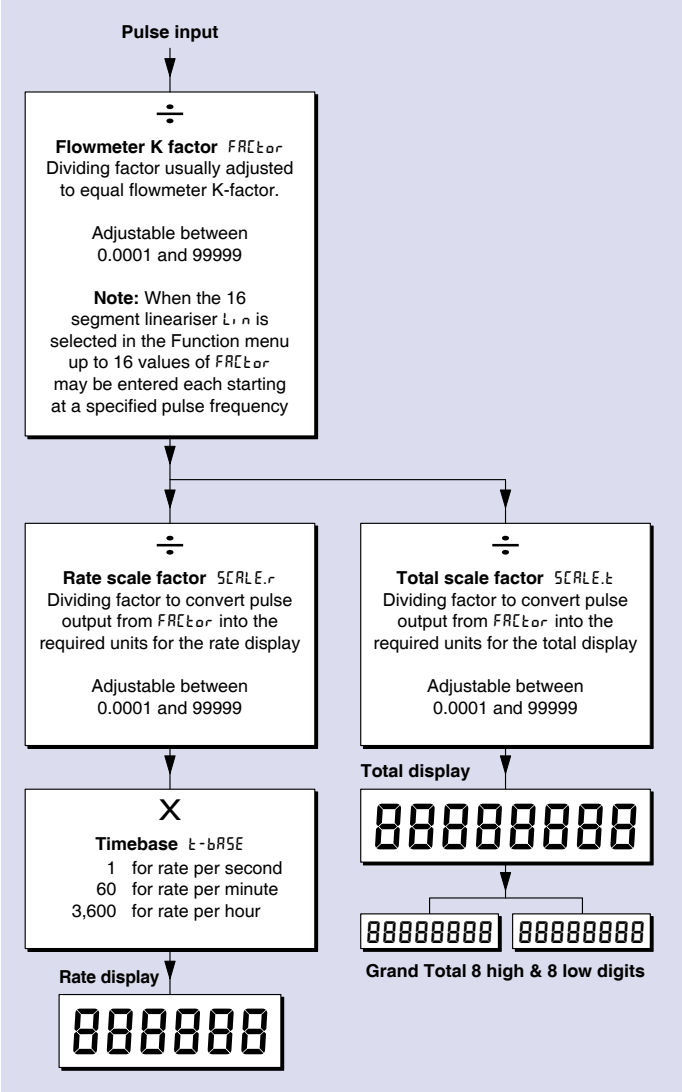


Fig 7 Single input Rate Totaliser Configuration structure

4.1 Flowmeter K-factor

Each output pulse from a flowmeter or flow transducer represents a defined flow volume that has passed through the flowmeter. For most flowmeters this is small compared with the total flow volume that is to be measured. The performance of flowmeters and flow transducers is therefore defined by the number of output pulses they produce for each unit of flow volume passing through them e.g. 200 pulses per gallon of flow. This is known as the K-factor of the meter or transducer. Most flowmeters and transducers are supplied with a test certificate showing the average K-factor over a range of flow rates.

To convert the pulse output from a flowmeter or flow transducer into engineering units, the number of output pulses must be divided by the K-factor of the flowmeter or flow transducer.

This can be illustrated with a simple example. To calculate the total flow in engineering units measured by a flowmeter having a K-factor of 70 pulses per litre after it has output 1075 pulses.

$$\frac{\text{Number of output pulses}}{\text{Flowmeter K-factor}} = \frac{1075}{70} = 15.36 \text{ litres}$$

All BEKA pulse input Rate Totalisers achieve this conversion using a configurable dividing constant called FACtor which can be adjusted between 0.0001 and 99999 as shown in Fig 7.

For the flowmeter in this example having a K-factor of 70 pulses per litre, the dividing constant FACtor in the Rate Totaliser should be set to 70. After the Rate Totaliser has received 70 pulses from the flowmeter it will *transfer* one pulse, representing 1 litre of flow, to the following Rate Totaliser adjustable functions Scale Factor SCALE r and the Total Scale Factor SCALE t as shown in Fig 8.

Unless a resolution greater than one K-factor unit of measurement is required, i.e. 1 litre in the above example, for most applications FACtor should be set to the K-factor of the flowmeter. Section 4.3.1 contains additional information about Rate Totaliser resolution.

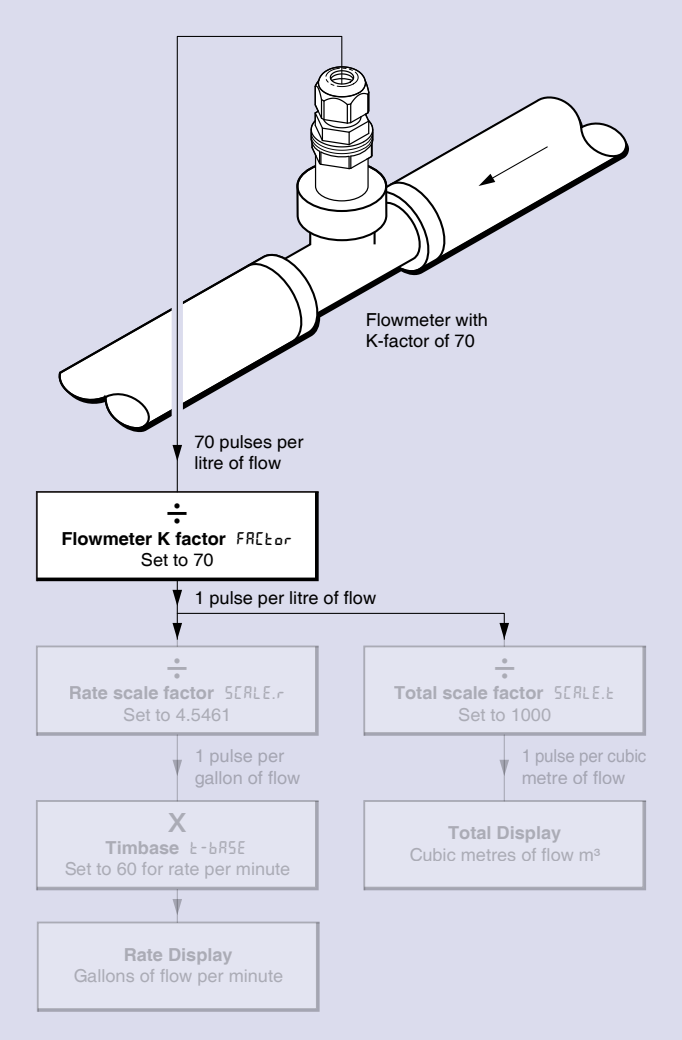


Fig 8 FACtor set to flowmeter K-factor

4.2 Total Scale Factor SCALE.t

As shown in the previous section the Rate Totaliser function FACtor is used to convert the number of input pulses received into engineering units such as litres or gallons.

If the Rate Totaliser's total display is required in the engineering units produced by FACtor no further scaling is required. However, to enable the total display to be in different engineering units, or in multiples of the engineering units produced by FACtor such as thousand of litres or gallons, an additional scaling factor SCALE.t is included.

SCALE.t is a dividing factor adjustable between 0.0001 and 99999 that divides the output of the factor function to produce the total display in the required engineering units.

Fig 9 illustrates how SCALE.t can be used to extend the example shown in Fig 8 to produce a total display in m³. Each pulse output from FACtor represent one litre of total flow. There are 1,000 litres in a cubic metre, therefore the output from FACtor requires dividing by 1000 to convert it to cubic metres m³.

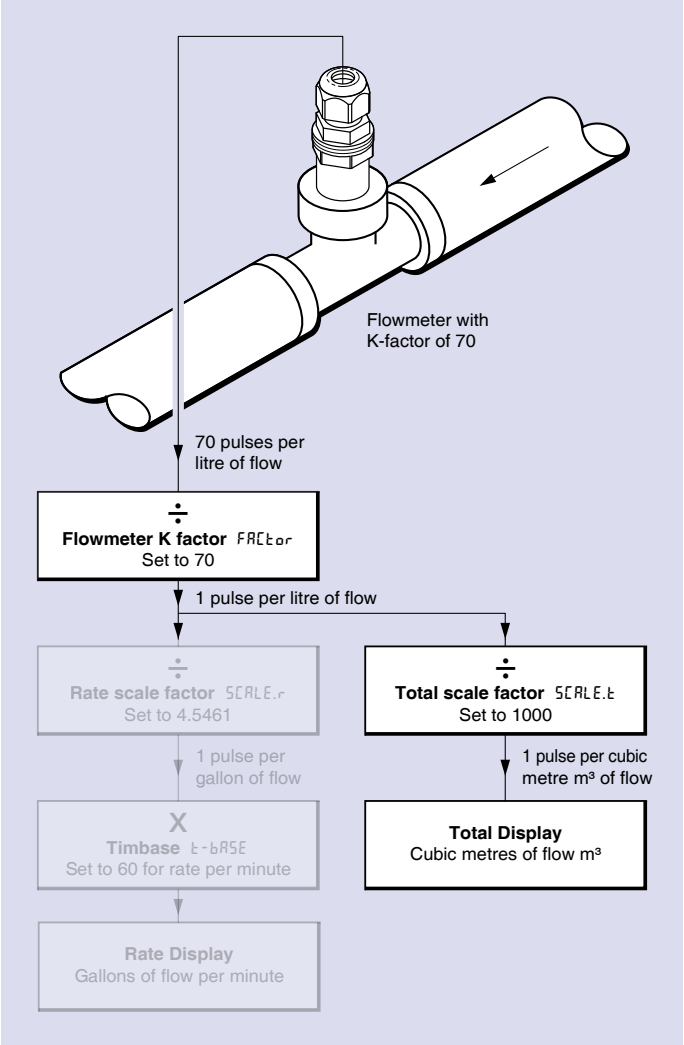


Fig 9 SCALE.t set to 1000 to produce total flow display in cubic metres m³

4.3 Rate scale factor SCALE.r

Function SCALE.r is similar to SCALE t described in the previous section. As shown in section 4.1 the Rate Totaliser function FACtor is used to convert the number of input pulses received from the flowmeter into engineering units such as litres or gallons.

If the Rate Totaliser's rate display is required in the engineering units produced by FACtor no further scaling is required. However, to enable the rate display to be in different engineering units, or in multiples of the engineering units produced by FACtor, such as thousands of litres or gallons, an additional scaling factor SCALE.r is included.

Functions SCALE.r and SCALE.t receive their inputs from FACtor. Both are independently adjustable which enables the Rate Totaliser to have rate and total displays with different units of measurement.

SCALE.r is a dividing factor adjustable between 0.0001 and 99999 that enables rate of flow to be displayed in the required engineering units. It is used in conjunction with the Rate Totalisers timebase t-bASE which determines whether the flow rate is displayed per second, per minute or per hour.

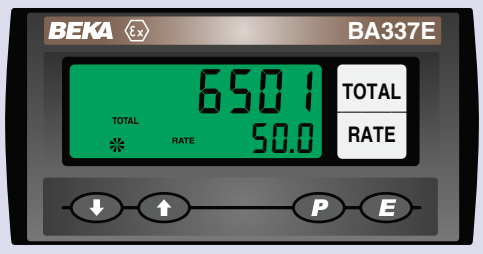
Continuing the example shown in Fig 8 and assuming that the flow rate display is required in gallons per minute. Fig 10 illustrates how SCALE.r is set to produce a rate display in gallons. Each pulse output from the FACtor function represent one litre of total flow. There are 4.5461 litres in an imperial gallon, therefore the output from factor requires dividing by 4.5461 to convert it to imperial gallons. This is achieved by setting SCALE.r to 4.5461.

4.3.1 Resolution

The output from FACtor will determine the resolution of the Rate Totaliser. If increments of flow smaller than one K-factor unit of measurement are significant, FACtor should be reduced.

The effect of reducing FACtor for a flowmeter having a K-factor of 200 pulses per litre are shown below.

FACtor	**Instrument resolution**
200	1 litre
20	0.1 litre
2	0.01 litre



Total and Rate are displayed simultaneously and can have different units of measurements

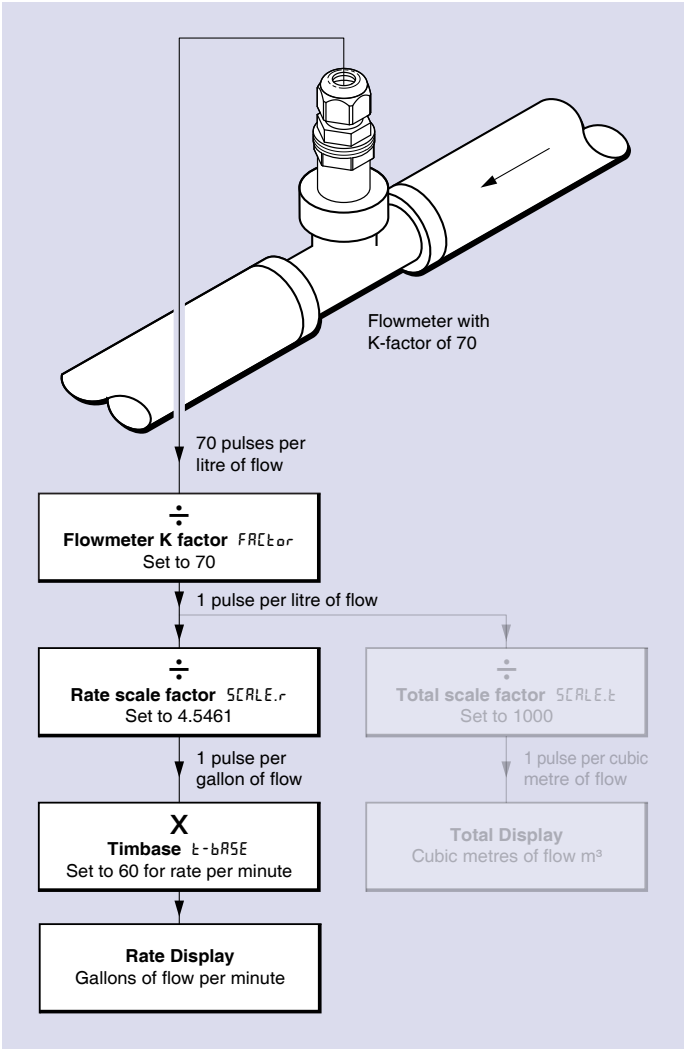


Fig 10 SCALE.r and t-bASE set to provide a Rate Display in Gallons / minute

4.4 Timebase: t-bASE

As described in the previous section, the rate scale factor SCALE.r defines the engineering units of the rate display. The Rate Totaliser can display rate of flow per second, per minute or per hour.

The Rate Totaliser timebase t-bASE enables the output from SCALE.r to be multiplied by 1, 60 or 3,600 to produce a rate display per second, per minute or per hour as shown below:

t-bASE **menu options**	
tb-1	x 1 for flow / second
tb-60	x 60 for flow / minute
tb-3600	x 3600 for flow / hour

For this example the rate display is required in gallons per minute, therefore t-bASE is set to tb-60 as shown in Fig 6.

5 Linearisation

Flowmeters are usually supplied with a calibration certificate specifying their average K-factor and the flow range over which it applies. For use over extended flow ranges and for non-linear flowmeters, multiple K-factors will be specified each at a different flow rate. For these devices the calibration certificate is likely to contain a table similar to the one shown below.

Flow Rate Litres/min	**K-factor** Pulses/litre
5	200
10	230
15	239
20	242

Table 3 Typical flowmeter calibration certificate

To minimise display errors resulting from flowmeter non-linearity, all BEKA Rate Totalisers incorporate a 16 segment straight line lineariser which when correctly configured will compensate for the flowmeter non-linearity. When the Rate Totaliser's lineariser is enabled up to 16 values of the flowmeter's K-factor may be entered in the L-FACtor function, each at a specified input pulse frequency PuLSE FrE.

The output frequency of the flowmeter, which is required for calibrating the Rate Totaliser lineariser, can be calculated from the information in the flowmeter calibration certificate.

$$\text{Output frequency Hz} = \frac{\text{(Flow rate per min) x (K-factor)}}{60}$$

Or if the flow rate is specified per second.

$$\text{Output frequency Hz} = \text{(Flow rate per second) x (K-factor)}$$

Flow Rate Litres/min	**K-factor** Pulses/litre	**Output frequency** Hz
0	0	0
5	200	16.666
10	230	38.333
15	239	59.750
20	242	80.666

Table 4 Calculated lineariser calibration information

6 Pulse output

All field mounting BEKA Rate Totalisers and the 144 x 72mm panel mounting models have an optically isolated open collector pulse output. This pulse output is available as a factory fitted option for the smaller 96 x 48mm and the rugged 105 x 60mm panel mounting models.

The output pulse may be a synchronous duplicate of the input pulse for re-transmission applications, or it may be derived from incrementation of the least significant digit of the total display, irrespective of the decimal point position. When derived from the total display the output pulse frequency may be divided and the output pulse width defined.

Selecting dirECt in the pulse output configuration menu produces a synchronous duplicate of the Rate Totaliser input pulse at frequencies up to 5kHz.

When SCALEd is selected in the pulse output configuration menu, the pulse output is derived from the incrementation of the least significant digit of the total display, irrespective of the position of the displayed decimal point. When SCALEd is selected the Rate Totalisers pulse output frequency may be divided by:

1
10
100
1000
10000

and the pulse output width (duration) may be selected from eleven options:

0.1 ms
0.5 ms
1 ms
2.5 ms
5 ms
10 ms
25 ms
50 ms
100 ms
250 ms
500 ms

If configured such that the output pulse frequency with the specified pulse width can not be output in real time, the number of pulses will be stored and transmitted at the maximum possible speed, but will not be stored if the total display is reset to zero or the Rate Totaliser is disconnected or switched off.

To prevent misleading or dangerous pulse outputs after any changes are made to the Rate Totaliser configuration, the pulse output must be manually re-enabled before it will function.

The pulse output of a two input Rate Totaliser may be a synchronous duplicate of either pulse input, or it may be derived from incrementation of the least significant digit of the composite total display (input A + input b) irrespective of which total is being displayed by the instrument. A pulse output can not be derived from a composite total display of (input A - input b).

7. Optional 4/20mA output

All BEKA Rate Totalisers can be supplied with a factory fitted galvanically isolated 4/20mA current sink output which can be used for retransmission to other instrumentation. This output appears as a 4/20mA loop powered transmitter requiring an external power supply between 5 and 28V. The output can be configured to represent any part of the instrument's rate or total display.

To prevent a misleading or dangerous current output after any changes to the Rate Totaliser configuration, the 4/20mA output must be manually re-enabled before it will function.

8. Optional dual Alarm outputs

All BEKA Rate Totalisers can be supplied with factory fitted dual alarms. Each alarm has a galvanically isolated, solid state single pole, voltage free output that may be independently configured as a high or low, rate or total alarm with a normally open or normally closed output.

Configurable functions for each alarm include the setpoint, alarm delay and silence time. Hysteresis may be applied to rate alarms.

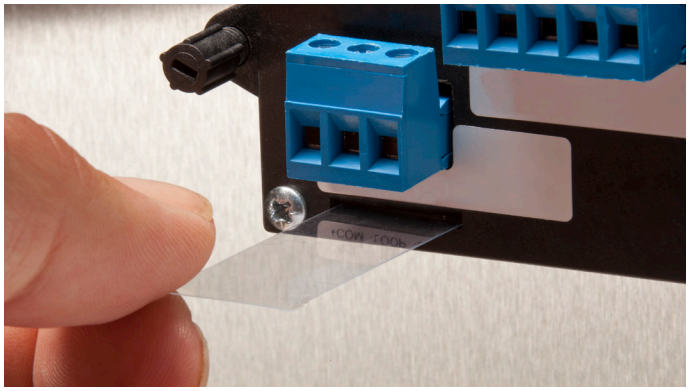
When the Rate Totaliser's power supply is turned off or disconnected, alarm outputs will open irrespective of whether normally open or normally closed outputs have been selected. When designing a system it is recommended that an open output should be selected for the alarm condition.

Alarm annunciators on the instrument display indicate the status of each alarm. If an alarm delay or silence time has been selected the annunciator will flash during the delay or silence period.

9. Slide-in scale card

All Rate Totaliser's, except the 'E' suffix field mounting models, have a slide-in scale card which can be printed to show the instruments units of measurement. The scale card is mounted on a flexible strip that is inserted into a slot at the rear of panel mounting Rate Totalisers and adjacent to the terminals on field mounting instruments.

New Rate Totalisers can be supplied with a printed scale card showing requested units of measurement for no additional charge. If this information is not supplied when the instrument is ordered a blank card will be fitted which can easily be marked on-site.



Inserting scale card in panel Rate Totaliser

10. Configuration examples

This section contains some examples of Rate Totaliser configurations requested by BEKA customers. Step-by-step instructions are not included nor are non-calibration configuration functions.

Example 1

In this example a user required a BEKA Rate Totaliser to display total flow in Gallons with a resolution of 0.1 and the flow rate in Gallons per Minute with a resolution of 1.

An output pulse is required for each gallon of total flow.

The flowmeter has a K-factor of 10 pulses per Gallon.

Summary

Flowmeter K-factor	10 pulses / gallon
Required total display	0.0 gallons
Required rate display	0 gallons / minute
Pulse output	1 pulse / 1 gallon of flow

Rate Totaliser Configuration

Flowmeter K-factor

FACtor 10.0

Converts output from flowmeter into engineering units gallons.

Total display

SCALE t 1.0
dP totAL 0.0

Display is required in gallons, therefore SCALE t is set to 1 as FACtor has converted pulse input into gallons. Total display resolution of 0.1 gallons is required, hence decimal point is positioned before the least significant digit.

Rate display

SCALE r 1.0
dP rAtE 0
t-bASE tb-3600

Display is required in gallons, therefore SCALE r is set to 1 as FACtor has converted pulse input into gallons. Rate display resolution of 1 gallon is required, hence decimal point is positioned after least significant display digit where it is not visible.
Selecting a timebase of tb-60 multiplies the rate display by 60 to show flow rate per minute.

Pulse output

SourCE SCALEd
di Vi dE 10

The Rate Totaliser outputs a pulse each time the least significant digit of the total display is incremented. The least significant digit represents 0.1 gallons so this rate has to be divided by 10 to produce one output pulse per gallon of total flow.

Example 2

This example illustrates a Rate Totaliser with the rate and total displays having different engineering units. Total flow is required in m³ with a resolution of 0.1 and the flow rate in litres per Minute with a resolution of 1.

An output pulse is required for each 0.1m³ of total flow.

The flowmeter has a K-factor of 1 pulse per litre.

Summary

Flowmeter K-factor	1 pulse / litre
Required total display	0.0 m³
Required rate display	0 litres / minute
Pulse output	1 pulse / 0.1 litres of flow

Rate Totaliser Configuration

Flowmeter K-factor

FACtor 1

Each output pulse from the flowmeter represents 1 litre therefore no further conversion is required.

Total display

SCALE t 1000
dP totAL 0.0

Display is required in m³, therefore SCALE t is set to 1000 as there are 1000 litres in a m³. Total display resolution of 0.1 m³ is required, hence decimal point is positioned before the least significant digit.

Rate display

SCALE r 1.0
dP rAtE 0
t-bASE tb-60

Display is required in litres / minute. Each pulse already represents 1 litre so no further scaling is required and SCALE r is set to 1.0 Rate display resolution of 1 litre is required, hence decimal point is positioned after the least significant display digit where it is not visible.
Selecting a timebase of tb-60 multiplies the rate display by 60 to show the flow rate per minute.

Pulse output

SourCE SCALEd
di Vi dE 1

The Rate Totaliser outputs a pulse each time the least significant digit of the total display is incremented. The least significant digit of the total display represents 0.1 m³ which is the required output pulse resolution,therefore no further division is required.

Example 3

The requirements of this example are identical to those for example 2 except for the pulse output. In this example an output pulse is required for each litre of flow. which is the same as that being produced by the flowmeter.

Pulse output

SourCE dirECt

The required output pulse from the Rate Totaliser is the same as pulse output from the flowmeter i.e. 1 pulse per litre. Selecting dirECt in the pulse output configuration menu, results in the output pulse being a synchronous duplicate of the Rate Totaliser input pulse.

Example 4

This example illustrates how a Rate Totaliser can display total flow and the rate of flow from a stroke sensor on a reciprocating pump.

A display of the total oil flow is required in barrels of oil with a resolution of 0.1. The Rate Totaliser is also required to display the pump stroke rate in pump strokes per Minute.

An output pulse is required for each barrel of total flow.

Each pulse from the pump represents one stroke which is equivalent to 0.6247 US Gallons.

Summary

Flowmeter K-factor	1 pulse / 0.6247 USG
Required total display	0.0 Barrels
Required rate display	0 Strokes / minute
Pulse output	1 pulse / Barrel

Rate Totaliser Configuration

Flowmeter K-factor

FACtor 1.0

Each output pulse from the pump represents 1 stroke therefore no further conversion is required.

Total display

SCALE t 67.232
dP totAL 0.0

The display is required in Barrels, therefore SCALE t has to convert pump strokes to Barrels.
Each pump stroke displaces 0.6247 US Gallons and there are 42 US Gallons in a barrel.

SCALE t = 42 / 0.6247 = 67.232

Total display resolution of 0.1 barrels is required, hence decimal point is positioned before the least significant digit of the display.

Rate display

SCALE r 1.0
dP rAtE 0
t-bASE tb-60

Display is required in pump strokes / minute. Each pulse already represents 1 pump stroke so no further scaling is required and SCALE r is set to 1. Rate display resolution of 1 Stroke is required, hence decimal point is positioned after least significant display digit where it is not visible.
Selecting a timebase of tb-60 multiplies the rate display by 60 to show pump strokes rate per minute.

Pulse output

SourCE SCALEd
diUidE 10

The Rate Totaliser outputs a pulse each time the least significant digit of the total display is incremented. The least significant digit represents 0.1 barrels so this rate has to be divided by 10 to produce one output pulse per barrel of total flow.

Example 5

This example illustrates how a BEKA two input Rate Totaliser can be used to display the rate of flow and the total flow of two reciprocating mud pumps and their composite rates and totals i.e. pump 1 + pump 2. Each pump has a displacement of 1 litre per stroke and a sensor outputs one pulse per stroke.

The rate display is required in pump strokes per minute and the total mud flow is to be displayed in m³ with a resolution of 0.1 m³. Operating the Rate Totalisers front panel ⏶ or ⏷ push button while the instrument is functioning scrolls the display through pump 1, pump 2 or the composite output of both pumps, but it does not affect the instruments performance or output.

A pulse is to be transmitted by the Rate Totaliser for each 0.1 m³ of composite mud pumped i.e. pump 1 + pump 2.

Summary

Pump K-factor	1 pulse / stroke which is equivalent to 1 litre.
Required total display	0.0 m³
Required rate display	0 strokes / minute
Pulse output	1 pulse / 0.1m³ of composite total flow.

Rate Totaliser Configuration

K-factor

FACtor-A	*pump 1*	1.0
FACtor-b	*pump 2*	1.0

Each output pulse from pump 1 and pump 2 represents 1 stroke which is equivalent to 1 litre of flow therefore no further conversion is required.

Total display

SCALE.t-A	1000
SCALE.t-b	1000

The display is required in m³, therefore SCALE.t has to convert litres to m³. Each pump stroke displaces 1 litre and there are 1000 litres in each m³.

Rate Display

SCALE.r-A	1
SCALE.r-b	1
dP rAtE	0
t-bASE	tb-60

The rate display is required in strokes per minute. Each pulse from pumps 1 and 2 represents 1 pump stroke so no further scaling is required for either input. Therefore both SCALE.r-A and SCALE.r-b are set to 1. Rate display resolution of 1 stroke is required, hence decimal point is positioned after the least significant display digit where it is not visible. Selecting a timebase of tb-60 multiplies the rate display by 60 to show pump stroke rate per minute.

Pulse output

SourCE	SCALEd
di Ui dE	1

An output pulse is required for each composite 0.1 m³ of mud pumped. The Rate Totaliser outputs a pulse each time the least significant digit of the composite total (pulse input A + pulse input b) is incremented, irrespective of whether the composite total is being displayed. In this example the least significant digit of the composite total represents 0.1m³ so scaling is not required.

However, if an output pulse was required for every 1.0m³ of composite total that was pumped, di Ui dE would have to be set to 10 i.e. 10 increments of the least significant digit (0.1m³ per increment) would occur before an output pulse was produced.

11. Additional information

If additional information or help is required with Rate Totaliser configuration, please call one of our sales engineers who will be pleased to help.

Although Rate Totalisers are easy to configure on-site, they can be supplied configured to customer specified requirements with a printed slide-in scale card for no additional charge.