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1. Introduction

This Application Guide is intended to aid the selection of the most suitable loop powered 4/20mA Rate Totaliser from the range manufactured by BEKA associates. It contains detailed background information about the certified intrinsically safe models together with a configuration example.

This guide does not contain detailed system design or step-by-step configuration information which is contained in the instruction manual for each model. The instrument instruction manual also contains detailed installation information. The instruction manual for each model can be viewed on the BEKA website at www.beka.co.uk

These loop powered instruments are primarily intended for use with flowmeters having an analogue 4/20mA output representing rate of flow. The instruments display the 4/20mA current as a flow rate in engineering units and integrate this flow rate to calculate and display the total flow in the same or different engineering units of measurement.

The BEKA range of loop powered 4/20mA Rate Totalisers 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 variety of factory fitted options including a display backlight and alarm outputs.

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 or escutcheon showing customer specified information for no additional charge.

BEKA also manufacture an extensive range of pulse input Rate Totalisers which have similar functions and are described in Application Guide AG334.



Loop powered Rate Totalisers


Model	BA354E	BA358E	BA354NE	BA554E	BA558E
					
Mounting & enclosure	Field GRP	Panel 144 x 72	Field GRP	Field GRP	Panel 144 x 72
Protection	IP66	IP66 front IP20 rear	IP66	IP66	IP66 front IP20 rear
Separate terminal compartment	Yes	No	Yes	Yes	No
Displays	Rate 5 digits 12mm high Total 8 digits 18mm high				
Certification International IECEx	Ex ia IIC T5 Ga Ex ia IIIC T80°C Da IP66 -40°C ≤ Ta ≤ +70°C	Ex ia IIC T5 Ga Ex ia IIIC T80°C Da IP20 -40°C ≤ Ta ≤ +70°C	Ex nA ic IIC T5 Gc Ex tc IIIC 80°C Dc IP66 -40°C = Ta = +70°C	Only for use in safe areas	
Certification Europe ATEX	II 1G Ex ia IIC T5 Ga II 1D Ex ia IIIC T80°C Da IP66 -40°C ≤ Ta ≤ +70°C	II 1G Ex ia IIC T5 Ga II 1D Ex ia IIIC T80°C Da IP20 -40°C ≤ Ta ≤ +70°C	II 3G Ex nA ic IIC T5 Gc II 3D Ex tc IIIC 80°C Dc IP66 -40°C = Ta = +70°C		
Certification USA & Canada FM & cFM	Div I, II, III Gp A, B, C, D, E, F, G T5 4X IP66 AEx ia IIC T5 Ta 70°C	Div I Gp A, B, C, D T5 4X IP66 AEx ia IIC T5 Ta 70°C			
Options					
Backlight	Yes	Yes	Yes	Yes	Yes
Alarms	Yes	Yes	Yes	Yes	Yes
External keypad	Yes	Standard	Yes	Yes	Standard

Table 1: All the models in this range of loop powered 4/20mA rate totalisers

2. Selecting a model

When selecting a model the following requirements should be considered:

Mounting	Field or panel
Location	Safe area
or	Gas Hazardous area Zone 0, 1 or 2 Type of protection
or	Dust hazardous area Zone 20, 21 or 22
Options	Display backlight Dual alarm outputs

To simplify selection Table 1 summarises the specifications of all the field and panel mounting Rate Totalisers. 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 loop powered 4/20mA Rate Totalisers includes models for field and panel mounting.

2.1.1 Field mounting

The field mounting Rate Totalisers have a robust glass reinforced polyester (GRP) enclosure with a 6mm 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 have 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. GRP is very strong and will not corrode or degrade when used for Rate Totaliser installations in marine and waste water environments.

The instrument's units of measurement and tag information can be shown on an internal escutcheon around the display. Although easy to configure on-site, field mounting Rate Totalisers can be supplied calibrated with the escutcheon printed with customer specified information for no additional charge.

A stainless steel legend plate, laser engraved with customer specified tag information, which can be secured to the front of the enclosure, is available as an accessory.

Field mounting instruments have three M20 x 1.5 threaded cable entries and are supplied fitted with two certified M20 x 1.5 IP66 blanking plugs and one temporary hole plug. The FM certified models have three unthreaded 22.25mm diameter plain holes which will accept 3/4 inch NPT fittings.

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

2.1.2 Panel mounting

Panel mounting loop powered Rate Totalisers are housed in a 144 x 72mm glass loaded Noryl (modified PPE) DIN enclosure with a toughened scratch resistant glass display window. The panel enclosure has IP66 front of panel ingress protection, and when correctly installed provides 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.

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.



Inserting scale card in panel Rate Totaliser

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 loop powered 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.

BA554E	Field mounting
BA558E	Panel mounting

2.2.2 Explosive atmosphere applications

To select a loop powered Rate Totaliser for a hazardous area installation, the Zone or Division in which it is to be installed and the hazard must be known,

The range includes intrinsically safe Ex ia models for installation in most gas and dust Zones. For installations in Zone 2 or 22 without the need for Zener barriers or galvanic isolators, the BA354NE has non-sparking Ex nA certification for gas hazards and Ex tc certification for dust hazards.

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.

Field mounting

BA354E Zones 0, 1, 2, 20, 21 & 22

BA354NE Zones 2 and 22

Panel mounting

BA358E Zones 0, 1 & 2
Zones 20, 21 & 22
special conditions may apply

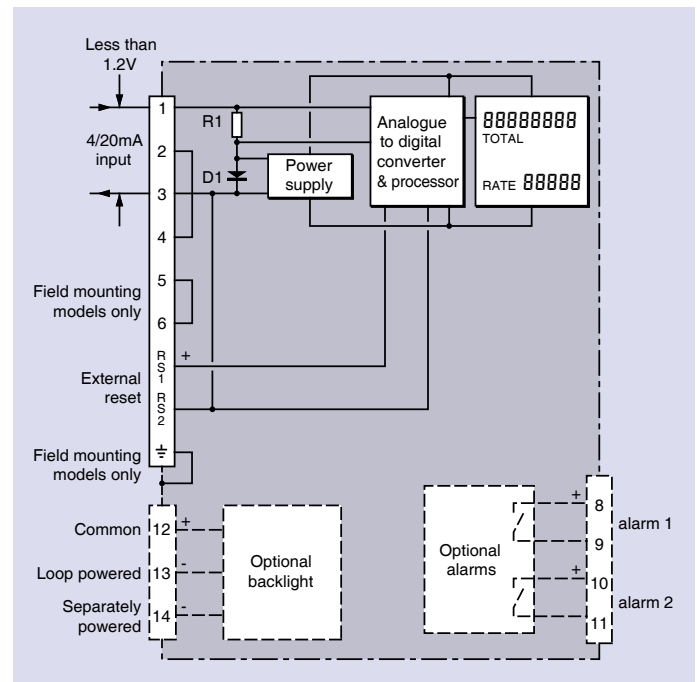


Fig 1 Simplified block diagram of BA354E and BA358E loop powered Rate Totalisers

3. Rate Totaliser function

All BEKA loop powered 4/20mA Rate Totalisers have similar functions, Fig 1 shows a simplified block diagram. The Rate Totalisers can be configured to simultaneously display the rate of flow in engineering units and the total flow in the same or different units. Fig 2 shows the instrument display.

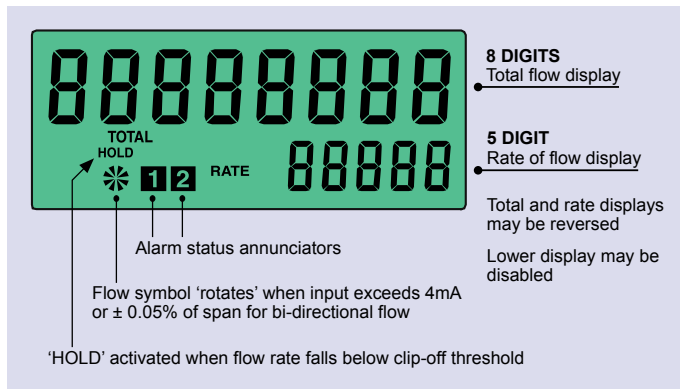


Fig 2 Rate Totaliser display

In the operating mode i.e. when the instrument is displaying rate and total flow the push button functions are:

Summary of Push Button Functions

- P** Displays input current in mA or as a percentage of span. Modified when optional alarms are fitted.
- ▼** Shows flow rate display calibration at 4mA input.
- ▲** Shows flow rate display calibration at 20mA input.
- E** + **▼** Grand total – displays least significant 8 digits
- E** + **▲** Grand total – Displays most significant 8 digits.
Configurable to reset grand total to zero after buttons are pressed for 10 seconds.
- ▼** + **▲** Resets total display
Configurable function can be disabled.
- P** + **▼** Shows firmware version
- P** + **▲** Access to alarm setpoint from operating mode.
Configurable function can be disabled.
- P** + **E** Access to configuration menu

4. Rate Totaliser Configuration

Loop powered Rate Totalisers are configured and calibrated via four front panel push buttons using a simple intuitive menu. To prevent accidental adjustment, access to the configuration menu can be protected by a four digit user selectable code. The push buttons on the field mounting models are located behind an IP66 cover providing increased security. If frequent adjustments are required an external keypad is available as an accessory. The instruments can be calibrated without disconnection from the 4/20mA loop and without the need for an external calibrator. Although simple to configure and calibrate, Rate Totalisers can be supplied calibrated to customer requirements for no additional cost, but can easily be recalibrated on-site.

4.1 Calibration structure

Fig 3 shows the Rate Totalisers calibration structure. The 4/20mA input current, which in flow applications represents flow rate, is displayed on the five digit lower display. If necessary this flow signal may be linearised using the square root extractor or the 16 segment lineariser which are selectable in the instrument's configuration menu.

The flow rate display may be calibrated using an external 4/20mA calibrator or the instruments internal references. Both the zero (flow rate display at 4mA) and the span (flow rate display at 20mA) are adjustable, although for unidirectional flow applications the display at 4mA is usually zero.

The position of the decimal point in the flow rate display is configurable and affects the instrument's totalisation. i.e. if the position of the rate display decimal point is moved one digit to the right, totalisation increases by a factor of ten.

For bi-directional flow applications, zero flow will be represented by an input current other than 4mA. For bi-direction flow applications, input currents below that representing zero flow will be shown as a negative flow rate and the total flow display will integrate down. For input currents above that representing zero flow will be shown as a positive flow rate and the total flow display will integrate up.

The total flow display is calculated from the flow rate display using two configurable factors, a timebase and a total scaling factor. The timebase converts the instrument's flow rate display be it flow per second, minute or per hour into an internal signal representing flow rate per second. This internal signal and the wide ranging configurable total scaling factor, enable the instrument to display total flow and rate of flow in different engineering units.

For example, if a Rate Totaliser is displaying flow rate in litres per minute, a total scale factor of 4.5461 will result in a total flow display in UK gallons. Alternatively, a total scale factor of 4546.1 will produce a total flow display in thousands of UK gallons.

The total is calculated and the display updated once per second, which defines the resolution of the total flow display. When an alarm output is configured as a total alarm this resolution may define the accuracy of the system. e.g. in a flow batching system.

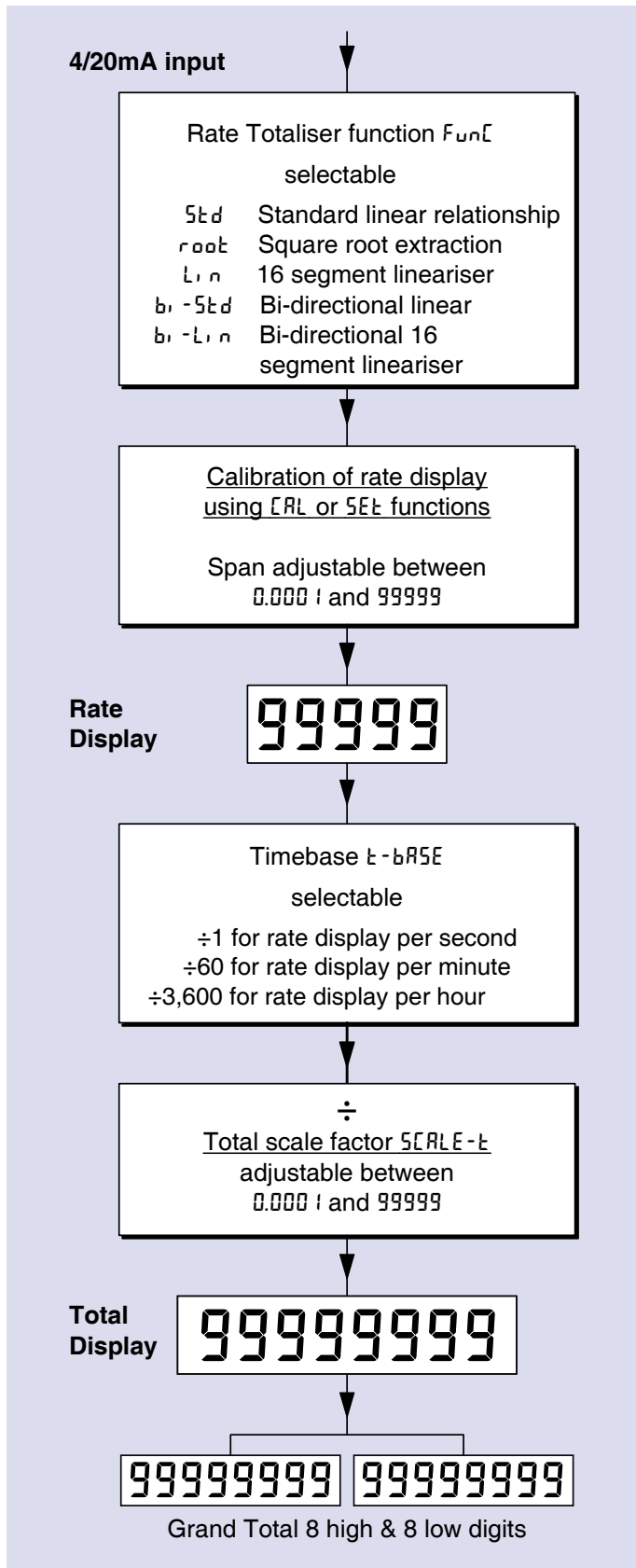


Fig 3 Calibration structure

In addition to the total flow display, all models have a sixteen digit grand total flow counter which is not reset to zero when the total flow display is reset to zero. The grand total flow is stored in the same engineering units as the total flow display and can only be reset to zero from within the configuration menu. The grand total flow can be viewed while the Rate Totaliser is in the operating mode.

Rate Totalisers can be supplied calibrated to customer requirements for no additional charge. If calibration is not requested, Rate Totalisers will be supplied with default configuration which can easily be changed on-site.

4.2 Square root extractor

In addition to a linear relationship between the 4/20mA input current and the flow rate display, the Rate Totalisers incorporate a square root extractor to linearise the output of differential pressure flowmeters which have a square law output.

For reference, the following table shows the output current from a non-linearised differential pressure flowmeter.

% of full flow	Current output mA
2.5	4.01
10.0	4.16
25.0	5.00
50.0	8.00
75.0	13.00
100.0	20.00

When the root function is selected the Rate Totaliser will display flow rate in linear units for uni-directional flow.

4.3 Lineariser

All loop powered Rate Totalisers have a sixteen segment lineariser which can be adjusted to compensate for flowmeter non-linearity. The position of each break-point is fully adjustable so that the slope of the straight line between each pair of break-points can be adjusted.

4.4 Clip-off

To prevent totalisation of very low flow rates, which over long periods may result in significant totalisation errors, all models incorporate an adjustable clip-off function. Adjustable from within the configuration menu, when the input flow rate falls below the clip-off threshold totalisation is inhibited and the HOLD annunciator on the instrument display is activated.

5. Intrinsic Safety Certification

The BA354E and BA358E have international intrinsic safety certifications allowing them to be installed in gas and dust hazardous areas worldwide.

Both models have IECEx Certificates of Conformity issued by Certification Body Intertek Testing and Certification Ltd. IECEx certificates, which are based on international IEC standards, are accepted directly or indirectly in large parts of the world.

Notified Body Intertek Testing and Certification Ltd have also issued both models with an EC-Type Examination Certificate confirming compliance with BS EN harmonised standards which have been used to confirm compliance with the European ATEX Directive 2014/34/EU. The instruments carry the Community Mark and, subject to local codes of practice, may be installed in any of the European Economic Area (EEA) member countries. ATEX certificates are also accepted for installations in many other countries - see Blue Book for details.

BS EN standards are identical to international IEC standards, therefore the ATEX and IECEx certificates for these Rate Totalisers use the same terminology and have the same safety parameters.

For use in the USA and Canada both models have FM and cFM intrinsic safety approval.

5.1 IECEx and ATEX certification.

5.1.1 Gas atmospheres

The BA354E and BA358E Rate Totalisers have been certified:

Group II Category 1G
Ex ia IIC T5 Ga
 $-40^{\circ}\text{C} \leq \text{Ta} \leq 70^{\circ}\text{C}$

When connected to a suitable system the Rate Totalisers and accessories may be installed in:

- Zone 0 explosive gas air mixture continuously present.
- Zone 1 explosive gas air mixture likely to occur in normal operation.
- Zone 2 explosive gas air mixture not likely to occur, and if it does will only exist for a short time.

Be used with gases in groups:

Group A	propane
Group B	ethylene
Group C	hydrogen

In gases which may be safely be used with equipment having a temperature classification of:

T1	450°C
T2	300°C
T3	200°C
T4	135°C
T5	100°C

In an ambient temperature of between

-40°C and $+70^{\circ}\text{C}$.

This allows the BA354E and BA358E Rate Totalisers to be installed in all Zones and to be used with most common industrial gases.

Note: Although certified safe at temperatures between -40°C and $+70^{\circ}\text{C}$, at temperatures below -20°C the display contrast will be reduced and at some temperature will stop functioning, but the instrument will continue totalising without any loss of data. When the temperature rises and the display function returns, the Rate Totaliser will operate normally.

5.1.2 Dust atmospheres

Both instruments and all accessories have been certified:

Field mounting BA354E
Group II Category 1D
Ex ia IIIC T80°C Da IP66
 $-40^{\circ}\text{C} \leq \text{Ta} \leq 70^{\circ}\text{C}$

Panel mounting BA358E
Group II Category 1D
Ex ia IIIC T80°C Da IP20
 $-40^{\circ}\text{C} \leq \text{Ta} \leq 70^{\circ}\text{C}$

When connected to a suitable system the Rate Totalisers and accessories may be installed in:

- Zone 20 explosive atmosphere in the form of a cloud of combustible dust in air is continuously present, or for long periods or frequently.
- Zone 21 explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur occasionally in normal operation.
- Zone 22 explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation, but if it does occur, will only persist for a short period.

Be used with dusts in subdivisions:

IIIA	combustible flyings
IIIB	non-conductive dust
IIIC	conductive dust

Having a minimum ignition temperature of:

Dust cloud	120°C
Dust layer on instrument up to 5mm thick.	155°C
Dust layer on instrument over 5mm thick	Refer to IEC 60079-14

At ambient temperatures between:
-40°C and +70°C.

- Notes: 1. Dust certification for the field mounting BA354E is a factory fitted option and must be specified when the instrument is ordered.
2. The BA358E panel mounting Rate Totaliser has IP20 rear protection and is therefore subject to the following special conditions for safe use indicated by an 'X' suffix on both the IECEx and ATEX certificate numbers.

'When installed in a IIIC conductive dust atmosphere, the BA358E shall be mounted such that the instrument terminals have at least IP6X protection'

These special conditions do not apply for installations in IIIA or IIIB dusts or gas atmospheres.

This means that when used in a IIIC conductive dust atmosphere the BA358E should be mounted in an IP6X panel enclosure or cubicle so that conductive dust can not contaminate the instrument terminals.

5.2 4/20mA input

For IEC based certifications, sources of energy which do not generate more than 1.5V; 100mA and 25mW are, for intrinsic safety purposes, considered to be *simple apparatus* (Clause 5.7 of IEC 60079-11).

Although the BA354E and BA358E Rate Totalisers do not themselves comply with the requirements for *simple apparatus*, the ATEX and IECEx certificates specify that under fault conditions the voltage, current and power output (U_o ; I_o ; P_o) from the 4/20mA input terminals will not exceed those specified for *simple apparatus*. This allows terminals 1, 2, 3 and 4 of the Rate Totaliser to be connected in series with any certified intrinsically safe 4/20mA loop without affecting the safety of the loop, simplifying assessment and documentation. The output parameters of the loop, which are defined by the Zener barrier, galvanic isolator or associated apparatus powering the loop, must be equal to or less than:

U_o	\leq	30V dc
I_o	\leq	200mA
P_o	\leq	0.84W

The IECEx and ATEX intrinsic safety certificates specify the maximum equivalent capacitance and inductance between the two 4/20mA input terminals:

C_i	=	13nF
L_i	=	16 μ H

To determine the maximum permissible cable parameters, these figures, plus those for any other instruments in the loop, must be subtracted from the maximum output capacitance C_o and output inductance L_o permitted by the certificate for the Zener barrier or galvanic isolator powering the loop.

5.3 External reset

The total flow display can be reset to zero by temporarily connecting terminals RS1 and RS2 together. This may be accomplished in the hazardous area by any mechanically operated switch and connecting cable which can withstand a 500V insulation test to earth. Most industrial push buttons are acceptable.

The output safety parameters of the reset terminals are:

U _o	=	6V dc
I _o	=	2.5mA dc
P _o	=	3.75mW

Therefore the maximum permissible capacitance and inductance which may be safely connected to these terminals is very large. Almost any practical length and type of cable may be used to connect the reset switch to the instrument.

To reset the total display from the safe area a Zener barrier, galvanic isolator or intrinsically safe relay is required to transfer the contact closure into the hazardous area. The maximum input safety parameters of the reset terminals RS1 and RS2 are:

U _i	=	30V dc
I _i	=	200mA
P _i	=	0.84W

Almost any positive polarity Zener barrier with output parameters equal to or less than these input parameters may be used. The industry standard 28V; 93mA may be used.

The IECEx and ATEX intrinsic safety certificates specify the maximum equivalent capacitance and inductance between the two reset terminals:

C _i	=	13nF
L _i	=	10µH

To determine the maximum permissible cable parameters, these figures should be subtracted from the maximum output capacitance C_o and output inductance L_o permitted by the certificate for the Zener barrier or galvanic isolator connected to the reset terminals.

Alternatively almost any intrinsically safe relay, with certification permitting the contacts to be connected into the hazardous area, may also be used to reset the total display from the safe area.

Rate Totalisers may also be configured so that the total flow display is reset to zero when the ▲ and ▼ push buttons are operated simultaneously for more than 2 seconds.

5.4 FM and cFM certification for installations in USA and Canada,

Both intrinsically safe Rate Totalisers have FM and cFM approvals allowing installation in Divisions and Zones in the USA and Canada.

Following the publication of ANSI/ISA-60079-11 which is based on the IEC intrinsic safety standard with modifications for the US market, FM Certificates of Compliance use similar terminology as ATEX & IECEx certificates, apart from definitions of hazardous locations.

The Rate Totalisers FM and cFM safety parameters are similar to the IECEx and ATEX safety parameters.

Both models also have nonincendive certification for applications in Division 2 and Zone 2.

- Note:**
1. FM and cFM certification of the field mounting BA354E is a factory fitted option that has to be specified when the instrument is ordered.
 2. When the BA358E panel mounting Rate Totaliser is located in a Class II or Class III hazardous location, the instrument shall be installed as defined by Note 11 of BEKA Control Drawing CI300-73 and the enclosure shall provide Type 4 protection.

Control Drawing CI300-73 can be downloaded with the FM Certificate of Compliance from the BEKA website.

6. Rate Totaliser intrinsic safety loop design

This guide describes ATEX and IECEx installations which conform with IEC / BS EN60079:14 *Electrical installation design, selection and installation*. When designing systems for installation outside of the UK, the local Code of Practice should be consulted.

6.1 Transmitter loops

The BA354E and BA358E Rate Totalisers may be connected in series with almost any certified intrinsically safe 4/20mA flow loop and calibrated to display the rate of flow and total flow in the same or different units. There are four simple design steps:

1. Select the BA354E for field mounting or the BA358E for panel mounting.
2. Ensure that the 4/20mA loop can support the additional 1.2V required to power the Rate Totaliser. This rises to 5V if the optional backlight is loop powered.
3. Ensure that the output safety parameters of the 4/20mA measurement loop, which are defined by the Zener barrier or galvanic isolator, are equal to or less than:

$$\begin{aligned} U_o &\leq 30V \text{ dc} \\ I_o &\leq 200\text{mA} \\ P_o &\leq 0.84W \end{aligned}$$

4. Ensure that the sum of the internal capacitances C_i of the Rate Totaliser, the flow transmitter and the cables is less than the C_o specified for the Zener barrier or galvanic isolator powering the loop. Similarly, ensure that the sum of the internal inductances L_i of the Rate Totaliser, the flow transmitter and the cables is less than the L_o specified for the Zener barrier or galvanic isolator powering the loop.

Fig 4 illustrates how a field mounting BA354E Rate Totaliser may be connected in series with a 2-wire intrinsically safe flow transmitter protected by a Zener barrier.

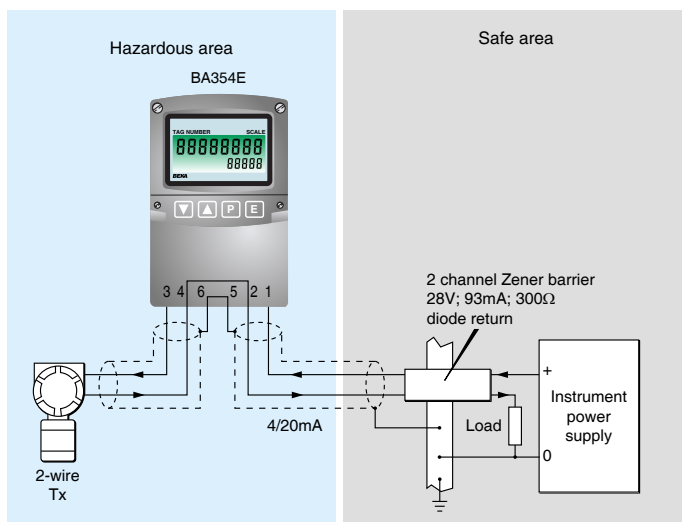


Fig 4 BA354E displaying rate of flow and total flow in hazardous area

6.2 Remote indication

If the flowmeter is located in a safe area, the BA354E or BA358E may be driven via an intrinsically safe interface to provide a remote rate and total flow display within a hazardous area. The type of interface is not critical; either a Zener barrier or a galvanic isolator may be used, but again U_o , I_o and P_o must not exceed 30V dc, 200mA and 0.84W.

Fig 5 illustrates three alternative circuits which may be used. If one side of the 4/20mA current loop may be earthed, a single channel Zener barrier provides the lowest cost protection. If the 4/20mA signal is not isolated, two Zener barriers, a two channel Zener barrier or a galvanic isolator must be used. Again it is necessary to ensure that the voltage capabilities of the 4/20mA signal is sufficient to drive the indicator plus the voltage drop introduced by the intrinsically safe interface.

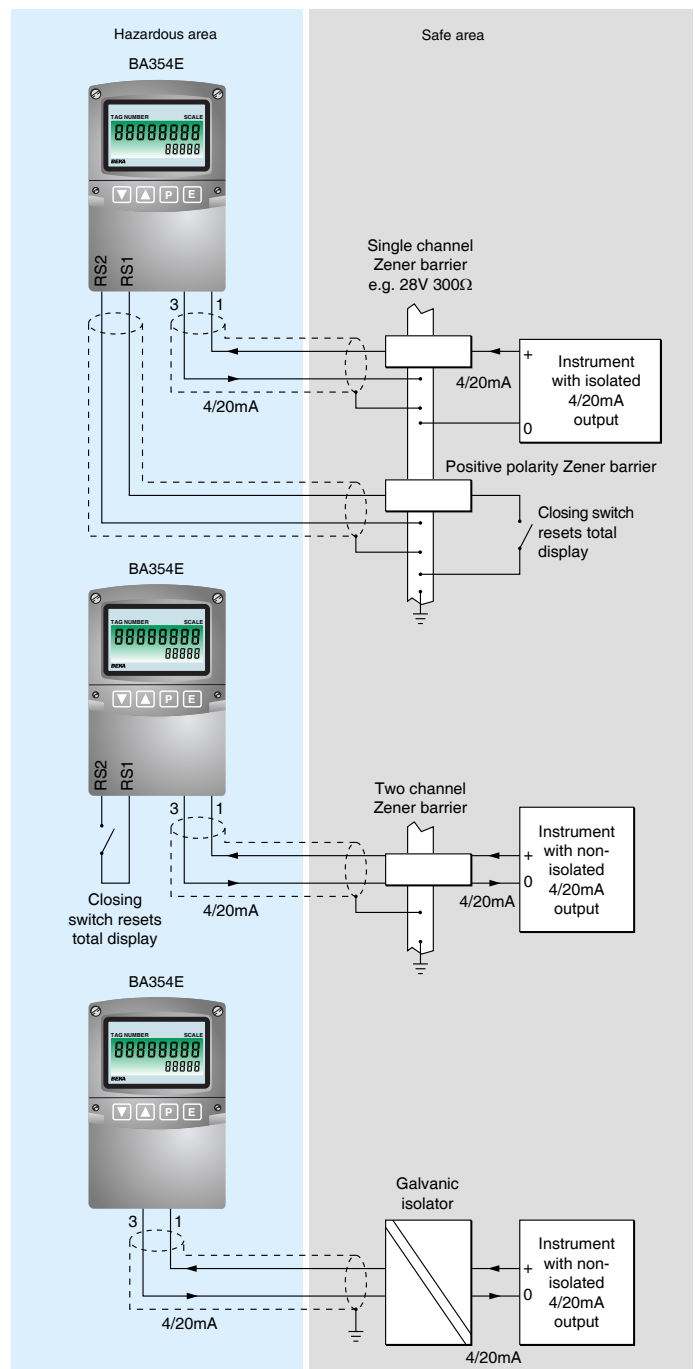


Fig 5 Alternative circuits for remote totalisation in hazardous area

7. Accessories

7.1 Display backlighting

All Rate Totaliser models can be supplied with an optional factory fitted display backlight that has three terminals allowing it to be loop, or separately powered.

When loop powered the backlight produces green background illumination allowing the instrument display to be read at night and in poor lighting conditions. Loop powering does not require an additional power supply, or field wiring, but the maximum voltage drop in the 4/20mA loop caused by the Rate Totaliser is increased from 1.2 to 5.0V. Backlight brilliance is constant between 6 and 20mA but slightly diminishes below 6mA.

When separately powered the backlight produces a brighter green background illumination which enhances daylight viewing of the indicator display.

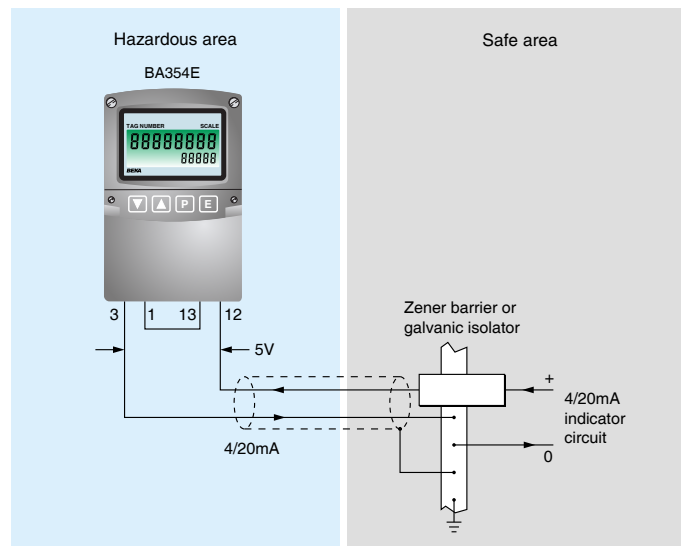


Fig 6 Loop powering the display backlight

7.1.1 Loop powering the display backlight

To power the display backlight from the 4/20mA loop, backlight terminals 12 & 13 should be connected in series with the 4/20mA Rate Totaliser input terminals 1 and 3 as shown in Fig 6. Both the ATEX and IECEx certificates confirm that the intrinsically safe Rate Totalisers input terminals still comply with the requirements of *simple apparatus* when the backlight is powered from the 4/20mA loop. The input intrinsic safety parameters of the combined Rate Totaliser and loop powered backlight are the same as those for the indicator alone. The indicator and loop powered backlight may therefore be connected in series with any certified intrinsically safe circuit providing the output parameters of the circuit do not exceed:

$$\begin{aligned} U_o &= 30V \text{ dc} \\ I_o &= 200mA \\ P_o &= 0.84W \end{aligned}$$

The maximum equivalent capacitance and inductance between input terminals 3 and 12 is:

$$\begin{aligned} C_i &= 13nF \\ L_i &= 0.02mH \end{aligned}$$

To determine the maximum permissible cable parameters of the loop these figures, plus C_i and L_i for any other instrument in the loop, should be subtracted from the specified C_o and L_o for the Zener barrier, galvanic isolator or associated apparatus powering the loop.

The loop powered backlight increases the maximum voltage drop of the Rate Totaliser to 5V.

7.1.2 Separately powering the display backlight

The backlight is segregated from all other circuits within the Rate Totaliser and may be separately powered via terminals 12 and 14 from an 11 to 30V dc supply. Any intrinsically safe power supply such as a certified Zener barrier or galvanic isolator may be used to power the BA354E and BA358E backlight providing the output parameters are equal to or less than:

$$\begin{aligned} U_o &\leq 30V \text{ dc} \\ I_o &\leq 200mA \\ P_o &\leq 0.84W \end{aligned}$$

The ATEX and IECEx certificates specify that the maximum equivalent capacitance and inductance between the backlight terminals is:

$$\begin{aligned} C_i &= 13nF \\ L_i &= 0.01mH \end{aligned}$$

To determine the maximum permissible cable parameters these figures should be subtracted from the specified C_o and L_o for the Zener barrier or galvanic isolator powering the backlight.

When separately powered as shown in Fig 7 with a supply voltage above 11V the backlight consumes a constant 35mA. With a supply less than 11V the backlight will continue to function but the brilliance will be reduced. Varying the supply voltage allows the backlight brilliance to be adjusted which is useful when an operators night vision has to be preserved.

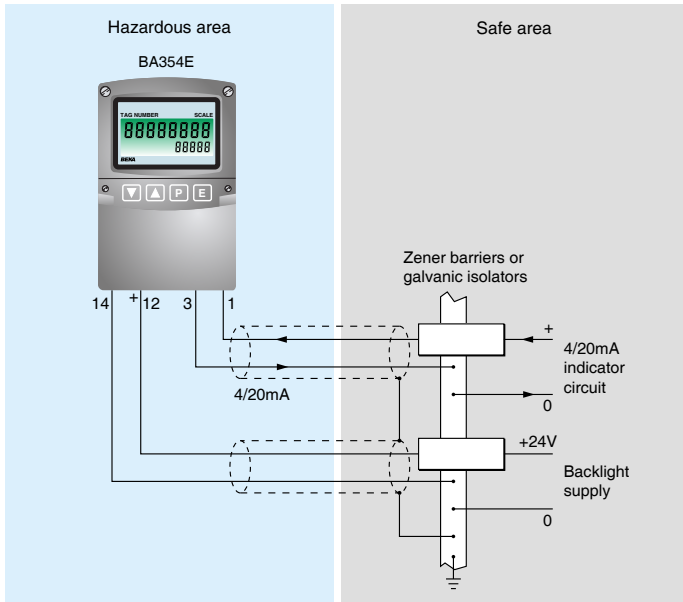


Fig 7 Separately powering the display backlight

7.2 Alarm outputs

All Rate Totalisers can be supplied with factory fitted galvanically isolated dual single pole solid state alarm outputs. Each alarm may be independently configured as a low or a high, flow rate or total flow alarm with a normally open or a normally closed solid state contact. Fig 8 illustrates the conditions available, and shows which are fail safe. i.e. output is in alarm condition ('contact' open) when the 4/20mA input current is zero.

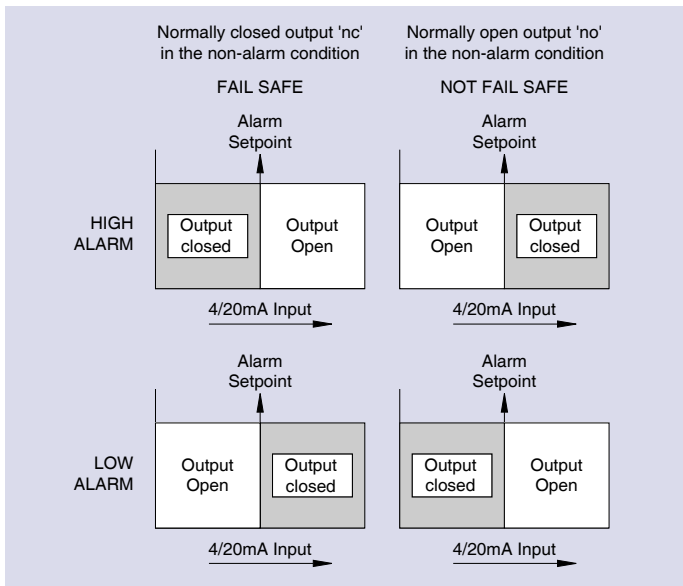


Fig 8 Fail safe conditions

These alarms are not suitable for critical safety applications such as emergency shut down systems.

Each alarm output on the intrinsically safe instrument is an isolated single pole solid state voltage free contact which complies with the requirements for *simple apparatus*. This allows each alarm output to switch any intrinsically safe dc circuit protected by a Zener barrier or galvanic isolator with output parameters equal to or less than:

U_o	\leq	30V dc
I_o	\leq	200mA
P_o	\leq	0.84W

The EC-Type Examination certificate specifies the maximum equivalent capacitance and inductance between the terminals of each alarm output:

C_i	$=$	24nF
L_i	$=$	0.01mH

To determine the allowable cable parameters, these figures must be subtracted from the maximum cable capacitance and inductance permitted by the certificate for the circuit being switched.

The alarm output may also be used to switch safe area loads via a Zener barrier or a galvanic isolator. Almost any switch transfer galvanic isolator or Zener barrier may be used, providing output safety parameters are less than 30V, 200mA and 0.84W.

Fig 9 shows a BA358E panel mounting Rate Totaliser displaying the rate of flow measured by a loop powered flow transmitter and calculating the total flow. Alarm one has been configured as a low flow rate alarm. If the flow rate drops below the alarm setpoint the hazardous area sounder is activated. The second alarm has been configured as a high total flow alarm. When total flow exceeds the total alarm set point the pump in the safe area is stopped.

Resetting of the total display is accomplished from the safe area via a certified intrinsically safe relay.

When an alarm output is used to activate an annunciator such as the sounder in this application, the Rate Totaliser push button may be configured to operate as an alarm 'accept' button. This allows the operator to silence the alarm for a pre-programmed time. If the alarm condition still exists at the end of the silence time, the alarm is reactivated.

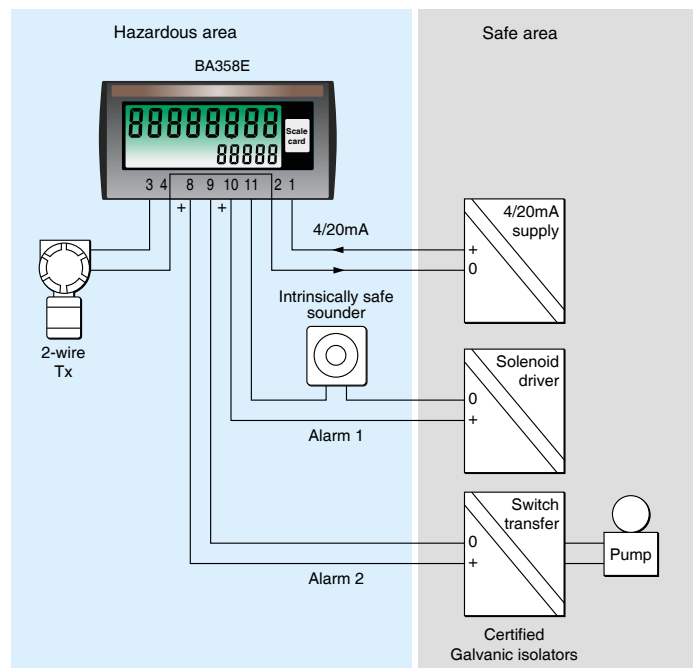


Fig 9 Application of Rate Totaliser alarm outputs

7.3 Accessories for field mounting models

The field mounting Rate Totalisers have a rugged IP66 GRP surface mounting enclosure with a separate terminal compartment. Two pipe mounting kits are available which enable the BA354E to be mounted on a horizontal or vertical pipe:

BA392D Stainless steel bracket supported by two stainless steel hose clips.

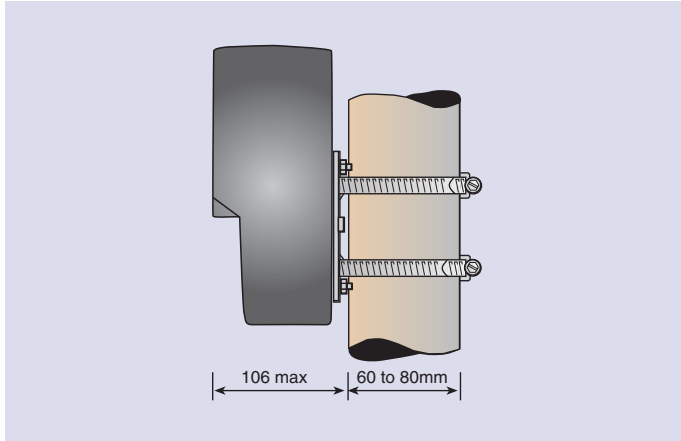


Fig 10 BA392D Pipe mounting kit

BA393 Heavy duty 316 stainless steel bracket supported by a 316 stainless steel 'V' bolt.

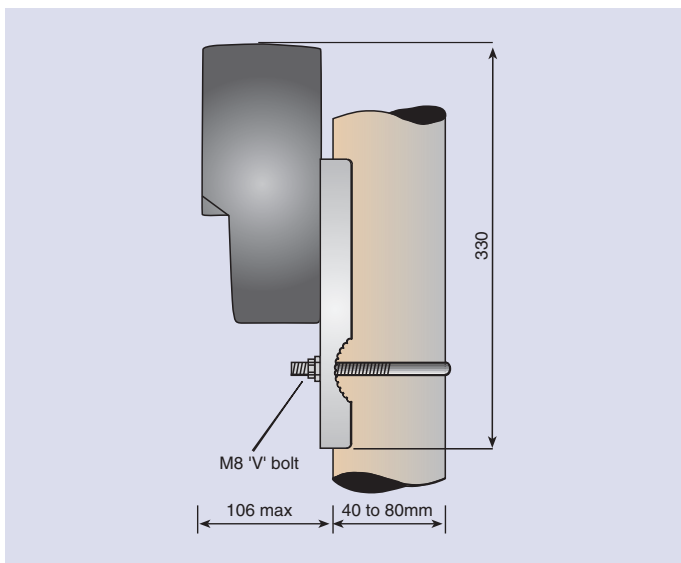


Fig 11 BA393 Pipe mounting kit

The Rate Totaliser is supplied with an internal blank escutcheon around the display. If specified at time of purchasing, this can be printed with the customer's specified scale and tag information for no additional charge.

An external stainless steel legend plate, laser engraved with customer specified scale and tag information is available as a factory fitted accessory.

7.4 Accessories for panel mounting models

Panel mounting Rate Totalisers are supplied with a blank slide-in scale card which can be seen through a window at the right hand end of the display, see page 1. If specified at time of purchasing, this can be marked with customer specified scale and tag information for no additional charge. The scale card can easily be changed on-site without removing the instrument from the panel, or opening the instrument's enclosure.

8. Configuration example

This section contains a loop powered 4/20mA Rate Totaliser configuration example. Step-by-step instructions are not included as they are fully explained in the instruction manual for each model. Configuration and calibration of all models is the same and easy to perform on-site without test equipment.

The rate of flow display can be calibrated using the internal 4 and 20mA references which are adequate for most industrial flow applications and described below. The configuration menu also contains CAL functions allowing an external 4/20mA calibrator to be used

In this example a BA354E field mounting Rate Totaliser is connected to a flowmeter having a linear output of 20mA at a flow rate of 1100 litres per minute. The BA354E is required to display flow in litres per minute with a resolution of 1 litre and total flow in cubic metres with a resolution of 0.1 cubic metres. The total flow is to be shown on the upper large 8 digit display and the rate of flow on the lower 5 digit display.

Totalisation is to occur for flow rates between 1 and 100% of maximum flow. The configuration menu is to be protected by a security code of 1112. In the operating mode when the instrument is totalising, the BA354E is required to display the input current as a percentage of span when the **[P]** push button is operated. Local resetting of the total flow display and the grand total flow counter are not required.

Summary

Input	4/20mA linear
Flow rate display	0 to 1100 litres / minute
Total flow display	cubic metres with resolution of 0.1
Clip-off	1% of flow rate 11.0 litres / minute

Rate Totaliser Configuration

Instrument function

Func 5td

The 4/20mA input current represents a linear flow rate

Flow rate display resolution

rESn 1

Required resolution of rate display is 1

Function of upper 8 digit display

d, SP-1 t0tRL

Upper 8 digit display to show total flow

Position of display decimal points

dP (total display) 0000000.0

(rate display) 00000

Defines position of decimal point on each display

Calibrate flow rate display

SEt 2Er0 00000

SPRn 01100

Calibrates rate display at 4 and 20mA using the internal reference.

Select flow rate display timebase

t-bR5E t0-60

Sets flow rate display timebase to minutes

Function of **[P]** push button in operating mode

[--P PC

Configures the **[P]** push button to change instrument display to show input current as a % of span.

Enter totaliser scale factor

SCALE-t 01000

The flow rate display is in litres per minute but the total flow display is required in cubic metres.

$$\text{SCALE-t} = \frac{\text{Units of rate display}}{\text{Units of total display}}$$

There are 1,000 litres in a cubic metre thus:

$$= \frac{\text{litres}}{\text{cubic metres}}$$

$$= \frac{1 \text{ litre}}{1/(1000) \text{ litres}}$$

$$\text{SCALE-t} = 1000$$

Enter clip-off threshold

[L, P-off 00011

Sets flow rate threshold at 1% below which totalisation is inhibited.

Local reset

L0Cr5Et t-rE5Et oFF

0t-r5Et oFF

In this example the total flow display and the grand total flow display are not to be resettable to zero via the instruments front panel push buttons.

Enter configuration menu access code

[odE 1112

Sets customer specified four digit configuration menu access code.

